Navigating the digitalization of individuals as employees, customers, and themselves

DISSERTATION

to obtain the doctoral degree of Economic Sciences (Dr. oec.)

Faculty of Business, Economics and Social Sciences

University of Hohenheim

Institute of Marketing & Management

submitted by

Niclas Nüske (M.Sc.)

from Rosenheim

2022

Date of disputation: March 22, 2022

Supervisor and first reviewer:	Prof. Dr. Henner Gimpel
Second reviewer:	Prof. Dr. Nils Urbach
Exam chairperson:	Prof. Dr. Karsten Hadwich
Dean of faculty:	Prof. Dr. Karsten Hadwich

Abstract

Digitalization has long since entered and transformed our professional lives, our interaction with companies, and our private lives. Many people can no longer imagine working without the help of digital technologies. Customers order products online and enjoy services provided by companies using the internet, smartphones, or voice assistants. In the context of sports, health, or learning in the private domain, digital technologies represent ubiquitous companions and facilitators. With the progress in digitalization in general and of individuals in particular, both opportunities and challenges arise. Digitalization represents a double-edged sword, with its vast potential on the one end and a number of risks and detrimental effects for individuals, such as technostress, on the other. Individuals need to navigate the opportunities provided by digitalization, as well as its risks, in all areas of their lives.

Addressing digitalization in a way that is in the best interest of individuals requires a thorough understanding of developments, challenges, and possible interventions and solutions. Matt et al. (2019)[1] propose a framework for studying the digitalization of individuals, which represents a holistic approach to structure, classify, and position research along different roles of individuals from a comprehensive set of research angles. By applying this framework as a guiding structure, this dissertation aims to advance knowledge for an improved, safer, and more deliberate navigation of digitalization for individuals in their roles as employees, customers, and themselves from the research angles design, behavior, and consequences. While building on and integrating qualitative research methods such as literature analysis and expert interviews, this dissertation mainly relies on the collection of empirical data and their quantitative analysis. This comprises several small- and large-scale surveys and field experiments, as well as analytical methods such as structural equation modeling, regression analysis, and cluster analysis.

Chapter 2 of this dissertation discusses the digitalization of individuals in their role as employees. Chapter 2.1 covers workplace design in terms of equipment with digital workplace technologies (DWTs) and the user behavior of employees. It determines which DWTs exist and are used by individual employees in a comprehensive and structured fashion. Contributing to a deeper understanding of workplace digitalization, chapter 2.1 also demonstrates and elaborates how this overview of DWTs represents a basis for individualized digital work design

[1] Matt, C., Trenz, M., Cheung, C. M. K., & Turel, O. (2019). The digitization of the individual: Conceptual foundations and opportunities for research. *Electronic Markets, 29*(3), 315–322.

as well as adequate interventions. Chapter 2.2 deals with the consequences of DWT user behavior. It focuses on the relationship between workplace digitalization, the negative consequence technostress, and possible countermeasures termed “technostress inhibitors.” By enabling a more detailed understanding of the underlying mechanisms as well as evaluating the effects of countermeasures, chapter 2.2 discusses the overall finding that workplace digitalization increases technostress. The dynamics of its different components and technostress inhibitors, however, require individual consideration at a more detailed level, as the interrelationships are not consistently intuitive.

In chapter 3, the focus changes to individuals in their role as customers. As a response to increasing data collection by companies as well as increasing data privacy concerns of customers, chapter 3.1 focuses on the identification of a comprehensive list of data privacy measures that address these concerns. Furthermore, it is identified that the implementation of some of these measures would lead to increased customer satisfaction, demonstrating that there is an upside to data privacy for companies and that mutually beneficial outcomes for both involved parties are conceivable. Chapter 3.2 analyzes whether and how digital nudging can be applied to influence customers’ online shopping behavior towards the selection of more environmentally sustainable products in online supermarkets and how this influence differs with respect to individual customer characteristics. It determines the digital nudging element “default rules” to be generally effective and “simplification” to be effective among environmentally conscious customers. On a macro level, the findings contribute to a safer environment in which individuals live their lives, while at the individual level, they foster decision-making quality and health.

Chapter 4 highlights the digitalization of individuals themselves. Chapter 4.1 deals with the design of a habit-tracking app that offers users autonomy in their goal-directed behavior. It is found that the provision of autonomy enhances well-being. Its exercise improves performance, which in turn positively affects well-being. Chapter 4.1 thus contributes insights into how digital technologies can foster the flourishing of individual users.

As a summary, this dissertation aims to provide research and practice with contributions to a deeper understanding of how individuals as employees, customers, and themselves can successfully navigate digitalization. It provides insights into how the digitalization of individuals manifests itself. It examines the selection of detrimental effects that need to be considered and dealt with. Finally, it deals with mechanisms that mitigate these detrimental effects as well as opportunities to exploit the benefits of digitalization to advance individual flourishing.

Zusammenfassung

Die Digitalisierung und durch sie verursachte Veränderungen haben längst in unserem Berufsleben, unserer Interaktion mit Unternehmen und unserem Privatleben Einzug erhalten. Viele Menschen können sich nicht mehr vorstellen, ohne die Unterstützung digitaler Technologien zu arbeiten. Über das Internet, Smartphones oder Sprachassistenten bestellen Kund:innen online Produkte und nehmen Dienstleistungen von Unternehmen in Anspruch. Und auch in Bereichen wie Sport, Gesundheit oder Lernen im privaten Kontext sind digitale Technologien allgegenwärtige Begleiter und Helfer. Mit der fortschreitenden Digitalisierung im Allgemeinen und der fortschreitenden Digitalisierung von Individuen im Speziellen ergeben sich sowohl Chancen als auch Herausforderungen. Die Digitalisierung stellt ein zweischneidiges Schwert dar. Den enormen Potenzialen stehen eine Reihe von Risiken und negativen Auswirkungen für Individuen wie z.B. Technostress gegenüber. Individuen müssen sich in allen Lebensbereichen in einem Spannungsfeld der Digitalisierung zurechtfinden, welches am einen Ende vielfältige Chancen für Weiterentwicklung und Selbstverwirklichung bereithält, aber am anderen Ende auch zahlreiche Fallstricke und Risiken birgt.

Mit der Digitalisierung auf eine Art und Weise umzugehen, die im besten Interesse von Individuen liegt, erfordert ein gründliches Verständnis der Entwicklungen und Herausforderungen sowie möglicher Interventionen und Lösungen. Matt et al. (2019)[2] schlagen ein Framework für die Untersuchung der Digitalisierung von Individuen vor, das einen ganzheitlichen Ansatz zur Strukturierung, Klassifizierung und Positionierung von Forschung entlang verschiedener Rollen von Individuen und unterschiedlicher Forschungsperspektiven darstellt. Unter Anwendung dieses Frameworks als Leitstruktur zielt diese Dissertation darauf ab, aus den Forschungsperspektiven Design, Verhalten und Konsequenzen Wissen zu schaffen und zu erweitern, wie Individuen in ihren Rollen als Arbeitnehmer:innen, Kund:innen und im privaten Kontext die Digitalisierung besser, sicherer und bewusster meistern können. Aufbauend auf und unter Einbeziehung von qualitativen Forschungsmethoden wie Literaturanalyse und Experteninterviews stützt sich diese Dissertation vor allem auf die Erhebung empirischer Daten und deren quantitative Auswertung. Dies umfasst mehrere kleiner und größer angelegte Umfragen und Feldexperimente sowie analytische Methoden wie Strukturgleichungsmodelle, Regressions- und Clusteranalysen.

[2] Matt, C., Trenz, M., Cheung, C. M. K., & Turel, O. (2019). The digitization of the individual: Conceptual foundations and opportunities for research. *Electronic Markets, 29*(3), 315–322.

Kapitel 2 der Dissertation befasst sich mit der Digitalisierung von Individuen in ihrer Rolle als Arbeitnehmer:innen. Kapitel 2.1 beschäftigt sich mit der Gestaltung von Arbeitsplätzen hinsichtlich der Ausstattung mit digitalen Technologien und des Verhaltens von Arbeitnehmer:innen bei deren Nutzung. Es wird umfassend und strukturiert ermittelt, welche digitalen Technologien vorhanden sind und von individuellen Arbeitnehmer:innen genutzt werden. Zum einen trägt dies zu einem vertieften Verständnis der Digitalisierung von Arbeitsplätzen bei. Zum anderen arbeitet Kapitel 2.1 heraus, inwiefern dieser Überblick der digitalen Technologien eine Grundlage für die individualisierte Gestaltung digitaler Arbeit sowie für adäquate Interventionen darstellt. Kapitel 2.2 beschäftigt sich mit den Konsequenzen des Nutzungsverhaltens dieser digitalen Technologien. Im Mittelpunkt steht dabei der Zusammenhang zwischen der Digitalisierung von Arbeitsplätzen, der negativen Konsequenz Technostress und möglichen Gegenmaßnahmen, den sogenannten Technostress-Inhibitoren. Kapitel 2.2 ermöglicht ein detaillierteres Verständnis der zugrunde liegenden Mechanismen und bewertet die Wirksamkeit von Gegenmaßnahmen. Es kommt zu dem Ergebnis, dass die Digitalisierung von Arbeitsplätzen zwar im Allgemeinen Technostress erhöht. Dabei muss die Dynamik zwischen den verschiedenen Komponenten von Technostress und den Technostress-Inhibitoren jedoch differenziert und auf einem detaillierteren Level betrachtet werden, da die Beziehungen nicht konsistent und nicht intuitiv ausfallen.

In Kapitel 3 liegt der Fokus auf Individuen in ihrer Rolle als Kund:innen. Als Reaktion auf zunehmende Datenerfassung seitens Unternehmen und wachsende Datenschutzbedenken seitens Kund:innen konzentriert sich Kapitel 3.1 auf die Identifizierung einer umfassenden Liste von Datenschutzmaßnahmen, die diese Bedenken adressieren. Darüber hinaus wird festgestellt, dass die Umsetzung einiger dieser Maßnahmen zu einer höheren Kundenzufriedenheit führen würde. Dies zeigt, dass Datenschutz auch Vorteile für Unternehmen mit sich bringen kann und dass Lösungen denkbar sind, die sowohl für Kund:innen als auch Unternehmen positiv ausfallen. In Kapitel 3.2 wird analysiert, ob und wie digitales Nudging eingesetzt werden kann, um das Online-Einkaufsverhalten von Kund:innen in Richtung der Auswahl umweltfreundlicherer nachhaltiger Produkte in Online-Supermärkten zu beeinflussen und wie sich dieser Einfluss in Bezug auf einzelne Kundenmerkmale unterscheidet. Es wird festgestellt, dass das digitale Nudging-Element „Default Rules“ übergreifend und „Simplification“ bei umweltbewussten Kund:innen wirksam sind. Auf der Makroebene tragen die Ergebnisse zu einem nachhaltigeren und sichereren Lebensumfeld von Individuen bei, während sie auf der individuellen Ebene Entscheidungsqualität und Gesundheit fördern.

Kapitel 4 beleuchtet die Digitalisierung von Individuen im privaten Kontext. Kapitel 4.1 befasst sich mit der Entwicklung einer App zum Festhalten und zur Verfolgung von Gewohnheiten, die ihren Nutzer:innen Autonomie in Bezug auf ihr zielgerichtetes Verhalten bietet. Es wird festgestellt, dass die Bereitstellung von Autonomie das Wohlbefinden der Nutzer:innen steigert. Die Ausübung von Autonomie verbessert die Leistung bei der Zielerreichung, was sich wiederum positiv auf das Wohlbefinden auswirkt. Kapitel 4.1 trägt somit Erkenntnisse bei, wie digitale Technologien die Selbstverwirklichung individueller Nutzer:innen fördern können.

Zusammenfassend stellt diese Dissertation für Forschung und Praxis Beiträge bereit, die zu einem tieferen Verständnis eines erfolgreichen Umgangs von Individuen als Arbeitnehmer:innen, Kund:innen und Individuen im privaten Kontext mit der Digitalisierung führen sollen. Sie gibt Einblicke, wie sich die Digitalisierung von Individuen manifestiert. Sie untersucht eine Auswahl von negativen Auswirkungen, die es zu berücksichtigen und zu bewältigen gilt. Zu guter Letzt untersucht sie Mechanismen, die diese nachteiligen Auswirkungen abmildern, sowie Möglichkeiten, die Vorteile der Digitalisierung zu nutzen, um individuelle Selbstverwirklichung zu fördern.

Content overview

Table of contents

List of figures

List of tables

1. Introduction

1.1. Motivation[3]

Ubiquitous digitalization in the professional and private lives of individuals

Digitalization has long since entered and transformed our professional lives as employees, our interaction with companies as customers, and our private lives as individuals (Legner et al., 2017; Matt et al., 2019). Most people cannot imagine working without the help of digital technologies and, for many, work without digital support would no longer be possible. Using the internet, smartphones, or voice assistants, customers order products online and enjoy a multitude of services provided by companies that capitalize on the digital transformation of their business or completely new business models. In addition, in the context of sports, health, or learning in the private domain, digital technologies represent ubiquitous companions and facilitators on our desks, in our pockets, or on our wrists. Matt et al. (2019, p. 315) eloquently summarize the illustrated developments: they define the digitalization of individuals as "the proliferation of digital technologies in the lives of individual users."

Originally, research on information systems (IS) addressed digital technologies in business environments and organizational contexts (Legner et al., 2017; Österle, 2020). As apparent, for example, in numerous studies on digital transformation, companies implement and apply digital technologies such as social, mobile, analytics, cloud, and Internet-of-Things technologies (SMACIT) to strive for positive impacts such as operational efficiency, organizational performance, and industry and society improvements (Vial, 2019) as well as driving forward digital product and service innovations (e.g., Wiesböck & Hess, 2020). First, this deep and ubiquitous permeation of companies with digital technologies has consequences for individuals in their roles inside of companies. Digital technologies are integral to almost all workplaces today (Richter et al., 2018; Schmid & Dowling, 2020). *Employees* are surrounded by digital technologies in their daily work, and a professional life without digital technologies is hardly conceivable.

Second, digitalization can be observed in individuals' interactions with companies. Digitalization opens up possibilities for new business models and interaction modes with *customers* (Dreyer et al., 2019; Legner et al., 2017; Matt et al., 2019). Customers profit from new forms

[3] Since it is in the nature of a cumulative dissertation that it consists of individual research papers, this chapter (Introduction) as well as the last chapter (General discussion and conclusion) partly comprise content taken from the research papers included in this dissertation. To improve the readability of the text, I omit the standard labeling of these citations.

of being integrated into the value creation process, new channels, and increasing automation, leading to faster, less effortful, and more customer-centric service experiences and purchases (Dreyer et al., 2019; Matt et al., 2019). Thereby, the digitally facilitated collection of customer data, the ability to draw the correct conclusions from it, and the way companies handle customer data are increasingly important in terms of competitive advantages as well as to successfully introduce new business models (Akter & Wamba, 2016; Morey et al., 2015; Saarijärvi et al., 2014; Wieneke & Lehrer, 2016). The largest portion of customer data is likely to stem from the digital interactions between companies and customers, especially in e-commerce (see, e.g., Akter & Wamba, 2016).

Third, digitalization and research on digitalization are no longer limited to the professional lives of individuals or their interaction with companies as customers. Digitalization is also present in almost all aspects of the private lives of *individuals themselves* (Legner et al., 2017; Matt et al., 2019) to the extent that, in the *Business* and Information Systems Engineering (BISE) research community, there are discussions about a new successor discipline termed *Life* Engineering, which centers on individual users and takes a holistic perspective on how the application of digital technologies can support individuals in living their lives (Alt et al., 2021; Österle, 2020). Other research areas, such as the field of self-tracking or the quantified self (e.g., De Moya & Pallud, 2020; Lupton, 2014), deal with increasingly digitalized private contexts and emphasize the apparent infusion of our private lives with digital technologies.

Digitalization of individuals as boon and bane at the same time

With the progress of digitalization in general and of individuals in particular, both opportunities and challenges arise. Digitalization represents a double-edged sword, with its vast potential on the one end and a number of risks and detrimental effects for individuals such as technostress, addiction, and cybercrime (Gimpel & Schmied, 2019; Pirkkalainen & Salo, 2014) on the other. This is observable in all the above-mentioned areas of the digitalization of individuals: individuals as employees in their professional lives, individuals as customers interacting with companies, and individuals themselves in their private lives. This dissertation aims to advance knowledge and understanding for improved, safer, and more deliberate navigation of the digitalization of individuals in these areas.

1.2. Navigating the digitalization of individuals as employees, customers, and themselves

Three roles of individuals with two sides of digitalization to each of them

Regarding individuals acting as employees within companies, digital transformation – "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" (Vial, 2019, p. 118)) – and the use of digital technologies in the workplace lead to positive outcomes such as improved efficiency (e.g., business process improvements, cost savings), improved organizational performance (e.g., in terms of growth or competitive advantage), and even higher-level positive impacts at the industry and society level (e.g., benefits of digital technologies in the healthcare sector) (Vial, 2019). This can be expected to have both immediate (e.g., performing a task more efficiently by using digital technologies) as well as indirect, far-reaching effects (e.g., employment security and salary owing to improved company performance) for employees. However, the proliferation of digital technologies at workplaces has adverse effects, which are pronouncedly notable in the novel phenomenon of technostress, defined as "stress that individuals experience due to their use of Information Systems" (Tarafdar et al., 2019, p. 7). Technostress results from employees' experience of technostress creators, such as techno-complexity (i.e., feelings of inadequacy owing to the lack of understanding and pressure to invest time and effort to address this inadequacy) and techno-unreliability (i.e., undependable features and capabilities of digital technologies) (Ayyagari et al., 2011; Ragu-Nathan et al., 2008) It is associated with a number of psychological and even physiological detrimental impacts, such as reduced job satisfaction or back pain and headaches (see, e.g., Gimpel et al., 2018; Ragu-Nathan et al., 2008).

In their roles as *customers*, individuals face mixed blessings of digitalization as well. On the one hand, they reap the benefits of digitally enabled business models and associated new products and services (e.g., Dreyer et al., 2019; Legner et al., 2017). Digital technologies enable faster, more efficient, and more convenient purchases and service experiences, for example, reflected in the growing e-commerce sector with a multitude of channels and fast delivery to the doorstep, or the rising spread of reliable chatbots or robo advisors in service interactions. E-commerce, thereby, is defined as "the process of buying and selling products or services using electronic data transmission via the Internet" (Grandon & Pearson, 2004, p. 197). Global e-commerce sales are growing at remarkable rates, especially against the backdrop of the

COVID-19 pandemic (United Nations UNCTAD, 2021). On the other hand, these improvements in products and services often come at the price of a pronounced need for customer data and challenges regarding the proper handling of customer data, resulting in increased customer privacy concerns (Karwatzki et al., 2017). Fittingly, Vial (2019) identifies security and privacy as the primary domains where digital transformation leads to challenges and impacts. Furthermore, more consumption, as observable in growing e-commerce sales, however beneficial for companies and their customers, is not necessarily desirable from a macro perspective. For example, the food sector significantly contributes to environmental deterioration (Noleppa, 2012). This, in turn, could have severe effects on the lives of individuals.

Regarding the private lives of individuals themselves, digital technologies support individuals in improving their lives in various areas. An entire field of research exists around positive technologies, "the scientific and applied approach to the use of technology for improving the quality of our personal experience," on the hedonic (enjoyment), eudaimonic (self-growth), and social and interpersonal level (connectedness) (Botella et al., 2012, p. 78). Illustrated using the concrete example of self-tracking with quantified-self technologies, De Moya and Pallud (2020) find empowering effects, such as the support of self-improvement and strengthened motivation. However, they also find disempowering effects of individual self-surveillance, such as a lack of autonomy and control. In the private context, individuals' digitalization poses challenges such as cybercrime, adverse health effects such as mental illness or addiction, or distractions from other activities (Gimpel & Schmied, 2019; Pirkkalainen & Salo, 2014).

The need to better understand the digitalization of individuals

It is apparent that individuals need to navigate the opportunities and pitfalls of digitalization in all aspects of their lives. Addressing digitalization in a way that is in the best interest of individuals requires a thorough understanding of developments, challenges, and possible interventions and solutions (Matt et al., 2019). In addition to individuals, this applies to companies in their capacity as employers, companies in their capacity as designers and providers of products and services, and researchers concerned with the digitalization of individuals.

A systematic approach to studying the digitalization of individuals

Matt et al. (2019) propose a framework for studying the digitalization of individuals, representing a holistic approach to structure, classify, and position research along all aspects of their lives (roles) from a comprehensive set of perspectives (research angles). Figure 1.2-1 depicts the framework.

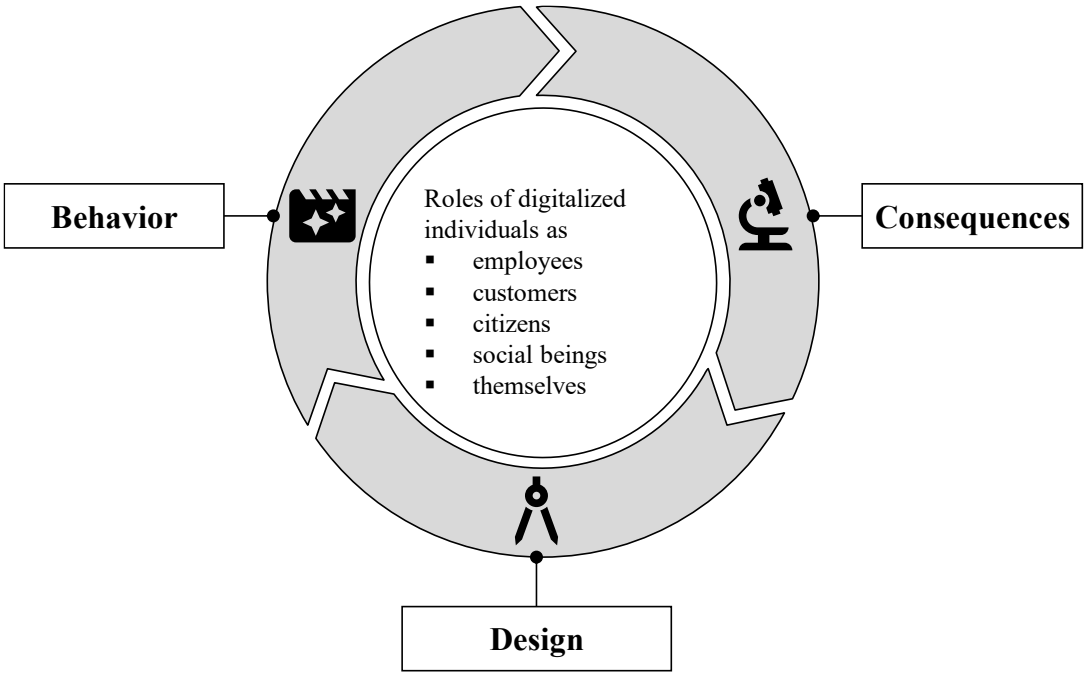


Figure 1.2-1: Framework for studying the digitalization of individuals in their different roles from different research angles based on Matt et al. (2019)

The research angles represent major perspectives of interest that research endeavors consider. They thereby are not isolated but are dependent on each other, with results from one angle informing and drawing on that from the other angles (Matt et al., 2019). Table 1.2-1 presents an overview of the respective foci and examples of topics of interest for research.

Research angle	Focus	Exemplary topics of study
Design	▪ Design of digital technologies for digitalized individuals ▪ Facilitation of the digitalization of individuals	▪ Support for optimal design of interfaces ▪ Expectation-adequate service design ▪ Tools for the management of IS use's influences
Behavior	▪ Drivers and ways of behavior of digitalized individuals ▪ Influences on these behaviors	▪ Use of digital technologies ▪ Purchasing behavior ▪ Work performance
Consequences	▪ Potential positive or negative consequences for digitalized individuals ▪ Boundaries of these consequences depending on context	▪ Autonomy of individuals ▪ Technostress ▪ Customer satisfaction

Table 1.2-1: Research angles for studying the digitalization of individuals based on Matt et al. (2019)

All of the presented research angles can be applied to study the digitalization of individuals across five different spheres in which they act in their roles as employees, customers, citizens, social beings, and themselves. Table 1.2-2 describes the five different roles and examples of potential research areas. This dissertation focuses on the three roles of individuals as employees, customers, and themselves.

Role	Focus	Exemplary topics of study
Individuals as *employees*	Interaction of digitalized individuals with *employers*	▪ Understanding and leveraging the use and outcomes of private digital technologies at the workplace (bring your own device policies) ▪ Measuring and managing the level of digitalization at workplaces
Individuals as *customers*	Interaction of digitalized individuals with *companies* to acquire and use their *products and services*	▪ New forms of interacting with digitalized individuals and integrating them into the value creation process ▪ Implications of digital technologies for purchasing behavior and customer preferences
Individuals as *citizens*	Interaction of digitalized individuals with *society*	▪ Implications of the digitalization of individuals for social culture and processes ▪ Facilitating fair and beneficial use of and access to digital technologies
Individuals as *social beings*	Interaction of digitalized individuals with their *social environment*	▪ Overcoming physical distances between individuals using digital technologies ▪ Understanding and designing for social inclusion through digital technologies
Individuals *themselves*	*Engagement* of digitalized individuals *with private digital technologies*	▪ Adoption and use of digital technologies in the private context ▪ Balancing positive and negative outcomes of using digital technologies in the private context

Table 1.2-2: Roles of digitalized individuals based on Matt et al. (2019)

The presented framework constitutes a starting point for approaching the overarching goal of a "deeper, contextualized understanding of how digital technologies shape individuals' behaviors and interactions, and what consequences such developments entail for individuals, organizations, and society" (Matt et al., 2019, p. 315) in an ordered and deliberate fashion. Therefore, this dissertation applies the framework as a guiding structure. The following section describes the overall goal of this dissertation and how the included research articles address the three focalized roles.

1.3. Aim and outline of this dissertation

This dissertation aims to contribute to mitigating the apparent contradictions of the digitalization of individuals as boon as well as bane, which are presented in section 1.1. Organized based on the framework of Matt et al. (2019), the dissertation focuses on the roles of individuals as employees, customers, and themselves. Thereby, on the one hand, this dissertation aims to create a deeper understanding of selected aspects of the digitalization of individuals and on the other hand, it analyzes concrete interventions regarding the design of digital technologies and selected beneficial and detrimental consequences of their users' behavior. As presented in Figure 1.3-1, chapter 2 deals with individuals as employees, chapter 3 deals with individuals as customers, and chapter 4 highlights individuals themselves. For each role, the included research articles as a whole consider all three research angles. An introductory chapter and a chapter containing a general discussion and conclusion frame the included papers.

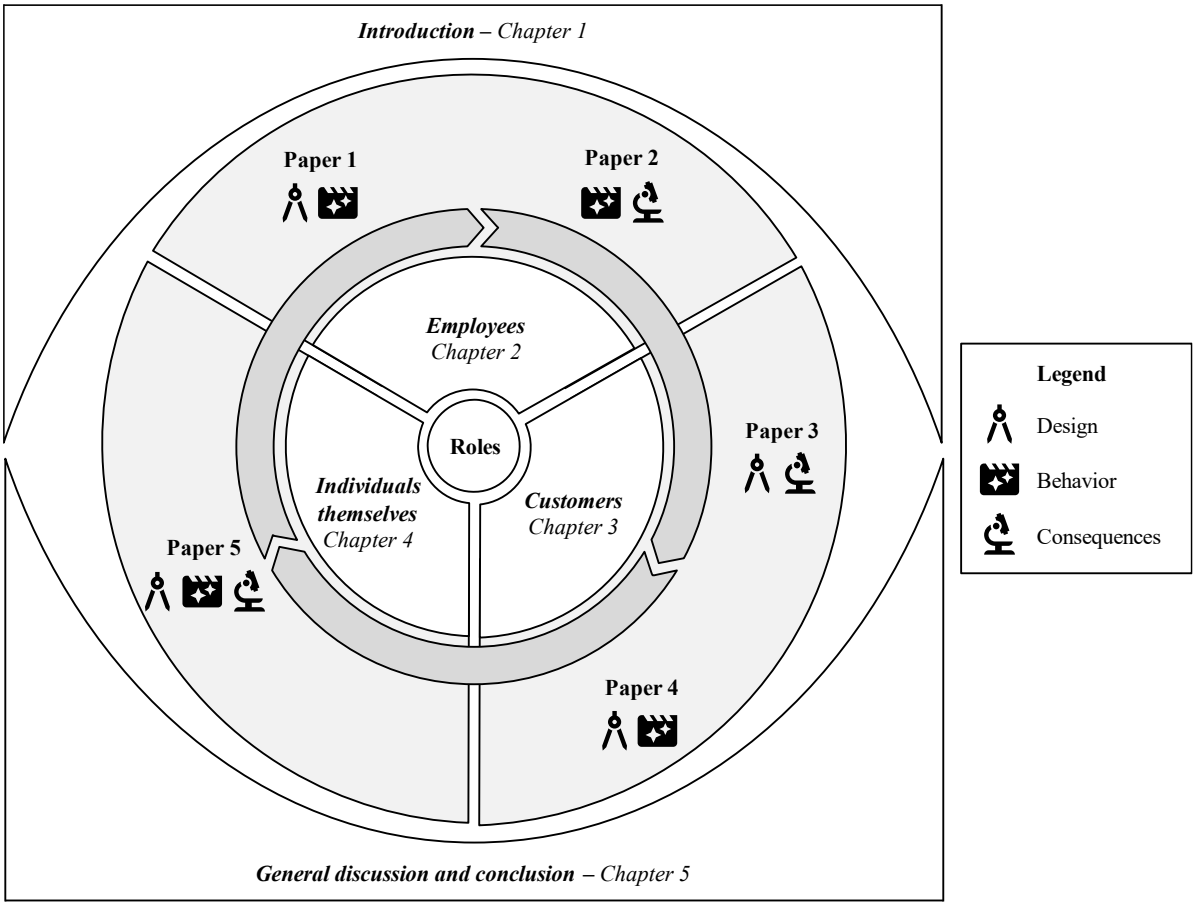


Figure 1.3-1: Structure of this dissertation, roles of digitalized individuals, and research angles in the focus of the included papers

Digitalized individuals as employees

Chapter 2 of this dissertation deals with the digitalization of individuals in their role as *employees*. It comprises two research articles that cover the *design* of workplaces with regard to equipment with digital workplace technologies (DWTs) and their users' *behavior* (paper 1), as well as the *consequences* of this user *behavior* (paper 2). Paper 1 explores which DWTs exist and are used by individual employees in the first place, contributing to a deeper understanding of workplace digitalization and creating a basis for individualized digital work design as well as adequate interventions. Paper 2 draws on these findings and focuses on the relationship between workplace digitalization and the use of DWTs, including the negative consequence technostress, enabling a more detailed understanding of the underlying mechanisms and evaluating the effects of countermeasures.

Although currently digital technologies are an integral part of nearly all workplaces (Richter et al., 2018; Schmid & Dowling, 2020), a structured overview of DWTs that is comprehensive, employee-centric, and adequately detailed for researchers and practitioners to draw conclusions and design interventions in the best interest of individual employees is missing in the

literature. However, such an overview would facilitate a necessary optimization of digital work design and work practices tailored to individuals, as opposed to generic approaches (Köffer, 2015; Richter et al., 2018). Paper 1, consequently, aims to answer the following research question:

RQ1: Which DWTs are we talking about, exactly, and can we comprehensively list the DWTs that surround employees at their workplaces?

Paper 1 sets out to compile DWTs from sources involving both literature and practice, structure them in a comprehensive overview, and elaborate on and demonstrate its possible applications. With regard to research methods, card sorting is applied to validate the overview of DWTs, and the paper comprises a large-scale online survey among German employees to gather data regarding the user behavior of these DWTs. Paper 1 takes a design perspective on the digitalization of individuals as employees such that it describes the status quo of workplace digitalization in general and provides a tool to capture it specifically by accumulating empirical data. In turn, the derived findings can provide information on workplace (re)design decisions. This paper takes a behavioral perspective such that it analyzes real-world data pertaining to the use and perception of DWTs at German workplaces.

The increasing penetration of digital technologies at workplaces has emphasized the rise of the phenomenon of technostress, to which a growing body of IS literature is dedicated (see, e.g., Tarafdar et al., 2019). Employees experience technostress creators, such as techno-complexity or techno-unreliability. If individual employees are unable or feel unable to deal with the experience of technostress creators arising from the use of digital technologies, this can lead to technostress, which in turn is associated with detrimental outcomes such as decreased job satisfaction or even physical complaints (e.g., Gimpel et al., 2018; Ragu-Nathan et al., 2008). As countermeasures or prevention, organizations can implement the technostress inhibitors literacy facilitation (i.e., "mechanisms that encourage and foster the sharing of ICT-related knowledge within the organization"), involvement facilitation (i.e., "keeping users informed about the rationale for introducing new ICTs, […] letting them know about the effects of such introduction, and […] encouraging them to use and experiment with new ICTs"), and technical support provision (i.e., "activities related to end-user support that reduce the effects of technostress by solving users' ICT problems") to help and protect their employees (Ragu-Nathan et al., 2008, p. 427). Paper 2 aims to analyze the previously underresearched effect of the degree of workplace digitalization on technostress and the moderating role of technostress inhibitors. Specifically, it asks the following research questions:

RQ2.1: How is the degree of workplace digitalization linked to technostress?

RQ2.2: How do the technostress inhibitors literacy facilitation, involvement facilitation, and technical support provision moderate the relationship of the degree of workplace digitalization and technostress?

Building on a research-in-progress version of paper 1, it applies the overview of DWTs to measure the degree of workplace digitalization. Paper 2 employs structured equation modeling as the method for data analysis and is based on the same large-scale dataset as in paper 1. Paper 2 takes a behavioral perspective in the sense that real-world data about DWT use is the basis of the independent variable degree of workplace digitalization. It highlights technostress as a possible negative consequence of the digitalization of employees.

Digitalized individuals as customers

In chapter 3, the focus changes from individuals working for companies as employees to individuals who interact with companies in their role as *customers*. Again, it includes two research articles that deal with the *design* of data privacy measures and the possible *consequences* of their implementation by companies (paper 3), as well as the *design* of interventions that influence the online-shopping *behavior* of individuals in a beneficial way (paper 4). In response to the increasing amounts of customer data that companies collect and process as well as the growing concerns of customers regarding data privacy, paper 3 focuses on the design of data privacy measures that address these concerns. Furthermore, it analyzes how customers would evaluate them as a consequence of their implementation by companies, demonstrating that a mutually beneficial outcome for both parties is possible. Paper 4 analyzes whether and how digital nudging can be applied to influence customers' online shopping behavior towards the selection of more environmentally sustainable products in online supermarkets and how this influence differs with respect to individual customer characteristics. On a macro level, the findings contribute to a safer environment in which individuals live their lives, while at the individual level, they foster decision-making quality and health.

Interactions between customers and companies increasingly take place in digital environments (e.g., online shopping) or completely depend on and are made possible by digital technologies in the first place (e.g., social media or streaming services). Therefore, the collection and handling of customer data that result from these interactions, their analysis, and the implementation of the findings in product, service, or business model (re)designs is a critical success factor for companies (Akter & Wamba, 2016; Morey et al., 2015; Saarijärvi et al., 2014; Wieneke & Lehrer, 2016). At the same time, individual data privacy concerns are increasing

(Karwatzki et al., 2017; Matt et al., 2019). These concerns are emphasized by regular data privacy breaches and scandals that receive significant coverage in the media (e.g., the scandal revolving around the covert collection, analysis, and use of Facebook user data for political purposes by Cambridge Analytica). Data privacy concerns can be structured along seven dimensions, such as concerns regarding the extensive collection of personal data per se or concerns regarding the improper access of these data by unauthorized individuals (Smith et al., 1996). Aiming at fostering the data privacy of individual customers on the one hand and seeing that data privacy breaches can have severe negative effects on companies in terms of market value on the other hand (see, e.g., Acquisti et al., 2006), paper 3 aims to address the following two research questions:

RQ3.1: Which data privacy measures can companies take?

RQ3.2: Are some of these measures perceived as attractive measures that delight customers?

Through an extensive research of scientific, practitioner, and legislative texts as well as by conducting expert interviews, paper 3 first derives a set of data privacy measures that companies can take to address the seven dimensions of concerns. Furthermore, the paper examines the effect of the hypothetical implementation of these measures by companies on customer satisfaction. Thereby, the Kano model and method (Kano et al., 1984; Matzler et al., 1996) are applied to the data privacy measures in two online surveys, covering two different industries and analyzing the data of nearly 500 participants. Paper 3 takes a design perspective regarding the identification of concrete data privacy measures. It integrates the perspective on consequences by examining the potential effects of the implementation of these measures on customer satisfaction.

Paper 4 focuses on e-commerce and interactions between customers and online grocery stores. Aside from challenges arising from data privacy concerns, the increasing worldwide consumption that is reflected in the growing e-commerce sector poses challenges at both the macro and individual levels in the context of food. Our consumption of food (and its upstream production and transportation) represents one of the biggest contributors to environmental deterioration in terms of land depletion and greenhouse gas emissions (Noleppa, 2012). The accumulated consumption behavior of humans is damaging the very basis of our existence (Schubert, 2017). At the individual level, choosing more sustainable groceries to alleviate these consequences is often challenging, as food choices are highly habitual (van't Riet et al., 2011). Additionally, shoppers are often overwhelmed with choices and information, leading

them to stick to familiar products (Mont et al., 2014) which are not necessarily the most sustainable choice. Paper 4 takes this as a starting point and explores the potential of digital nudging – "the use of user-interface design elements to guide people's behavior in digital choice environments" (Weinmann et al., 2016, p. 433) – to promote more sustainable food choices in online grocery stores. More specifically, it focuses on three digital nudging elements (DNEs) and asks the following research questions:

RQ4.1: Which of the DNEs default rules, simplification, and social norms are effective in online food shopping contexts regarding the promotion of ecologically sustainable food choices?

RQ4.2: Do the DNEs differ in their influence on different consumer groups?

Based on previous literature that mainly focused on nudging in physical environments, paper 4 first derives an exemplary digital implementation of the three DNEs. Subsequently, data on the shopping behavior of about 300 participants are accumulated in an online field experiment at a fictitious online grocery store. By applying parametric and non-parametric comparative tests as well as regression and cluster analyses, the effects of the different DNEs on environmentally sustainable choices and variations regarding individual differences are analyzed. On the one hand, paper 4 focuses on the design of DNEs. On the other hand, it observes and analyzes customer shopping behavior.

Digitalized individuals themselves

Chapter 4, which comprises one research paper, highlights the digitalization of *individuals themselves*. Paper 5 deals with the *design* of a habit-tracking app that offers its users autonomy in their behavior, the observation of this *behavior*, and the analysis of its *consequences* on performance and well-being.

In the private context, the permeation of the lives of individuals themselves with digital technologies provides unprecedented possibilities for the "datafication" of individuals. This is eloquently subsumed in the quantified-self movement, described as "any individual engaged in the self-tracking of any kind of biological, physical, behavioral, or environmental information" (Swan, 2013, p. 85). Digital technologies can harness these data to improve the lives of their users, and positive technologies aim to foster enjoyment, flourishing, and connectedness with others (Botella et al., 2012). Regarding the aspect of flourishing, Ryan and Deci's Self-determination Theory posits that optimal human functioning depends on the satisfaction of three basic universal needs: autonomy, competence, and relatedness (Ryan & Deci, 2017).

Thereby, autonomy plays a special role as autonomous behavior enables and fosters behaviors that pursue the satisfaction of the needs for competence and relatedness (Ryan & Deci, 2017). Paper 5 examines the potential of digitally provided autonomy and asks the following research question:

RQ5: What is the influence of the provision of enhanced autonomy affordance and its actualization in digital self-tracking IS on goal performance and well-being?

The research article first covers the design of a self-developed habit-tracking app that allows users to enter goals and track their progress while providing possibilities to adapt their plans regarding their goal-directed behavior (termed "autonomy affordance"). Second, the app is applied as a measurement instrument in a field study to observe the goal-directed behavior of about 50 participants and its outcomes over approximately one month on average. Finally, using path analysis, paper 5 analyzes the effects of autonomy affordance on the two consequences goal performance and well-being.

Table 1.3-1 summarizes the above explanations of the structure of this dissertation and the included research papers. It provides details regarding the current publication status, objectives, method, data, and co-authors of the research articles.

Paper # / *Chapter #*	Title of research paper / *Publication status at print date*	Objective	Method and data	Co-authors
Chapter 2: Digitalized individuals as employees				
Paper 1 *Chapter 2.1*	Digital technologies at German workplaces: What are we talking about, exactly? *Working paper*	Compile and structure an overview of digital workplace technologies, demonstrate its applicability and elaborate on its potential for further research	Compilation based on IS literature and sources from practice, validation of structuring with card sorting, demonstration of applicability in large-scale quantitative online survey	Bayer, Sarah Gimpel, Henner Lanzl, Julia
Paper 2 *Chapter 2.2*	Technostress and digitalization: Evidence from German employees *Working paper*	Establish and analyze the link between the degree of workplace digitalization and technostress as well as the moderating effect of technostress inhibitors	Quantitative large-scale online survey, structural equation modeling	Lanzl, Julia Gimpel, Henner Tarafdar, Monideepa
Chapter 3: Digitalized individuals as customers				
Paper 3 *Chapter 3.1*	The upside of data privacy – Delighting customers by implementing data privacy measures *Published in Electronic Markets, Volume 28(4), pp. 437-452 (2018)*	Derive data privacy measures for companies to address customers' data privacy concerns and analyze their relationship with customer satisfaction	Derivation based on sources from research and practice, two quantitative online surveys, Kano model	Gimpel, Henner Kleindienst, Dominikus Rau, Daniel Schmied, Fabian
Paper 4 *Chapter 3.2*	Digital nudging in online grocery stores – Towards ecologically sustainable nutrition *Published in the proceedings of the 41st International Conference on Information Systems (ICIS) in Hyderabad, India (2020)*	Analyze and compare the effect of digital nudging elements on ecologically sustainable grocery shopping behavior with respect to different customer groups	Online field experiment, comparative parametric and non-parametric tests, regression analysis, cluster analysis	Berger, Michelle Müller, Chiara
Chapter 4: Digitalized individuals themselves				
Paper 5 *Chapter 4.1*	How to conquer one's weaker self: Does autonomy affordance increase goal performance and well-being? *Published in the proceedings of the 54th Hawaii International Conference on System Sciences (HICSS) in Maui, Hawaii (2021)*	Examine the influence of autonomy affordance provided by self-tracking IS as well as its actualization on goal performance and well-being	Field experiment, path analysis	Gimpel, Henner Regal, Christian

Table 1.3-1: Overview of the research articles in this dissertation

1.4. References

Acquisti, A., Friedman, A., & Telang, R. (2006). Is there a cost to privacy breaches? An event study. In *Proceedings of the 27th International Conference on Information Systems (ICIS)*, Milwaukee, United States of America.

Akter, S., & Wamba, S. F. (2016). Big data analytics in e-commerce: A systematic review and agenda for future research. *Electronic Markets*, *26*(2), 173–194. https://doi.org/10.1007/s12525-016-0219-0

Alt, R., Göldi, A., Österle, H., Portmann, E., & Spiekermann, S. (2021). Life engineering. *Business & Information Systems Engineering*, *63*(2), 191–205. https://doi.org/10.1007/s12599-020-00680-x

Ayyagari, R., Grover, V., & Purvis, R. (2011). Technostress: Technological antecedents and implications. *MIS Quarterly*, *35*(4), 831–858. https://doi.org/10.2307/41409963

Botella, C., Riva, G., Gaggioli, A., Wiederhold, B. K., Alcaniz, M., & Baños, R. M. (2012). The present and future of positive technologies. *Cyberpsychology, Behavior and Social Networking*, *15*(2), 78–84. https://doi.org/10.1089/cyber.2011.0140

De Moya, J.-F., & Pallud, J. (2020). From panopticon to heautopticon: A new form of surveillance introduced by quantified-self practices. *Information Systems Journal*, *30*(6), 940–976. https://doi.org/10.1111/isj.12284

Dreyer, S., Olivotti, D., Lebek, B., & Breitner, M. H. (2019). Focusing the customer through smart services: A literature review. *Electronic Markets*, *29*(1), 55–78. https://doi.org/10.1007/s12525-019-00328-z

Gimpel, H., Lanzl, J., Manner-Romberg, T., & Nüske, N. (2018). *Digitaler Stress in Deutschland. Eine Befragung von Erwerbstätigen zu Belastung und Beanspruchung durch Arbeit mit digitalen Technologien* (Working Paper Forschungsförderung No. 101). Hans Böckler Stiftung.

Gimpel, H., & Schmied, F. (2019). Risks and side effects of digitalization: A multi-level taxonomy of the adverse effects of using digital technologies and media. In *Proceedings of the 27th European Conference on Information Systems (ECIS)*, Stockholm & Uppsala, Sweden.

Grandon, E. E., & Pearson, J. (2004). Electronic commerce adoption: An empirical study of small and medium US businesses. *Information & Management*, *42*(1), 197–216. https://doi.org/10.1016/j.im.2003.12.010

Kano, N., Seraku, N., Takahashi, F., & Tsuji, S. i. (1984). Attractive quality and must-be quality. *The Journal of the Japanese Society for Quality Control*, *14*(2), 147–156.

Karwatzki, S., Dytynko, O., Trenz, M., & Veit, D. (2017). Beyond the personalization–privacy paradox: Privacy valuation, transparency features, and service Personalization. *Journal of Management Information Systems*, *34*(2), 369–400. https://doi.org/10.1080/07421222.2017.1334467

Köffer, S. (2015). Designing the digital workplace of the future - What scholars recommend to practitioners. In *Proceedings of the 36th International Conference on Information Systems (ICIS)*, Fort Worth, United States of America.

Legner, C., Eymann, T., Hess, T., Matt, C., Böhmann, T., Drews, P., Mädche, A., Urbach, N., & Ahlemann, F. (2017). Digitalization: Opportunity and challenge for the business and information systems engineering community. *Business & Information Systems Engineering*, *59*(4), 301–308. https://doi.org/10.1007/s12599-017-0484-2

Lupton, D. (2014). Self-tracking cultures: Towards a sociology of personal informatics. In *Proceedings of the 26th Australian Computer-Human Interaction Conference on Designing Futures: The Future of Design*, Sydney, Australia.

Matt, C., Trenz, M., Cheung, C. M. K., & Turel, O. (2019). The digitization of the individual: Conceptual foundations and opportunities for research. *Electronic Markets*, *29*(3), 315–322. https://doi.org/10.1007/s12525-019-00348-9

Matzler, K., Hinterhuber, H. H., Bailom, F., & Sauerwein, E. (1996). How to delight your customers. *Journal of Product & Brand Management*, *5*(2), 6–18.

Mont, O., Lehner, M., & Heiskanen, E. (2014). *Nudging - A tool for sustainable behaviour?* The Swedish Environmental Protection Agency.

Morey, T., Forbath, T., & Schoop, A. (2015). Customer data: Designing for transparency and trust. *Harvard Business Review*, *2015*(5), 96–105.

Noleppa, S. (2012). *Climate change on your plate*. Berlin. WWF Germany.

Österle, H. (2020). Life engineering. *Electronic Markets*, *30*(1), 49–52. https://doi.org/10.1007/s12525-019-00388-1

Pirkkalainen, H., & Salo, M. (2014). Two decades of the dark side in the information systems basket : Suggesting five areas for future research. In *Proceedings of the 22nd European Conference on Information Systems (ECIS)*, Tel Aviv, Israel.

Ragu-Nathan, T. S., Tarafdar, M., Ragu-Nathan, B. S., & Tu, Q. (2008). The consequences of technostress for end users in organizations: Conceptual development and empirical validation. *Information Systems Research*, *19*(4), 417–433. https://doi.org/10.1287/isre.1070.0165

Richter, A., Heinrich, P., Stocker, A., & Schwabe, G. (2018). Digital work design. *Business & Information Systems Engineering*, *60*(3), 259–264. https://doi.org/10.1007/s12599-018-0534-4

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford Press.

Saarijärvi, H., Grönroos, C., & Kuusela, H. (2014). Reverse use of customer data: Implications for service-based business models. *Journal of Services Marketing*, *28*(7), 529–537. https://doi.org/10.1108/JSM-05-2013-0111

Schmid, Y., & Dowling, M. (2020). New work: New motivation? A comprehensive literature review on the impact of workplace technologies. *Management Review Quarterly.* Advance online publication. https://doi.org/10.1007/s11301-020-00204-7

Schubert, C. (2017). Green nudges: Do they work? Are they ethical? *Ecological Economics*, *132*, 329–342. https://doi.org/10.1016/j.ecolecon.2016.11.009

Smith, H. J., Milberg, S. J., & Burke, S. J. (1996). Information privacy: Measuring individuals' concerns about organizational practices. *MIS Quarterly*, *20*(2), 167–196.

Swan, M. (2013). The quantified self: Fundamental disruption in big data science and biological discovery. *Big Data*, *1*(2), 85–99. https://doi.org/10.1089/big.2012.0002

Tarafdar, M., Cooper, C. L., & Stich, J.-F. (2019). The technostress trifecta - Techno eustress, techno distress and design: Theoretical directions and an agenda for research. *Information Systems Journal*, *29*(1), 6–42. https://doi.org/10.1111/isj.12169

United Nations UNCTAD. (2021). *Estimates of global e-commerce 2019 and preliminary assessment of COVID-19 impact on online retail 2020* (UNCTAD Technical Notes on ICT for Development No. 18).

van't Riet, J., Sijtsema, S. J., Dagevos, H., & Bruijn, G.-J. de (2011). The importance of habits in eating behaviour. An overview and recommendations for future research. *Appetite*, *57*(3), 585–596.

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems*, *28*(2), 118–144. https://doi.org/10.1016/j.jsis.2019.01.003

Weinmann, M., Schneider, C., & Vom Brocke, J. (2016). Digital nudging. *Business & Information Systems Engineering*, *58*(6), 433–436. https://doi.org/10.1007/s12599-016-0453-1

Wieneke, A., & Lehrer, C. (2016). Generating and exploiting customer insights from social media data. *Electronic Markets*, *26*(3), 245–268. https://doi.org/10.1007/s12525-016-0226-1

Wiesböck, F., & Hess, T. (2020). Digital innovations. *Electronic Markets*, *30*(1), 75–86. https://doi.org/10.1007/s12525-019-00364-9

2. Digitalized individuals as employees

2.1. Digital technologies at German workplaces: What are we talking about, exactly?

Abstract: Researchers are likely to be taken aback when asked to name the digital technologies surrounding employees at their workplaces. Paradoxically, literature does not provide a comprehensive, employee-centric, and adequately detailed overview of digital workplace technologies (DWTs). A compilation of this kind would enable a deepened understanding of the technological landscape at workplaces and work practices, supporting digital work design. This research article deals with creating, structuring, and validating a comprehensive overview of DWTs based on literature and perspectives from practice. The overview of forty-one DWTs in eleven categories is an empirical contribution that informs research and practice about the status quo of DWTs. Applied to gather data regarding use and employee perception as demonstrated in this research article, it enables a deepened understanding of work practices. Combined with further data regarding work outcomes such as productivity or technostress, it provides the basis for researchers and practitioners for improved digital work design.

Keywords: Digital workplace; Digital technologies; Digital workplace technologies; Structured overview

Authors: Niclas Nüske, Sarah Bayer, Henner Gimpel, Julia Lanzl

Status: This article is a working paper.

2.1.1. Introduction

Digital technologies (DTs) are integral to almost all of today's workplaces (Richter et al., 2018; Schmid & Dowling, 2020). The Information Systems (IS) community keeps researching the frontier of digital workplace technologies (DWTs), for example, regarding digitalization and digital transformation driven by social, mobile, analytics, and cloud computing (SMAC) technologies (Legner et al., 2017), the internet of things, and artificial intelligence.

At the same time, while working on research regarding the digitalization of workplaces and its consequences, we noticed that literature struggles to answer the following question: *Which DWTs are we talking about, exactly, and can we comprehensively list the DWTs that surround employees at their workplaces?*

An overview of DWTs would tremendously benefit research revolving around the analysis and design of digital workplaces. To do so, it needs to meet three criteria: comprehensiveness, employee-centricity, and an adequate level of detail. Richter et al. (2018) identify Digital Work Design (DWD) – "an agile, participative, and interdisciplinary process of designing flexible workplaces by putting human work practices and their context in the center when investigating the potential of digital technologies" (Richter et al., 2018, p. 261) – as a future grand challenge. DWD, as a basis, firstly involves a holistic and profound understanding of work practices (Richter et al., 2018). A *comprehensive* overview of DWTs would represent an appropriate starting point. Second, "DWD reinstates the human worker at the core of information systems development efforts" (Richter et al., 2018, p. 260). An overview of DWTs should follow this aspiration and be *employee-centric*, focusing on the employees' perceptions of the DWTs they use at their workplaces. This opens up the possibility for the flexible and individualized design of work practices, workplaces, and DWTs, which is a crucial characteristic of DWD (Richter et al., 2018). Köffer (2015) as well stresses the need for individual workplace designs, based on a broad literature review on recommendations for designing digital workplaces. Third, the overview of DWTs should exhibit an *adequate level of detail* that corresponds to the employees' perceptions of DWTs: The contained DWTs should be distinct, yet neither too detailed to become overwhelming to handle nor too abstract to become challenging to pin down.

Several articles deal with a systemization, categorization, or enumeration of DTs in general or DWTs in specific, either focusing on Gartner Hype Cycle technologies (Berger et al., 2018), dealing with a subset of DWTs (Attaran et al., 2019; Mrass et al., 2014), or taking a high-level perspective (Baptista et al., 2020). A comprehensive, employee-centric overview of DWTs

with an adequate level of abstraction is missing, however. Hence, this article deals with developing such an overview based on sources from literature and practice, demonstrating its applicability in a large-scale survey among German employees, and elaborating on its more far-reaching potentials when combined with additional data.

The overview of DWTs, which per se represents an informative compilation for researchers, can be applied to gather data regarding, for example, DWT use and DWT experience both on the level of single DWTs and on an aggregated level for whole workplaces. Based on this empirical contribution in the spirit of Ågerfalk and Karlsson (2021), implications for research and practice can be drawn: In combination with further factors such as employee performance and well-being, it represents a comprehensive, employee-centric, and adequately detailed starting point for a deeper understanding and individualization of work practices as proposed and described above by Richter et al. (2018) and Köffer (2015). Possible applications include the identification of ideal DWT configurations for optimal employee performance and well-being.

The following section deals with the related work on DTs and DWTs. We then present the overview of DWTs and their identification and validation process. After demonstrating its application to survey DWT use and perception key figures, we elaborate on its relevance and potential for IS research. The paper concludes with a consideration of its limitations and a summary.

2.1.2. Related work

2.1.2.1. Defining DWTs

There are numerous conceptions of the term "digital technologies" (Berger et al., 2018). In his work on digital transformation involving an extensive literature review, Vial (2019) observes that a large proportion of the reviewed articles stays unclear regarding the terminology of DTs. To address this fuzziness, he follows the definition of Bharadwaj et al. (2013, p. 471) that DTs are "combinations of information, computing, communication, and connectivity technologies."

Zooming in from DTs in general to DWTs in particular, a similar picture unfolds. Definitions of the digital workplace range from a narrow focus on digital tools (e.g., Köffer, 2015; Tubb, 2013) to a broader spectrum including physical and cultural aspects (e.g., Dery et al., 2017). Likewise, different definitions of DWTs (and their synonym digital work tools) exist. The definitions of the digital workplace and DWTs partly blur into each other. Citing Tubb (2013),

Köffer (2015, p. 2) uses the following definition of the digital workplace: "the collection of all of the digital tools provided by an organization to allow its employees to do their jobs." While digital work tools can be defined as "tools that support the completion of digital work" (Mrass et al., 2014, p. 2519), workplace technologies – including physical technologies such as furniture – can be conceived as "technologies that surround the employee and are needed to get the job done" (Schmid & Dowling, 2020, p. 3).

Based on this background, we derive a more detailed and precise definition of DWTs for this paper. First, we take a purely technological perspective and set aside social aspects of digital work. Second, while DWTs may be typically provided by an organization to its employees as implied in the definition by Tubb (2013), we include the possibility of IT consumerization (i.e., the use of consumer DTs at the workplace (Köffer et al., 2015)). Third, following Vial (2019), we address the fuzziness of the term DTs by taking into account the perspective of Bharadwaj et al. (2013, p. 471). Combining the definitions mentioned above and the presented considerations, we define DWTs as *all combinations of information, computing, communication, and connectivity technologies that surround employees at work and allow them to perform their work routines and activities*.

2.1.2.2. Compiling and structuring DWTs

Few articles deal with a holistic compilation of DTs or DWTs and their systematization. For example, Berger et al. (2018) develop a descriptive taxonomy to capture the nature of DTs. Their taxonomy allows for classifying DTs along eight dimensions (e.g., human involvement, nature of input and output) belonging to four layers (e.g., network and device). However, they choose a high level of abstraction and primarily focus on emerging DTs from the Gartner Hype Cycle (Berger et al., 2018), leaving aside mature and widely used technologies. In their paper on digital work and organizational transformation, Baptista et al. (2020) structure workplace technologies into three layers based on their evolutional stage and potential effects on work (individual tools layer, group and community layer, intelligent augmentation layer). For each layer, they name a few examples of specific technologies. However, more suited to their article's goal, they stay at a high level of abstraction and group DWTs into relatively broad categories. Examining the importance of the digital workplace for productivity and its implementation, Attaran et al. (2019) treat DTs as one layer of the digital workplace. They suggest a variety of workplace solutions that they structure along different business activities. Lastly and most closely linked to our research, Mrass et al. (2014) create a taxonomy of digital work tools to build a foundation for further research on classifying digital work. Their collection of

digital work tools comprises various examples of DWTs belonging to categories such as devices, machines, and artificial intelligence.

While all of the mentioned attempts at compiling and systemizing DWTs are valid regarding the respective article's background and research goal and are a basis for our work, we conclude that literature lacks an overview of DWTs that at once a) is sufficiently comprehensive, b) takes an employee-centric perspective, and c) exhibits an adequate level of abstraction for DWD. Therefore, in the next section, we describe how we created such an overview of DWTs.

2.1.3. Methodology

The creation of the structured overview of DWTs can be segmented into three phases: the compilation, aggregation, and categorization of DWTs. Each phase consisted of an action step, which was executed by the research team, as well as at least one validation step. Table 2.1-1 presents an overview of the process and illustrative examples.

2.1.3.1. Compilation

We chose a hybrid approach to identify DWTs by taking both a scientific perspective with literature and a more practice-oriented, employee-centric perspective. Regarding the literature view, we employed the most recent ACM Computing Classification System of 2012 (ACM, Inc, 2012) as a comprehensive, structured list of the computing discipline's topics. Aside from general, theoretical ones, many topics such as communication hardware, interfaces and storage can be assigned to different DTs. Of those, we extracted DTs that are relevant for the workplace.

Regarding the practical perspective, we analyzed 40 well-kept, representative job descriptions (see Table 2.1-3 in Appendix 2.1-1) of all 16 occupational fields listed by the German Federal Employment Agency (2018). The institution functions as an official, encompassing point of contact for individuals who seek employment or information about a variety of job-related topics. Among others, the job descriptions list work items and technologies. Again, we extracted all mentioned DWTs.

Phase	Step	Procedure	Example	Result
I	**Compilation**			List of 126 DWTs
	Scientific perspective	Extracting DWTs from the ACM Computing Classification System of 2012 (ACM, Inc, 2012)	Inclusion of printers and social networking sites (work-related); exclusion of handheld game consoles (private context)	
	Practice-oriented perspective	Extracting DWTs from 40 job descriptions of the German Federal Employment Agency (2018)	Inclusion of stationary PCs and machine learning (digital); exclusion of flipcharts (physical)	
	Validation	Checking for completeness and timeliness based on 20 job advertisements of Monster Worldwide (2018)		
II	**Aggregation**	Aggregating the identified DWTs in three workshops of the research team based on content-related accordance or fit	Distinct DWT *laptop*, aggregation of software for webshops and software for online auctions to DWT *e-commerce systems*	Aggregated list of 41 DWTs (one of which was added as a result of the validation step)
	Validation	Checking for completeness and timeliness based on missing DWTs mentioned by the participants of a large-scale survey among German employees, and 40 job advertisements of Monster Worldwide (2021) and StepStone (2021)		
III	**Categorization**	Categorizing the identified DWTs in a workshop of the research team based on content-related accordance or fit	DWT *visualization systems* assigned to category *communication, interaction, and collaboration*	Structured overview of 41 DWTs in 11 categories
	Validation	Closed card sorting with 15 information systems researchers		
	Categorization	Recategorizing the identified DWTs by the research team based on the card sorting's results	DWT *visualization systems* reassigned to category *information processing and presentation*	
	Validation	Closed card sorting with 26 information systems researchers		

Table 2.1-1: Creation process of the overview of DWTs

We then performed a check for completeness and timeliness since both the ACM Computing Classification System and the job descriptions of the German Federal Employment Agency date several years back and might not be regularly updated. We randomly selected 20 job advertisements from the popular platform Monster (Monster Worldwide, 2018), collected all DWTs listed under the required IT skills, and compared them to the previous collection of DWTs. We concluded that no new DWTs needed to be incorporated.

2.1.3.2. Aggregation

In three workshops and starting with an unstructured and unordered list, the authors sorted the 126 identified DWTs based on content-related accordance or fit in joint discussions until an aggregated assortment of 40 single DWTs or groups of DWTs emerged. For better readability and brevity, we will use the term DWTs to describe both single DWTs and groups of DWTs in the remainder of the paper.

The list of DWTs was then checked for completeness and timeliness a second time in an extensive survey among German employees (see section Study design for more details). The

participants indicated which of the 40 DWTs they used at their workplace and had the opportunity to add further DWTs if they could not find them in the list. As a result, one new group of DWTs was added to the existing list, namely visualization systems (e.g., smartboards or digital positioning tables). Furthermore, we again randomly selected and checked 40 current job advertisements from the popular platforms Monster (Monster Worldwide, 2021) and StepStone (StepStone, 2021). We concluded that no new DWTs needed to be incorporated.

2.1.3.3. Categorization

Next, the team of authors grouped the 41 DWTs into 11 categories in an additional workshop. Two to eight DWTs were assigned to the emerging categories based on content-related accordance or fit in in-depth discussions. We named and defined the 11 categories based on the DWTs belonging to them and our knowledge accumulated in the DWT identification process. As validation and based on descriptions and examples of the DWTs and the descriptions and definitions of the categories, 15 information systems researchers were then asked to assign the randomly ordered DWTs to one of the randomly ordered categories in a closed card sorting. The assessment criterium Fleiss' Kappa for inter-rater reliability indicated moderate agreement with a value of 0.590 (Landis & Koch, 1977).

The majority of researchers assigned five DWTs to other categories as proposed by the authors. Including feedback from discussions with the raters, we reassigned four DWTs to different categories and attributed one unexpected assignment to a misinterpretation. To prevent misunderstanding and improve the inter-rater agreement, we clarified the descriptions and definitions of the categories and the examples given for the DWTs. The revised categorization proposal was assessed in a second card sorting with 26 information systems researchers, 5 of whom had already taken part in the first one. A Fleiss' Kappa of 0.667 indicated substantial strength of agreement (Landis & Koch, 1977). One group of DWTs was assigned in another way as expected. After discussion, we reassigned the group of DWTs to another category in concordance with the raters' opinion and concluded that the overall list exhibited an acceptable agreement.

2.1.4. A comprehensive, structured overview of DWTs

The resulting overview of DWTs is presented in Table 2.1-2. We name and describe each of the eleven DWT categories, list the 41 DWTs assigned to the categories, and present illustrative examples where necessary. The order of the DWTs listed in each category corresponds to the raters' agreement in the second card sorting.

#	DWT categories	#	DWTs	Illustrative examples
1	**Standard hardware** Stationary and mobile devices for regular use by an individual or a smaller group.	1.1	Laptops	
		1.2	Stationary PCs	
		1.3	Tablets	
		1.4	Smartphones	
		1.5	Mobile phones (no smartphones)	
		1.6	Printers, scanners, and fax machines	
		1.7	Headsets	
		1.8	Stationary phones	
2	**Information processing and presentation** Systems that enable the recording, presentation, and further processing of information and knowledge.	2.1	Text, spreadsheet, and presentation software	Microsoft Office applications
		2.2	Visualization systems	Smartboards, digital positioning tables
		2.3	Document and knowledge management systems	Intranets, blogs, wikis
3	**Communication, interaction, and collaboration** Systems that enable and promote the exchange or collaborative processing of information between individuals in real or discontinuous time.	3.1	Real-time communication systems	Web-conferencing, chats
		3.2	Systems for social interaction and collaboration	Social networking sites, social collaboration
		3.3	E-mail	
4	**Security** Systems to ensure information security and data protection.	4.1	Background security systems without user interaction	Firewalls, encryption, VPN
		4.2	Security systems involving user interaction	Password entry, authentication
5	**Network and data infrastructure** Systems that act as infrastructure to link human and non-human actors of any kind and to access, manage, and exchange data.	5.1	Network hardware	Network systems, fieldbus systems
		5.2	Wireless connections	Mobile networks, WIFI, radio devices
		5.3	Cloud computing and virtual machines	Access to infrastructure for computing power or software via the internet
		5.4	World wide web	Access to information via browser or web applications
		5.5	Databases and data warehouses	Data storage and data management systems accessible locally or via the internet
6	**Subject-specific development and application systems** Systems that enable the execution of subject-specific development tasks or other subject-specific tasks in delimited areas of work for which specialist knowledge is required.	6.1	Medical software	Control systems for diagnostic and therapy devices
		6.2	Modeling and simulation software	Mathematical modeling, physical simulations
		6.3	Software for creativity and design	Software for editing images, videos, or audio for the entertainment industry
		6.4	Software for product and software development	CAD/CAM systems, programming environments
		6.5	Statistics and analytics software	Software for the application of statistical methods for data mining
		6.6	Content management systems	Software for website creation and website management

#	DWT categories	#	DWTs	Illustrative examples
7	**Payment-processing and e-commerce** Systems that enable or support the physical or digital exchange of payments.	7.1	Cash register systems	Card readers, electronic cash register systems
		7.2	Digital cash flow systems	Digital cash, online transactions
		7.3	E-commerce systems	Software for webshops or online auctions
8	**Management and enterprise systems** Systems that specifically enable or support the management and administration of organizations.	8.1	Management information software	Project management software, business process modeling
		8.2	Organizational administration software	Systems for financial controlling, ERP systems, administrative software
		8.3	Decision support software	Decision support systems
9	**Production and logistics** Systems that enable or support the manufacturing and distribution of physical products.	9.1	Systems for production planning and production management	Software for purchasing and warehousing, production control units
		9.2	Logistics systems	Systems for storage and transportation management
		9.3	Automatic manufacturing systems	3D printers, CNC machines, robotics
10	**Environment-sensing** Systems that enable the recording of the environment or the positioning of human and non-human actors in relation to the environment.	10.1	Localization and distance measurement systems	Radar devices, devices for distance determination, navigation devices, GPS
		10.2	Sensor systems	Sensor networks, mobile data acquisition devices
11	**Emerging technologies** Relatively novel and not yet fully established technologies, often intensively covered in the media. These DWTs will move to other categories with growing maturity, and novel DWTs will enter this category.	11.1	Artificial intelligence	Machine learning
		11.2	Augmented, virtual, and mixed reality	Smart glasses
		11.3	Speech interaction	Voice control, software for speech-to-text conversion

Table 2.1-2: Comprehensive, structured overview of DWTs

2.1.5. Exemplary applications of the overview of DWTs

2.1.5.1. Study design

The overview of DWTs was included and refined in a large-scale online survey among German employees. The participants indicated which DWTs they used in their daily work, had the opportunity to enter missing DWTs, and chose up to five DWTs from the previously selected ones that they perceived most intensively in their daily work. Further questions covered their working and private lives and a set of personal, demographic, and occupational characteristics. Table 2.1-4 in Appendix 2.1-2 presents details regarding the questionnaire.

We recruited participants by employing the services of a professional panel provider and remunerated their participation. Excluding participants who were currently not employed either full-time or part-time and failed to answer an attention check question correctly, 2,496 German employees participated in the online survey. 53.89 % were female, 45.95 % were male, and 0.16 % identified as another gender. Their average age was 48 years, ranging from 19 to 88 years, with an average weekly working time of 36.96 hours. The participants' distributions across federal states and industries were representative in the sense that the distributions did not significantly differ from the German workforce as described in data accessible from the German Federal Statistical Office (the null hypotheses that the distributions are independent of each other are rejected with p-values under the 0.001 level in Chi-squared tests).

2.1.5.2. Total number and frequency of occurrence

The survey results firstly enable an overarching examination of the total number of DWTs used at German workplaces. The mean total number of DWTs used at workplaces is 13.12, with a minimum of 1, a median of 12, and a maximum of 40. Figure 2.1-1 shows the distribution.

Overall, the participants indicated e-mail (see DWT 3.3 in Table 2.1-2), printers, scanners, and fax machines (1.6), and the world wide web (5.4) as the most often used DWTs. They selected medical software (6.1), augmented, virtual, and mixed reality (11.2), and modeling and simulation software (6.2) the least often.

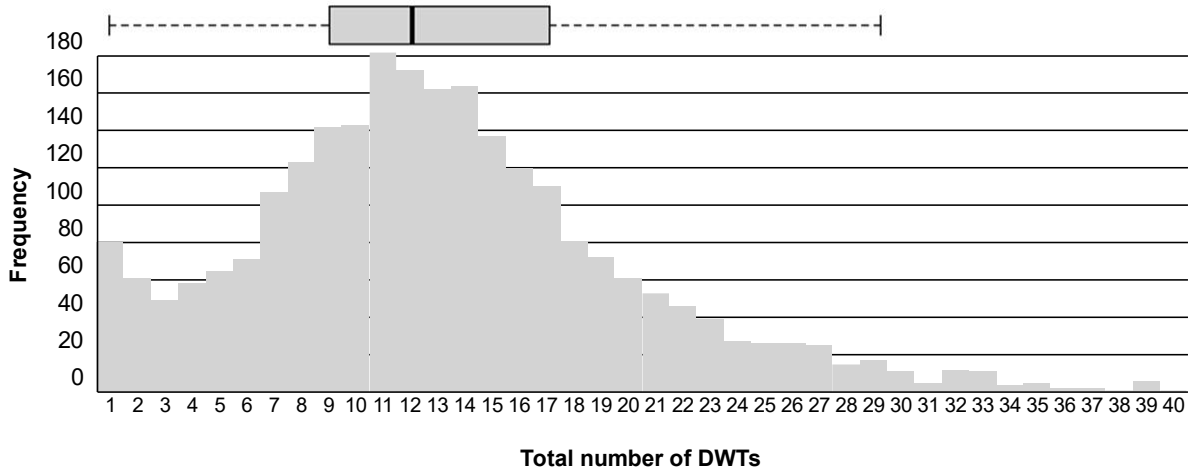


Figure 2.1-1: Histogram and boxplot of the number of DWTs per workplace (n = 2,496)

2.1.5.3. Perceived intensity

Aside from the mere use of DWTs, the question of which DWTs are perceived very intensively by employees sheds further light on their work practices. While some DWTs might be used infrequently or be of minor importance, DWTs that are intensively perceived are likely to be the most relevant ones for analyzing the effects of DWT use and the derivation of interventions. Stationary PCs (1.2), e-mail (3.3), and printers, scanners, and fax machines (1.6) are the most intensively perceived DWTs. Modeling and simulation software (6.2), augmented, virtual, and mixed reality (11.2), and decision support software (8.3) are the least intensively perceived DWTs. Table 2.1-5 in Appendix 2.1-3 provides an overview of the frequency of occurrence and perceived intensity of the complete set of DWTs.

2.1.6. Discussion

2.1.6.1. Relevance and potential

This research article presented a structured, comprehensive, employee-centric, and concrete overview of DWTs. The overview complements Mrass et al. (2014) by taking a more holistic and employee-centric perspective. Mrass et al. (2014) focus on digital work tools with digital work understood as paid "effort to create digital goods or that makes substantial use of digital tools" (Durward et al., 2016, p. 283). Our structured overview of DWTs, in contrast, deals with the use and perception of DWTs that surround employees at their workplaces. On the one hand, the taxonomy by Mrass et al. (2014) includes several digital work tools, mainly from the categories vehicles and artificial intelligence, that operate entirely autonomously. These are not reflected in our overview of DWTs as they might not be actively used or perceived by employees at their workplaces and do not meet the criterium of employee centricity. On the other hand,

our overview comprises numerous DWTs, mainly software systems for various purposes, that are distinctively used and perceived by employees. Hence, it is substantially more extensive than the taxonomy by Mrass et al. (2014).

Attaran et al. (2019) deal with a broader digital workplace concept with four layers: DTs, collaboration, digital identity and security, and information access. They go beyond a mere technological perspective and focus on how digital workplace solutions might enable the implementation of a forward-oriented vision of a digital workplace primarily used for knowledge work. Our structured overview focuses on DWTs, that is, the technological perspective, at any workplace. While the listed digital workplace solutions contain several DWTs that can be matched to our overview, it comprises numerous further DWTs relevant for employees at their workplaces.

Baptista et al. (2020) also take a forward-oriented and broader perspective and deal with the evolution of workplace technologies and their effects on work. The accumulation of workplace technologies in three layers is sufficient for examining the progression of workplace technologies. Our structured overview of DWTs exhibits a more detailed and concrete level of abstraction and covers distinct DWTs which are used and perceived by employees.

Beyond representing a comprehensive, employee-centric, adequately detailed compilation of DWTs, our structured overview can be employed to gather data for various purposes in research and practice which revolve around employees and their workplaces. We demonstrated examples of key figures in the previous section: the total number of DWTs at the workplace, the frequency of occurrence of single DWTs, and their perceived intensity. Combined with data such as workplace environment, employee, or demographic characteristics, it allows for a comparison of these key figures on within-company or between-company levels. These comparisons might lead to valuable insights regarding, for example, companies' DWT landscapes and a deeper understanding of the state of workplace digitalization within departments or industries. This also has direct implications for research revolving around digital work design (DWD; Richter et al., 2018). Our employee-centric overview of DWTs can be applied to gain valuable insights as to which DWTs are in use and how they are perceived and thus create a foundation for the informed design and redesign of ICT artifacts and work practices which center around digitally empowered employees.

The application of the structured overview of DWTs is self-evidently not limited to mere observation. It can be linked to employee characteristics and job outcomes as well. It unfolds its

full potential when data regarding DWT use and perception is combined with additional variables to form more elaborate models. Employees have individual and changing needs (Richter et al., 2018). Köffer's (2015) work on recommendations regarding digital workplace design as well stresses the necessity for individual workplace design regarding the areas collaboration, compliance, mobility, and stress and overload. In combining data regarding DWT use and perception with data on individual employee characteristics and job outcomes such as performance and employee well-being, valuable insights regarding their interplay and dependencies may be gained, resulting in a better understanding of flexible work practices for optimal employee productivity and well-being. As an example, on a highly aggregated level and among a large sample of companies, Cozzarin and Percival (Cozzarin & Percival, 2010) found higher IT use to increase productivity. Building on these findings and applying the structured overview of DWTs in combination with more detailed measures of productivity, the question of which DWTs exactly influence productivity in which ways could be answered in more depth.

As a concrete example with implications on employee well-being, building on an earlier version of the presented overview of DWTs, Becker et al. (2020) investigate the relationship between DWTs, specific characteristics of these DWTs, and technostress. Technostress is a highly relevant phenomenon against the backdrop of progressing digitalization which a growing body of literature is dedicated to (see, e.g., Tarafdar et al., 2019). It results from individuals' perception of five technostress creators such as techno-complexity and techno-overload (see, e.g., Ragu-Nathan et al., 2008). The perception of technostress creators, in turn, is based on the individuals' perception of specific technology characteristics (Ayyagari et al., 2011). Becker et al. (2020) identify ten technostress-related technology characteristics such as reliability and usefulness and have them evaluated for each DWT included in our structured overview in another large-scale survey among German employees. Based on the results, they derive specific characteristic profiles for the majority of DWTs. More importantly, they link the overall profiles of digital workplaces to technostress creators and find that each technostress creator is related to at least two technology characteristics. With a) the knowledge of which characteristics further or mitigate which technostress creators and b) which DWTs exhibit the characteristics to which extent, it becomes possible to precisely identify DWTs that are detrimental or beneficial for technostress.

Another possible application example that is related to technology characteristics is the work of Rubenstein-Montano and Dillon (Rubenstein-Montano & Dillon, 2005). The authors analyze how technology characteristics influence the relationships of individuals with groups as

well as organizations as a whole. Applying Grounded Theory and surveying a sample of students who are asked about their university life, they find that, for example, the informativeness of technologies or the extent to which they enable easy communication have a positive impact on individual-groups and individual-organization relationships (Rubenstein-Montano & Dillon, 2005). Building on this work, two promising next steps are conceivable: First, the work could be transferred to the business context – employees, teams, and companies. Second, the broader, more holistic overview of DWTs could be applied to analyze the technology characteristics and their impact on the relationships of individual employees to their teams and their employer. The results would enable optimizing working atmosphere and working conditions by deliberately reinforcing beneficial and discontinuing detrimental DWTs.

2.1.6.2. Contribution and implications for theory and practice

Our work contributes to information systems literature as follows. (1) The overview of DWTs constitutes the first structured, comprehensive, employee-centric, and adequately detailed collection of DWTs used at workplaces. It combines the perspectives of literature, job descriptions of the German Federal Employment Agency, required skills in job offerings, additional inputs from a large-scale survey among employees, and the perspectives of several researchers to create an indication of which DWTs are used by employees and how they can be structured. In the tripartite conceptualization of IT use as the interplay of users, tasks, and technology (Burton-Jones & Straub, 2006), it thus holistically covers the technology aspect at workplaces that can be linked to the user and task aspects in manifold ways depending on context and research goal. (2) It can be utilized – as demonstrated in the exemplary application – to survey the total number, the frequency of occurrence, and the employees' perception of intensity of DWTs. It allows for analyses and comparisons both within single companies and within broader contexts regarding, for example, employee or demographic characteristics, industries, or geographic regions.

On the broad spectrum of theorizing recently proposed by Hassan and Willcocks (2021), this research article thus represents a theory of the eighth category which answers the "What?" question of which DWTs there are at German workplaces in a structured way. In the taxonomy of theory types proposed by Gregor (2006), this relates to a theory for analyzing that says what is without proposing causal relationships or making predictions. Following Ågerfalk and Karlsson (2021, p. 64), it represents an empirical contribution in the sense that it provides "details of a phenomenon not previously covered by research or covered to a limited extent".

As such, it has fundamental implications for theory: We support the long-standing and still timely call to include the IT artifact in theorizing (e.g., Benbasat & Zmud, 2003). Combined with further variables related to, for example, employee productivity and well-being, the overview enables examining how and which DWTs relate to factors in the digital workplace environment. This is a fundamental prerequisite for many technology-related research endeavors – both of theoretical and empirical nature – and interventions centering around how DWTs influence our work practices and job outcomes, how beneficial relationships can be exploited and reinforced, and how destructive relationships can be mitigated.

Regarding practical implications, the overview of DWTs represents a comprehensive indication for practitioners from companies and public authorities as to which DWTs we are talking about when discussing workplace digitalization. It can be utilized as a foundation to better understand or compare the status quo of the total number of DWTs in use at workplaces or the use of specific DWTs. Based on this deepened understanding, concrete measures regarding an employee-centric and individualized design of work practices in the spirit of Richter et al. (2018) and Köffer (2015) can be taken by both companies and policymakers.

2.1.6.3. Limitations

When contemplating or applying the presented overview of DWTs, a few cautionary notes are in order. First, the overview of DWTs reflects the current times. In the future or specific contexts, some DWTs may be obsolete, and some new DWTs may occur. Furthermore, the assignment to categories may change, especially regarding the category of emerging technologies. The overview of DWTs is therefore not to be understood as static. It rather represents an adaptable tool for both researchers and practitioners. As from an overall economic perspective, the processes of the digital transformation of companies and workplaces proceed rather gradually, we recommend updating the overview of DWTs regularly after a period of five years. Second, the appropriate level of detail is dependent on the concrete purpose that researchers or practitioners who apply the overview of DWTs pursue. It may be warranted to work with a lower (e.g., categories in Table 2.1-2) or higher (e.g., examples in Table 2.1-2) level of detail. Third, while one of the merits of the overview of DWTs lies in the fact that it is employee-centric, the resulting survey data is based on employee perception and self-reports. Therefore, it may be complemented by insights from sources such as reports from IT departments or usage data.

2.1.7. Conclusion

While DWTs lie at the heart of our discipline and are the center of many research questions, it turns out to be challenging to answer which collection of DWTs we are talking about exactly. In this research article, we derived a list of DWTs from literature and employee-centered information sources from practice and structured them in a comprehensive, employee-centric, concrete overview. Based on a large-scale dataset, we then demonstrated how the overview of DWTs can be utilized to gather descriptive data about the use and intensity of perception of single DWTs and the total number of DWTs at workplaces. We proceeded to elaborate on how these insights can be the basis for employee-centric and individualized interventions regarding the design of work practices, the promotion of beneficial job outcomes, and the mitigation of negative ones. The overview of DWTs represents a valuable tool for informational and action-oriented purposes for both researchers and practitioners.

2.1.8. References

ACM, Inc. (2012). *The 2012 ACM computing classification system*. https://www.acm.org/publications/class-2012. Accessed on 2021-02-25.

Ågerfalk, P. J., & Karlsson, F. (2021). Theoretical, empirical, and artefactual contributions in information systems research: Implications implied. In N. R. Hassan & L. P. Willcocks (Eds.), *Technology, Work and Globalization. Advancing information systems theories: Rationale and processes* (1st ed., pp. 53–73). Springer International Publishing. https://doi.org/10.1007/978-3-030-64884-8_2

Attaran, M., Attaran, S., & Kirkland, D. (2019). The need for digital workplace: Increasing workforce productivity in the information age. *International Journal of Enterprise Information Systems*, *15*(1), 1–23. https://doi.org/10.4018/IJEIS.2019010101

Ayyagari, R., Grover, V., & Purvis, R. (2011). Technostress: Technological antecedents and implications. *MIS Quarterly*, *35*(4), 831–858. https://doi.org/10.2307/41409963

Baptista, J., Stein, M.-K., Klein, S., Watson-Manheim, M. B., & Lee, J. (2020). Digital work and organisational transformation: Emergent digital/human work configurations in modern organisations. *The Journal of Strategic Information Systems*, *29*(2), 1–10. https://doi.org/10.1016/j.jsis.2020.101618

Becker, J., Berger, M., Gimpel, H., Lanzl, J., & Regal, C. (2020). Considering characteristic profiles of technologies at the digital workplace: The influence on technostress. In *Proceedings of the 41st International Conference on Information Systems (ICIS)*, Hyderabad, India.

Benbasat, I., & Zmud, R. W. (2003). The identity crisis within the IS discipline: Defining and communicating the discipline's core properties. *MIS Quarterly*, *27*(2), 183–194.

Berger, S., Denner, M.-S., & Roeglinger, M. (2018). The nature of digital technologies - Development of a multi-layer taxonomy. In *Proceedings of the 26th European Conference on Information Systems (ECIS)*, Portsmouth, United Kingdom.

Bharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital business strategy: Toward a next generation of insights. *MIS Quarterly*, *37*(2), 471–482.

Burton-Jones, A., & Straub, D. W. (2006). Reconceptualizing system usage: An approach and empirical test. *Information Systems Research*, *17*(3), 228–246. https://doi.org/10.1287/isre.1060.0096

Cozzarin, B. P., & Percival, J. C. (2010). IT, productivity and organizational practices: Large sample, establishment-level evidence. *Information Technology and Management*, *11*(2), 61–76. https://doi.org/10.1007/s10799-010-0067-0

Dery, K., Sebastian, I. M., & van der Meulen, N. (2017). The digital workplace is key to digital innovation. *MIS Quarterly Executive*, *16*(2), 135–152.

Durward, D., Blohm, I., & Leimeister, J. M. (2016). Crowd Work. *Business & Information Systems Engineering*, *58*(4), 281–286. https://doi.org/10.1007/s12599-016-0438-0

Federal Employment Agency. (2018). *Berufsfelder*. https://berufenet.arbeitsagentur.de/berufenet/faces/index?path=null/berufsfelder. Accessed on 2021-02-25.

Gregor, S. (2006). The nature of theory in information systems. *MIS Quarterly*, *30*(3), 611–642.

Hassan, N. R., & Willcocks, L. P. (2021). Introduction: Why theory? (Mis)Understanding the context and rationale. In N. R. Hassan & L. P. Willcocks (Eds.), *Technology, Work and Globalization. Advancing information systems theories: Rationale and processes* (1st ed., pp. 1–52). Springer International Publishing. https://doi.org/10.1007/978-3-030-64884-8_1

Köffer, S. (2015). Designing the digital workplace of the future - What scholars recommend to practitioners. In *Proceedings of the 36th International Conference on Information Systems (ICIS)*, Fort Worth, United States of America.

Köffer, S., Ortbach, K., Junglas, I., Niehaves, B., & Harris, J. (2015). Innovation through BYOD? *Business & Information Systems Engineering*, *57*(6), 363–375. https://doi.org/10.1007/s12599-015-0387-z

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, *33*(1), 159–174. https://doi.org/10.2307/2529310

Legner, C., Eymann, T., Hess, T., Matt, C., Böhmann, T., Drews, P., Mädche, A., Urbach, N., & Ahlemann, F. (2017). Digitalization: Opportunity and challenge for the business and information systems engineering community. *Business & Information Systems Engineering*, *59*(4), 301–308. https://doi.org/10.1007/s12599-017-0484-2

Monster Worldwide. (2018). *monster.de*. https://www.monster.de/. Accessed on 2018-04-18.

Monster Worldwide. (2021). *monster.de*. https://www.monster.de/. Accessed on 2021-07-26.

Mrass, V., Li, M. M., & Peters, C. (2014). Towards a taxonomy of digital work. In *Proceedings of the 22nd European Conference on Information Systems (ECIS)*, Tel Aviv, Israel.

Ragu-Nathan, T. S., Tarafdar, M., Ragu-Nathan, B. S., & Tu, Q. (2008). The consequences of technostress for end users in organizations: Conceptual development and empirical validation. *Information Systems Research*, *19*(4), 417–433. https://doi.org/10.1287/isre.1070.0165

Richter, A., Heinrich, P., Stocker, A., & Schwabe, G. (2018). Digital work design. *Business & Information Systems Engineering*, *60*(3), 259–264. https://doi.org/10.1007/s12599-018-0534-4

Rubenstein-Montano, B., & Dillon, R. (2005). The impact of technology on relationships within organizations. *Information Technology and Management*, *6*(2-3), 227–251. https://doi.org/10.1007/s10799-005-5881-4

Schmid, Y., & Dowling, M. (2020). New work: New motivation? A comprehensive literature review on the impact of workplace technologies. *Management Review Quarterly.* Advance online publication. https://doi.org/10.1007/s11301-020-00204-7

StepStone. (2021). *stepstone.de*. https://www.stepstone.de/. Accessed on 2021-07-26.

Tarafdar, M., Cooper, C. L., & Stich, J.-F. (2019). The technostress trifecta - Techno eustress, techno distress and design: Theoretical directions and an agenda for research. *Information Systems Journal*, *29*(1), 6–42. https://doi.org/10.1111/isj.12169

Tubb, C. (2013). *So what is the digital workplace anyway?* Digital Workplace Group. https://digitalworkplacegroup.com/2013/11/05/so-what-is-the-digital-workplace-anyway/. Accessed on 2021-04-03.

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems*, *28*(2), 118–144. https://doi.org/10.1016/j.jsis.2019.01.003

2.1.9. Appendix

Appendix 2.1-1

#	Translation of job title	Original German job title
1	Actuary	Aktuar/in
2	Agricultural service	Agrarservice
3	Automation technology electronics technician	Elektroniker/in - Automatisierungstechnik
4	Bank clerk	Bankkaufmann/-frau
5	Biomathematician	Biomathematiker/in
6	Bookseller	Buchhändler/in (Hochschule)
7	Brewer	Betriebsbraumeister/in
8	CAM organizer	CAM-Organisator/in
9	Computer visualist	Computervisualist/in
10	Controller	Controller/in
11	Data scientist	Data Scientist
12	Database developer	Datenbankentwickler/in
13	Dental assistant	Zahnmedizinische/r Fachangestellte/r
14	Draftsman	Bauzeichner/in
15	E-commerce merchant	Kaufmann/-frau - E-Commerce
16	Electrical engineering process manager	Prozessmanager/in - Elektrotechnik
17	Facility manager	Facility-Manager/in
18	Hairdresser	Friseur/in
19	Industrial engineer	Wirtschaftsingenieur/in
20	Industrial pipe constructor	Industriemeister/in - Leitungsbau
21	Information systems technician	Betriebsinformatiker/in
22	International business specialist	Internationale/r Wirtschaftsfachmann/-frau
23	Logistics business administrator	Betriebswirt/in (Hochschule) - Logistik
24	Mechatronics engineer	Mechatroniker/in
25	Media and information systems technician	Techniker/in - Medien- und Informationssysteme
26	Media assistant	Medienassistent/in
27	Medical information systems technician	Medizininformatiker/in
28	Nautical technician	Nautiker/in
29	Optician	Augenoptiker/in
30	Pharmacist	Apotheker/in
31	Precision mechanic	Werker/in für Feinwerktechnik
32	Professional truck driver	Berufskraftfahrer/in
33	Project engineer	Projektingenieur/in
34	Quality manager	Qualitätsmanager/in
35	Retail merchant	Kaufmann/-frau - Einzelhandel
36	Secretary	Sekretär/in
37	Security guard	Wachpolizist/in
38	Software developer	Softwareentwickler/in
39	Statistician	Statistiker/in
40	Surgical mechanic	Chirurgiemechanikermeister/in
41	Tourism business administrator	Fachwirt/in - Tourismus

Table 2.1-3: Analyzed job descriptions of the German Federal Employment Agency (2018)

Appendix 2.1-2

Section	Content	Response options
Welcome	- Welcome of participants - Estimated duration of the survey - Sensibilization that there are no correct or false answers	n.a.
Introduction	Accessible explanation of the survey's key construct DWTs: *Digital technologies (colloquially also known as information technology (IT), information and communication technology (ICT), information systems (IS), or simply computers) enable the storage and processing of data, the transfer of information, and various types of electronically mediated communication. Digital technologies can be divided into hardware, software, and networks. Hardware includes computers, laptops, tablets, projectors, and smartphones. Software includes word processing programs such as Word, e-mail applications such as Outlook, Internet browsers such as Chrome, or cloud storage such as Dropbox. Intranet or social networks belong to the category networks.*	n.a.
	Check if the participant fulfills the requirement of being an employee: *Are you currently employed by an organization/company (full-time or part-time)?*	Yes/No
	Check for multiple employments: *How many employments do you currently have in parallel?*	Text box
DWTs	Query of DWTs: *As a first step, we would like to find out to what extent you are surrounded by digital technologies in your everyday work. Please call your workplace to mind and indicate on the following pages which technologies you use for your work. If you have two or more occupations, please limit all your answers to your primary occupation. While doing so, please read the list of digital technologies carefully. Some technologies may be less visible but still be used by you. Therefore, please also tick those technologies that you do not always see directly in front of you.*	Checklist of the DWTs and illustrative examples in parentheses as listed in Table 2.1-2 (excluding DWT visualization systems (2.2) which was only added after evaluating further potentially missing DTs (see next question))
	Query of further potentially missing DWTs: *If there are other digital technologies in your everyday work that cannot be assigned to any of the above categories, please name them here.*	Text box
	Query of the intensity of DWT perception: *Which of the technologies you selected do you perceive most intensively in your everyday work? Please select up to five technologies.*	Checklist of the previously selected DWTs with a limit of five selectable DWTs
Personal, demographic, and occupational characteristics	Query of gender: *What is your gender?*	Male/Female/Other
	Query of age: *In which year were you born?*	Text box

Section	Content	Response options
	Query of weekly working time: *How many hours do you work on average per week in your job - including overtime, on-call duty, etc.?*	Text box
	Query of federal state: *In which state is your principal place of work located?*	Drop-down menu of German federal states
	Query of industry: *In what industry do you work?*	Checklist of industries listed by the German Federal Statistical Office
Conclusion	- Information about the completion of the survey - Thank you to participants	n.a.

Table 2.1-4: Details of the questionnaire regarding DWT use and perception among German employees

Appendix 2.1-3

#	DWT categories and DWTs	Frequency (abs.)	Frequency (rel.)	Intensity (abs.)	Intensity (rel.)
1	**Standard hardware**				
1.1	Laptops	1,048	42%	590	24%
1.2	Stationary PCs	1,863	75%	1,548	62%
1.3	Tablets	434	17%	119	5%
1.4	Smartphones	1,083	43%	540	22%
1.5	Mobile phones (no smartphones)	460	18%	136	5%
1.6	Printers, scanners, and fax machines	1,959	78%	975	39%
1.7	Headsets	475	19%	154	6%
1.8	Stationary phones	1,717	69%	888	36%
2	**Information processing and presentation**				
2.1	Text, spreadsheet, and presentation software	1,857	74%	665	27%
2.2	Visualization systems[4]				
2.3	Document and knowledge management systems	923	37%	107	4%
3	**Communication, interaction, and collaboration**				
3.1	Real-time communication systems	739	30%	66	3%
3.2	Systems for social interaction and collaboration	611	24%	33	1%
3.3	E-mail	2,123	85%	1,141	46%
4	**Security**				
4.1	Background security systems without user interaction	1,452	58%	38	2%
4.2	Security systems involving user interaction	1,777	71%	120	5%
5	**Network and data infrastructure**				
5.1	Network hardware	1,405	56%	42	2%
5.2	Wireless connections	1,438	58%	116	5%
5.3	Cloud computing and virtual machines	440	18%	35	1%
5.4	Worldwide web	1,919	77%	658	26%
5.5	Databases and data warehouses	1,016	41%	81	3%
6	**Subject-specific development and application systems**				
6.1	Medical software	176	7%	44	2%
6.2	Modeling and simulation software	138	6%	7	0%
6.3	Software for creativity and design	536	21%	40	2%
6.4	Software for product and software development	336	13%	39	2%
6.5	Statistics and analytics software	462	19%	28	1%
6.6	Content management systems	372	15%	29	1%
7	**Payment-processing and e-commerce**				
7.1	Cash register systems	542	22%	104	4%
7.2	Digital cash flow systems	640	26%	16	1%
7.3	E-commerce systems	396	16%	12	0%
8	**Management and enterprise systems**				
8.1	Management information software	492	20%	26	1%
8.2	Organizational administration software	827	33%	79	3%
8.3	Decision support software	214	9%	4	0%
9	**Production and logistics**				
9.1	Systems for production planning and production management	371	15%	27	1%
9.2	Logistics systems	493	20%	49	2%
9.3	Automatic manufacturing systems	217	9%	13	1%

[4] Note that there are no data for visualization systems (2.2). After conducting the survey, this DWT was added to the overview based on the respondents' feedback regarding any DWTs they missed in the previously existing list.

#	DWT categories and DWTs	Frequency (abs.)	Frequency (rel.)	Intensity (abs.)	Intensity (rel.)
10	**Environment-sensing**				
10.1	Localization and distance measurement systems	547	22%	24	1%
10.2	Sensor systems	431	17%	12	0%
11	**Emerging technologies**				
11.1	Artificial intelligence	214	9%	25	1%
11.2	Augmented, virtual, and mixed reality	169	7%	6	0%
11.3	Speech interaction	427	17%	37	1%

Legend: Top 5 Bottom 5

Table 2.1-5: Frequency of occurrence of DWTs and intensively perceived DWTs (n = 2,496)

2.2. Technostress and digitalization: Evidence from German employees

Abstract: Technostress at work is well established. Nevertheless, the influence of the degree of workplace digitalization on technostress creating conditions has not yet been investigated extensively. Based on theoretical models on technostress and a large-scale survey (n = 2,640), this study analyzes the relationships between the degree of workplace digitalization and technostress creators. It further analyzes the moderating effects of three technostress inhibitors, namely, literacy facilitation, involvement facilitation, and technical support provision, on these relationships. The results reveal that a higher degree of workplace digitalization is positively associated with technostress creating conditions and with the three technostress inhibitors. However, the effect on technostress creators varies when considering each individual technostress creator instead of the combined technostress creating condition. For the inhibitors, the effects are also multifaceted. While literacy facilitation and technical support provision negatively affect technostress creators, literacy facilitation also decreases the effect of the degree of workplace digitalization on technostress creators. Involvement facilitation, however, is positively associated with technostress creators. The results are important for organizations willing to take advantage of the benefits of digital technologies at the workplace and at the same time prevent them from causing adverse effects such as technostress for their employees.

Keywords: Technostress; Technostress creators; Technostress inhibitors; Digitalization; Survey

Authors: Julia Lanzl, Henner Gimpel, Niclas Nüske, Monideepa Tarafdar

Status: This article is a working paper.

2.2.1. Introduction

Digitalization has changed the business world. Organizations keep on digitalizing their businesses or even their business models in order to achieve competitive advantages like increases in operational efficiency, performance, productivity, and sales as well as savings in cost and time, and innovations in value creation (Fitzgerald et al., 2013; Neumeier et al., 2017; Vial, 2019). Additionally, the COVID-19 pandemic and the associated social distancing measures have further accelerated workplace digitalization since many employees were forced to work from home using digital technologies. This continuing digitalization of the business world also has a major impact on the employees facing the proliferation of digital technologies at their workplace and the consequent changes of, for example, communication, working routines, and organizational structures (Colbert et al., 2016). Today, employees gain high flexibility in collaborating worldwide and at any time due to mobile internet, ubiquitous digital devices, and access to a vast amount of information on their tasks. However, they also are confronted with challenges like work overload due to high amounts of incoming emails and a blurring of work and non-work life (Barley et al., 2011; Colbert et al., 2016; Stanko & Beckman, 2014; van Knippenberg et al., 2015).

The imbalance between the demands due to digital technologies and an individual's resources to meet these demands leads to stress. In information systems (IS) literature, this increased stress for employees due to digital technologies is known as technostress (Tarafdar et al., 2019). Technostress was described by Brod (1984, p. 16) as an individual's "inability to cope with new computer technologies in a healthy manner." Research on technostress has identified different technostress creators (Adam et al., 2017; Ayyagari et al., 2011; Ragu-Nathan et al., 2008; Tarafdar et al., 2007): techno-invasion, techno-overload, techno-complexity, techno-uncertainty, techno-insecurity, and techno-unreliability. Further, many studies have investigated the impact of technostress on different outcomes in the business context (Tarafdar et al., 2019). Examples are job-related adverse outcomes such as reduced job satisfaction and organizational commitment (Gimpel et al., 2018; Ragu-Nathan et al., 2008; Tarafdar et al., 2007), IS-use related adverse outcomes such as lower end-user satisfaction (Tarafdar et al., 2010; Tarafdar et al., 2015) and non-adherence to IS use requirements (D'Arcy et al., 2014) as well as well-being related adverse outcomes such as exhaustion and burnout (Day et al., 2012; Galluch et al., 2015; Maier, Laumer, Weinert, & Weitzel, 2015).

Prior literature has studied organizational measures to inhibit technostress, especially literacy facilitation, involvement facilitation, and technical support provision (Ragu-Nathan et al.,

2008). Concerning the antecedents of technostress, Ayyagari et al. (2011) and Becker et al. (2020) find that technology usage and technology characteristics influence technostress. In several studies, selected digital technologies, including smartphones (Lee et al., 2014) and enterprise resource planning (ERP) systems (Maier, Laumer, & Weinert, 2015), have been investigated for their effects on technostress. However, to date, we lack understanding of the interplay of the degree of workplace digitalization and technostress.

The degree of workplace digitalization is the extent to which a workplace is equipped with digital technologies. For employees, the degree of workplace digitalization is primarily determined by their employers, who decide on IT strategies and procurement, deployment, and use of digital technologies. High levels of digitalization shall foster the positive effects of digitalization and support the efficiency and effectiveness of work (Colbert et al., 2016). However, increasing degrees of digitalization might lead to rising levels of technostress, which is associated with adverse effects on employees' productivity, satisfaction, well-being, and health. Nevertheless, since not digitalizing work is hardly an option for companies due to the constant competition with other organizations, we need to understand the exact relationship between the degree of workplace digitalization, possible inhibiting measures, and different technostress factors. Thus, we formulate the following two research questions:

RQ1: How is the degree of workplace digitalization linked to technostress?

RQ2: How do the technostress inhibitors literacy facilitation, involvement facilitation, and technical support provision moderate the relationship of the degree of workplace digitalization and technostress?

To answer these research questions, we build research models to assess the effect of the degree of workplace digitalization on technostress and the effects of three different inhibitors (literacy facilitation, involvement facilitation, and technical support provision) on this relationship. We chose these three inhibitors as they are the most established in prior technostress literature (e.g., Ragu-Nathan et al., 2008; Tarafdar et al., 2011). We test the models empirically with survey data of 2,640 German employees. We find that a higher degree of workplace digitalization increases technostress and is associated with higher inhibitors, but it shows different effects on individual technostress creators. The effects also differ between the three inhibitors. Literacy facilitation and technical support provision negatively affect technostress. Further, literacy facilitation moderates the effect of the degree of workplace digitalization on technostress. Surprisingly, involvement facilitation increases technostress. Our results give evi-

dence for the fact that high degrees of workplace digitalization cause high levels of technostress. Further, we can draw recommendations regarding possible measures to inhibit this effect.

The remainder of this paper is structured as follows: Section 2.2.2 sets up the theoretical foundation on the digitalization of workplaces and technostress. Section 2.2.3 introduces our research models and hypotheses. Section 2.2.4 describes the design and operationalization of the survey as well as its results. Section 2.2.5 discusses the findings. Section 2.2.6 illustrates the theoretical contributions and practical implications for individuals, organizations, and IT designers and provides an outlook for future research.

2.2.2. Theoretical background

2.2.2.1. Digitalization of workplaces

Employees today face major changes and ever more digital technologies at their workplaces through organizations' ongoing digitalization (Colbert et al., 2016). Digital technologies are all "combinations of information, computing, communication, and connectivity technologies" (Bharadwaj et al., 2013 according to Vial, 2019, p. 118). There is no particular research stream on workplace digitalization in IS literature (Köffer, 2015), and different definitions exist in practice. According to Williams and Schubert (2018, p. 480), "the digital workplace is an integrated platform that provides all the tools and services to enable employees to effectively undertake their work, both alone and with others, regardless of location and is strategically coordinated and managed through digital workplace designs that are agile and capable of being adapted to meet future organizational requirements and technologies."

The degree of digitalization of workplaces differs between jobs, organizations, and different sectors (Fitzgerald et al., 2013; Reimann et al., 2020). For example, many jobs are highly digital in the information and communication sector, with employees using laptops, smartphones, and various communication and collaboration applications. In other sectors, such as healthcare, many activities are still person-centered and non-digital, with employees using only a few different digital technologies.

Digitalization of workplaces brings chances for individuals (e.g., automation, enhanced decision making, access to information, increased performance, collaboration, flexibility) (Barley et al., 2011; Colbert et al., 2016; Neumeier et al., 2017; van Knippenberg et al., 2015). At the same time, working at a digital workplace requires employees to bring or build a specific set of skills like analytical skills, leadership skills, self-awareness, and digital fluency (Colbert et

al., 2016; Hess et al., 2016; Vial, 2019). Further, Colbert et al. (2016) name challenging effects on individuals like excessive amounts of emails that have to be answered, the blurring of boundaries between work and private life, and decreased productivity due to constant interruptions via digital technologies.

2.2.2.2. Technostress

In IS literature, a whole research stream addresses the consequence of workplace digitalization for individuals, namely technostress (i.e., stress caused by the use of digital technologies) (e.g., Adam et al., 2017; Lee et al., 2014; Maier, Laumer, & Weinert, 2015; Ragu-Nathan et al., 2008; Riedl, 2013; Tarafdar et al., 2011; Tarafdar et al., 2019). Tarafdar et al. (2015, p. 103) define technostress as "stress that users experience as a result of their use of IS in the organizational context." Recent literature on technostress can be categorized by three questions: Which technostress creators exist? Which consequences are caused by technostress? Which factors inhibit technostress?

Concerning technostress creators, research has identified six relevant factors: techno-invasion, techno-overload, techno-complexity, techno-uncertainty, techno-insecurity (Ragu-Nathan et al., 2008; Tarafdar et al., 2007), and techno-unreliability (Adam et al., 2017; Ayyagari et al., 2011). They are defined in Appendix 2.2-1. The technostress creators refer to the use of digital technologies. Tarafdar et al. (2019) see the "technology environment conditions" as an antecedent of technostress but also show that the stream of "future of work" is understudied in technostress literature. Concerning the relationship between the degree of workplace digitalization and technostress, several studies have been conducted to investigate the effect of digital technologies on technostress (e.g., Ayyagari et al., 2011; Lee et al., 2014; Maier, Laumer, & Weinert, 2015). However, there is even less evidence when considering the overall degree of workplace digitalization instead of single technologies, groups of technologies, or specific characteristics and features of technologies, and we do not find prior research investigating the relationship of the whole portfolio of digital technologies with technostress.

Concerning the consequences of technostress, many different studies have already been conducted. On the side of the organizational outcomes, reduced end-user satisfaction has been found, followed by reduced job satisfaction, performance, productivity, and organizational commitment (Ragu-Nathan et al., 2008; Srivastava et al., 2015; Tarafdar et al., 2007; Tu et al., 2005). Further, technostress harms individuals' well-being and is associated with increased exhaustion and burnout (Day et al., 2012; Galluch et al., 2015).

The adverse effects of technostress can be counteracted by establishing appropriate technostress inhibitors. Concerning these factors, research primarily concentrates on three inhibitors: literacy facilitation, involvement facilitation, and technical support provision (Ragu-Nathan et al., 2008). Literacy facilitation refers to measures taken by the employer to promote the sharing of knowledge on the use of digital technologies within the organization. Involvement facilitation refers to the employer's involvement of employees in the process of introducing new digital technologies. Technical support by the employer (e.g., a helpdesk) assists employees in solving problems related using digital technologies. See Appendix 2.2-1 for definitions of these three inhibitors. Ragu-Nathan et al. (2008) identify literacy facilitation, involvement facilitation, and technical support provision as fact that positively affect job satisfaction, organization, and continuance commitment. Hence, these inhibitors counteract some effects of technostress.

All studies contribute to acquiring knowledge about technostress, its antecedents, inhibitors, and possible outcomes. However, no research endeavor has yet put a holistic view on workplace digitalization and its effect on technostress. Nevertheless, we believe that such a view is required for being able to mitigate technostress. Thus, we aim to close this gap and investigate the effect of the degree of workplace digitalization (i.e., the number of digital technologies at a workplace) on technostress. We also aim to understand the inhibiting effects of organizational mechanisms like literacy facilitation, involvement facilitation, and technical support provision.

2.2.3. Hypotheses linking the degree of workplace digitalization, technostress creators, and technostress inhibitors

To answer our research questions, we build three models to investigate the relationship of the focused constructs. Our models' central paradigm is that the degree of workplace digitalization influences the level of technostress and that certain inhibiting factors can counteract this effect.

There is little evidence on the effect of technology usage on technostress. Ayyagari et al. (2011) include "technology usage" as a control variable for technostress. Further, some studies analyze different single technologies and their effect on technostress. Lee et al. (2014) show that compulsive smartphone usage increases technostress. Maier, Laumer, and Weinert (2015) find that different characteristics of ERP systems like usefulness and reliability can affect technostress. However, there is only little evidence on the effect of the degree to which digital technologies are used. Stich et al. (2019) investigate the extent to which an individual uses

email on technostress. Further, Galluch et al. (2015) find that a higher quantitative demand (i.e., the number of interruptions caused by digital technologies) increases the perceived stress.

According to Lazarus and Folkman (1984), stress occurs when environmental demands exceed an individual's resources to deal with the demands. At the digital workplace, the environmental demands are the technology environment conditions (Tarafdar et al., 2019). Thus, the different digital technologies an individual works with.

The ongoing digitalization of workplaces and the corresponding increase in the number of digital technologies at the workplace leads to a required increase in the individuals' skills and resources to deal with technologies. In many cases, this may happen due to increased media competence of individuals in general, rising experience with the digital technologies on the job, selection by the employer when recruiting employees for the respective workplace, or self-selection by the individual when applying for suitable jobs. However, as digitalization progresses rapidly, the change in resources does not always meet the changed technology environment conditions. Thus, we believe that a higher degree of workplace digitalization is associated with higher levels of technostress creators and hypothesize:

H1: A higher degree of workplace digitalization is associated with higher technostress.

To detail the understanding of the relationship of the degree of workplace digitalization with the second-order construct technostress, we also aim to analyze the effect on the underlying first-order constructs of technostress: techno-invasion, techno-overload, techno-complexity, techno-insecurity, techno-uncertainty, and techno-unreliability. As we hypothesize that the combined construct is positively affected by a higher degree of workplace digitalization, we consider the same effect for the detailed technostress creators. Thus, we propose the hypotheses H2a to H2f as follows.

H2a: A higher degree of workplace digitalization is associated with higher techno-invasion.

H2b: A higher degree of workplace digitalization is associated with higher techno-overload.

H2c: A higher degree of workplace digitalization is associated with higher techno-complexity.

H2d: A higher degree of workplace digitalization is associated with higher techno-insecurity.

H2e: A higher degree of workplace digitalization is associated with higher techno-uncertainty.

H2f: A higher degree of workplace digitalization is associated with higher techno-unreliability.

Technostress inhibitors are possible measures to counteract the emergence of technostress creators. Ragu-Nathan et al. (2008) analyzed the effect of all three inhibitors as a second-order construct on the consequences of technostress. They found that the inhibitors are associated with increased job satisfaction, organizational commitment, and continuance commitment. In the same direction, Fuglseth and Sørebø (2014) found increased satisfaction with ICT use associated with the inhibitors. Additionally, Day et al. (2012) found that technical support provision moderated the effect between technostress creators and its consequences. Higher technical support provision decreased the effect of ICT hassles on strain. Further studies analyzed the direct effect on the arising of technostress rather than on its consequences. Tarafdar et al. (2010) found a decreasing effect of involvement facilitation on technostress creators. In line with that, Tarafdar et al. (2015) found technostress inhibitors to be associated with lower levels of technostress creators.

However, none of these research contributions has investigated to what extent the degree of workplace digitalization is associated with technostress inhibitors. As Vial (2019) states, digital transformation of workplaces requires structural changes such as new employee skills for the digital work – which refers to literacy facilitation. Further, according to Vial's (2019) extensive literature review on digital transformation, involvement facilitation can be one mechanism to overcome employees' resistance to digital transformation. For technical support provision, we believe that in organizations with higher digitalization, key processes depend on digital technologies, making it essential to have adequate technical support to sustain the ability to work at any time. In line with these notions, we suggest that organizations take such measures when the degree of workplace digitalization is high. Thus, we hypothesize:

H3a: A higher degree of workplace digitalization is associated with higher literacy facilitation.

H3b: A higher degree of workplace digitalization is associated with higher involvement facilitation.

H3c: A higher degree of workplace digitalization is associated with higher technical support provision.

Literacy facilitation is an organizational measure to help employees enhance their personal resources and skills to deal with digital technologies. That is why it helps individuals to better deal with the increased demands of a higher number of digital technologies at the workplace. Thus, we hypothesize that literacy facilitation helps to decrease the increasing effect of digitalization on technostress creators.

H4a: Literacy facilitation moderates the effect of digitalization of the workplace on technostress creators in the sense that higher literacy facilitation attenuates the increasing effect of digitalization of the workplace on technostress creators.

Involvement facilitation means involving employees before launching new digital technologies at their workplace. Thereby, employees can influence the type of technology and, thus, the technology environment conditions at the workplace. According to the person-environment fit theory, a misfit between the environmental supplies and the personal values to what extent supplies are desired is associated with stress creators (Stich et al., 2019). Thus, if individuals can influence their environment, they can create it according to their values, leading to a decreased level of technostress creators. Further, involving individuals in launching new digital technologies makes them learn about the advantages and disadvantages of different technologies. This learning opportunity leads to an increased understanding of the digital technology in general and how it can be used for different tasks. Also, involvement facilitation gives the employees a feeling of having something to say, which increases the employees' self-efficacy to affect their workplace conditions and gives them a higher internal locus of control (Anderson, 1977). Control has already been found to reduce strain from technostress (Pirkkalainen et al., 2017). We believe that these involvement processes take action when the degree of workplace digitalization increases and suppose that involvement facilitation thus decreases the increasing effect of workplace digitalization on technostress creators.

H4b: Involvement facilitation moderates the effect of digitalization of the workplace on technostress creators in the sense that higher literacy facilitation attenuates the increasing effect of digitalization of the workplace on technostress creators.

Technical support provision helps individuals to deal with problems that occur when working with digital technologies. With an increasing number of digital technologies at the workplace, there are more issues with the technologies (e.g., due to updates or incompatibilities between different digital technologies) that individuals have to deal with. Here, helpdesk experts may help. Also, knowing that if they need help, individuals can reach out to the helpdesk increases the perceived internal locus of control. Thus, technical support provision also should decrease the effect of degree of workplace digitalization on technostress creators.

H4c: Technical support provision moderates the effect of digitalization of the workplace on technostress creators in the sense that higher literacy facilitation attenuates the increasing effect of digitalization of the workplace on technostress creators.

Figure 2.2-1 summarizes the hypotheses in three research models. Furthermore, we included several control variables into the models to identify the effect of the degree of workplace digitalization and the technostress inhibitors. The control variables are age, gender, occupational activity, school qualification, and professional qualification.

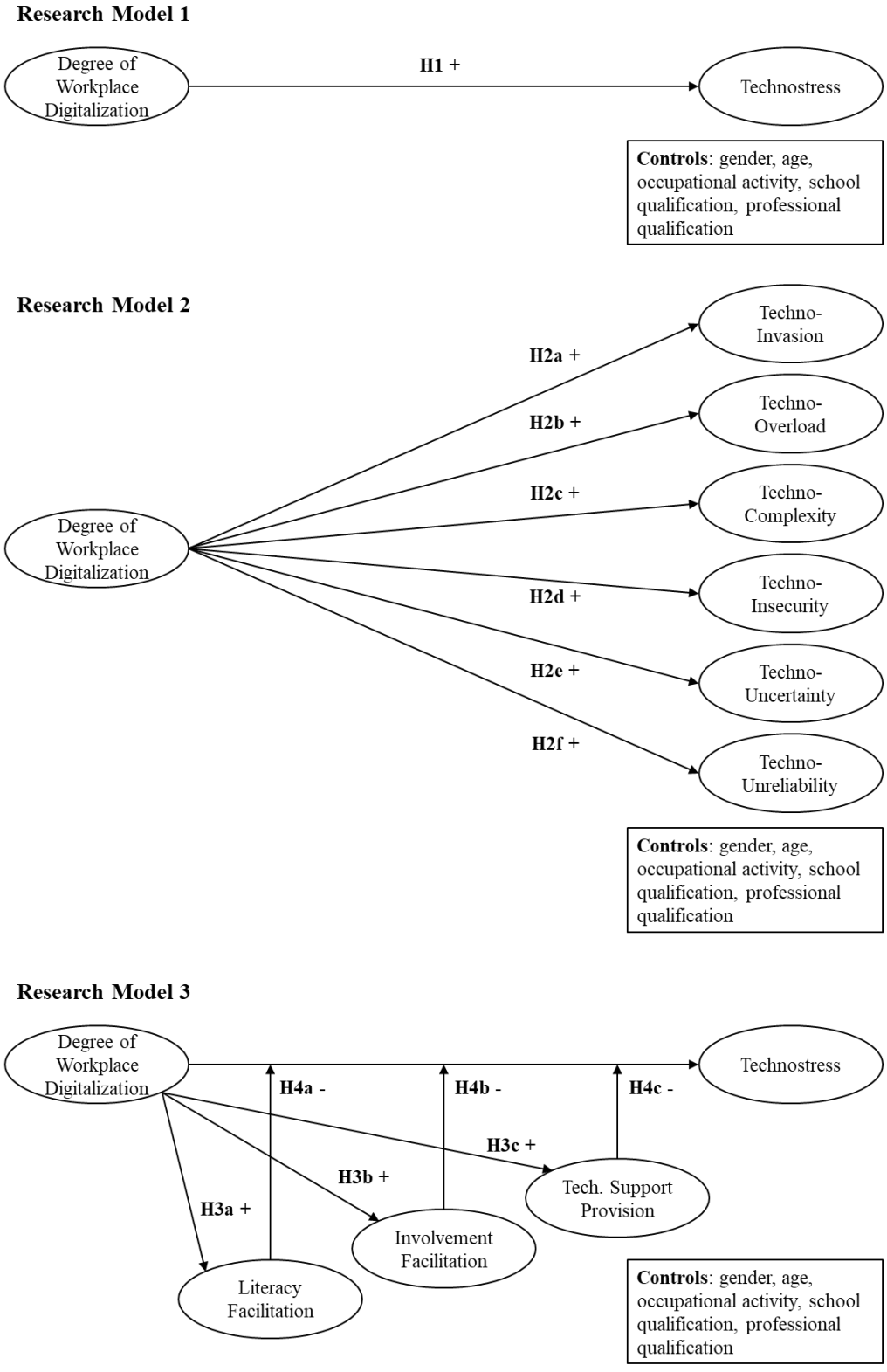


Figure 2.2-1: Research model

2.2.4. Research methodology, analysis, and results

We designed an online survey to measure all constructs from the research model and control variables to empirically test the hypotheses.

2.2.4.1. Questionnaire development

The first part of the survey was to measure respondents' workplace equipment with digital technologies, that is, the degree of workplace digitalization. For this purpose, participants were shown a list of 40 technologies, like smartphones, laptops, or text, spreadsheet, and presentation software. The list of technologies was generated based on the ACM Computing Classification System, the job information of the German Federal Employment Agency, and several job advertisements. The development process is described in detail in (disguised for review). The complete list of technologies is provided in Appendix 2.2-2. The survey participants were asked to select all technologies they use actively or passively in their daily work.

Following this section, the survey dealt with the six dimensions of technostress (invasion, overload, complexity, insecurity, uncertainty, and unreliability) and its inhibiting factors (literacy facilitation, involvement facilitation, and technical support provision). Therefore, we used the item scales from Ayyagari et al. (2011) for techno-unreliability and Ragu-Nathan et al. (2008) for all other constructs. Following Tarafdar et al. (2007) and Ragu-Nathan et al. (2008), we model technostress as a reflective second-order construct comprised of the individual dimensions of technostress.

Furthermore, we asked the participants for their gender (female, male, or other), year of birth, German federal state, industry, type of occupational activity according to the German Federal Employment Agency as well as the school qualification and professional qualification according to the German Federal Statistical Office.

As ex-ante precautions against common method bias (CMB), we assured the respondents of anonymity of their answers and stated that there were no right or wrong answers to the questions (Podsakoff et al., 2003). We translated all items into German for the questionnaire and measured them on a five-point Likert scale ("fully disagree," "rather disagree," "undecided," "rather agree," "fully agree"). Appendix 2.2-3 provides an overview of all items.

2.2.4.2. Sample characteristics

Participants were recruited via a professional panel provider, were compensated for their participation, and completed the survey online. The inclusion criterion was that they are active members of the German workforce. To ensure data quality, we implemented an attention check ("If you are answering this survey cautiously, tick the second box from the left.").

2,640 participants completed the survey and passed the attention check. Table 2.2-1 gives an overview of several demographics of our diverse sample. The average age was just under 48 years, with a range between 19 and 88 years. The average contracted weekly working time of the participants was 34.4 hours. The average actual weekly working time of 36.9 was slightly higher, resulting in average overtime of 2.5 hours.

Gender	**Absolute Frequency**	**Relative Frequency**
Female	1,417	53.7%
Male	1,219	46.2%
Other	4	0.2%
Total	2,640	100.0%
Age in Years	**Absolute Frequency**	**Relative Frequency**
Below 25	40	1.5%
25 to 34	387	14.7%
35 to 44	558	21.1%
45 to 54	835	31.6%
55 to 64	735	27.8%
65 and above	85	3.2%
Total	2,640	100.0%
Type of Occupational Activity according to the German Federal Employment Agency	**Absolute Frequency**	**Relative Frequency**
Unskilled or semi-skilled activities	153	5.8%
Specialist activities	1,248	47.3%
Complex specialist activities	595	22.5%
Highly complex activities	207	7.8%
Supervisory activities	124	4.7%
Leadership activities	313	11.9%
Total	2,640	100.0%
School Qualification according to the German Federal Statistical Office	**Absolute Frequency**	**Relative Frequency**
Without or primary / lower secondary school leaving certificate	221	8.4%
intermediate school leaving certificate	1,003	38.0%
Entrance qualification for studies at University of Applied Sciences	345	13.1%
higher education entrance qualification	1,071	40.6%
Total	2,640	100.0%

Professional Qualification according to the German Federal Statistical Office	Absolute Frequency	Relative Frequency
No professional qualification	96	3.6%
Apprenticeship	1,090	41.3%
Specialized Technical College	487	18.4%
Specialized Academy	138	5.2%
University of Applied Sciences	318	12.0%
University	471	17.8%
Doctorate	40	1.5%
Total	2,640	100.0%

Table 2.2-1: Demographics of the sample

We define the degree of workplace digitalization as the number of digital technologies used at a respondent's workplace. As respondents were able to select from a list of 40 different digital technologies, the degree of workplace digitalization ranges from 0 to 40, the mean is 13.08. Figure 2.2-2 shows the histogram. email, printers/scanners/fax machines, world wide web, stationary personal computers, and text/spreadsheet/presentation software were the most frequently selected digital technologies. Medical software, augmented/virtual/mixed reality, and modeling/simulation software were the least frequently chosen ones.

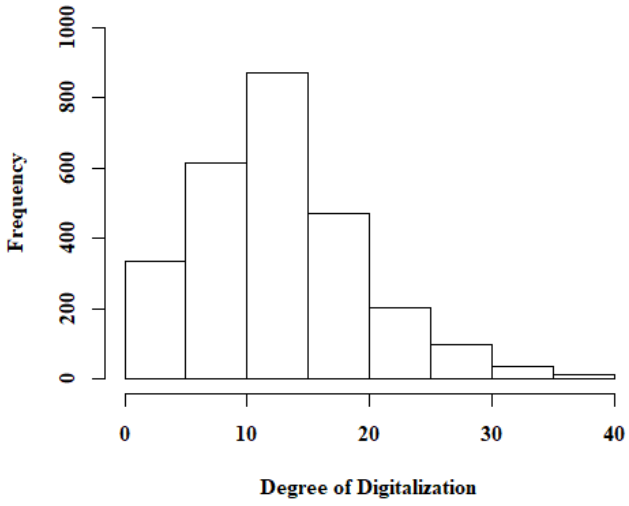


Figure 2.2-2: Histogram of the degree of workplace digitalization

2.2.4.3. Assessment of the measurement model

We tested the measurement model using confirmatory factor analysis (CFA). Therefore, we built a model containing all latent constructs and associated manifest survey items without any relationship among the latent constructs. Table 2.2-2 shows means (on a scale from 1 to 5), standard deviations (SD), loadings, Cronbach's Alpha, and the average variance extracted (AVE) for all constructs. Appendix 2.2-3 further shows the means, standard deviations, and

factor loadings for each item. As the results show, all factor loadings are greater than 0.6, and Cronbach's Alpha values are greater than 0.7 and, thus, meet the respective thresholds (Nunnally & Bernstein, 1994). These values indicate good construct reliability. Also, each construct's AVE is higher than 0.5, indicating convergent validity (Bagozzi & Yi, 1988; Hair et al., 2012).

Construct	# Items	Mean	SD	Loadings	Cronbach's α	AVE
Techno-Invasion	3	1.961	1.161	0.693-0.812	0.783	0.547
Techno-Overload	4	2.348	1.231	0.850-0.891	0.861	0.759
Techno-Complexity	5	2.085	1.109	0.708-0.850	0.884	0.611
Techno-Insecurity	4	1.869	1.050	0.644-0.798	0.758	0.512
Techno-Uncertainty	4	2.786	1.217	0.719-0.897	0.904	0.712
Techno-Unreliability	3	2.378	0.961	0.899-0.935	0.936	0.832
Literacy Facilitation	4	3.052	1.262	0.785-0.863	0.895	0.682
Involvement Facilitation	3	2.281	1.305	0.678-0.909	0.866	0.714
Technical Support Provision	3	3.460	1.226	0.835-0.932	0.923	0.807

Table 2.2-2: Mean, SD, loadings, Cronbach's α, and AVE of each construct after CFA

Further, each construct's square root of the AVE is higher than the highest correlation with other constructs (Fornell-Larcker criterion, see Table 2.2-3), indicating discriminant validity.

Construct	TIV	TO	TC	TIS	TUC	TUR	LF	IF	TSP
Techno-Invasion	0.740								
Techno-Overload	0.699	0.871							
Techno-Complexity	0.356	0.439	0.782						
Techno-Insecurity	0.572	0.626	0.700	0.716					
Techno-Uncertainty	0.367	0.422	0.134	0.376	0.844				
Techno-Unreliability	0.047	0.064	0.243	0.174	-0.121	0.912			
Literacy Facilitation	0.089	0.045	-0.186	-0.068	0.357	-0.451	0.826		
Involvement Facilitation	0.281	0.164	-0.130	0.085	0.308	-0.357	0.580	0.845	
Technical Support Provision	0.017	0.018	-0.185	-0.100	0.229	-0.452	0.711	0.379	0.898

Table 2.2-3: Inter-factor correlations (square root of the AVE in the diagonal)

We tested for common method variance (CMV) by applying the correlational marker technique without and with a theoretically unrelated marker variable as post-hoc detection method (Lindell & Whitney, 2001; Richardson et al., 2009). Both procedures suggest that CMV is not a major concern in our data. Overall, we conclude that the measurement model has satisfactory properties, and we can proceed with testing the theoretical hypotheses.

2.2.4.4. Hypotheses testing

We apply covariance-based structural equation modeling (CB-SEM) to estimate the three research models. The models' fit was judged according to various fit indices, as shown in Table 2.2-4. We present χ^2 values and degrees of freedom in Table 2.2-4 but did not consider them for model fit evaluation because this indicator has shown to be sensible to sample size in simulation studies (Boomsma, 1982). All indices comply with the respective thresholds indicating satisfactory model fit of all three models.

Fit Measures	Threshold	Source of Threshold	Model 1		Model 2		Model 3	
χ^2			3,135		1,596		8,175	
Degrees of Freedom			278		239		938	
RMSEA	< 0.06	Lei and Wu (2007)	0.062	X	0.046	✓	0.054	✓
SRMR	< 0.08	Gefen et al. (2000)	0.085	X	0.033	✓	0.116	X
NFI	> 0.90	Gefen et al. (2000)	0.914	✓	0.956	✓	0.904	✓
TLI	> 0.90	Gefen et al. (2000)	0.908	✓	0.949	✓	0.905	✓
CFI	> 0.90	Gefen et al. (2000)	0.921	✓	0.962	✓	0.914	✓
AGFI	> 0.80	Gefen et al. (2000)	0.880	✓	0.930	✓	0.846	✓

Note: ✓ indicates that a threshold is met, X indicates that it is not met.
Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), Normed Fit Index (NFI), Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), Adjusted Goodness of Fit Index (AGFI)

Table 2.2-4: Fit indices for the three research models

Figure 2.2-3 shows the estimated models. The results for the control variables and the loadings of the first-order technostress creators on the second-order technostress construct in model 1 and model 3 are in Appendix 2.2-4.

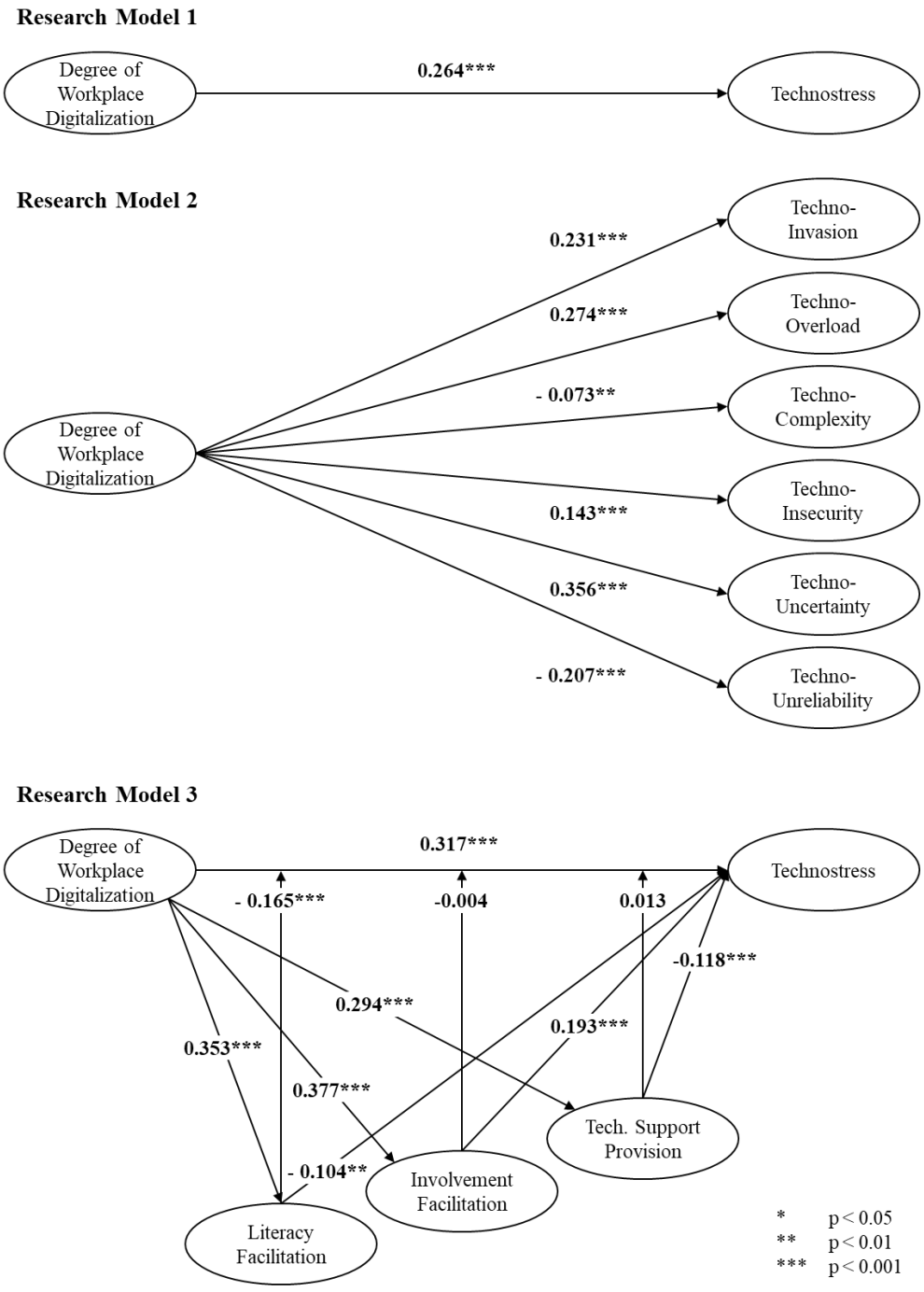


Figure 2.2-3: Results of research models

In model 1, the effect of a higher degree of workplace digitalization on technostress is significant and positive. This finding supports H1. In model 2, the effect of a higher degree of workplace digitalization on each single technostress creator is significant. However, only the effect on techno-invasion, techno-overload, techno-insecurity, and techno-uncertainty, is positive as expected in H2a, H2b, H2d, and H2e. Regarding techno-complexity and techno-unreliability, the effect is negative. Hence, H2c and H2f are not supported by the data.

Figure 2.2-4 plots the estimated linear effects of the degree of workplace digitalization on technostress and its dimensions. Since we restricted participation in the study to participants who use at least one digital technology at their workplace, the degree of digitalization starts at one on the scale. Due to the low number of respondents with a degree of workplace digitalization above 30, we exclude those 49 data points. The figure illustrates the data from model 1 and model 2 (see Figure 2.2-4): Among the technostress creators, techno-uncertainty is perceived as the strongest and is most affected by an increasing degree of workplace digitalization. Techno-complexity and techno-unreliability are lower with high levels of workplace digitalization as compared to low levels of workplace digitalization. The effect of the degree of workplace digitalization on technostress is a composite of the effects shown for the individual technostress creators. As such, the effect is positive with a moderate slope.

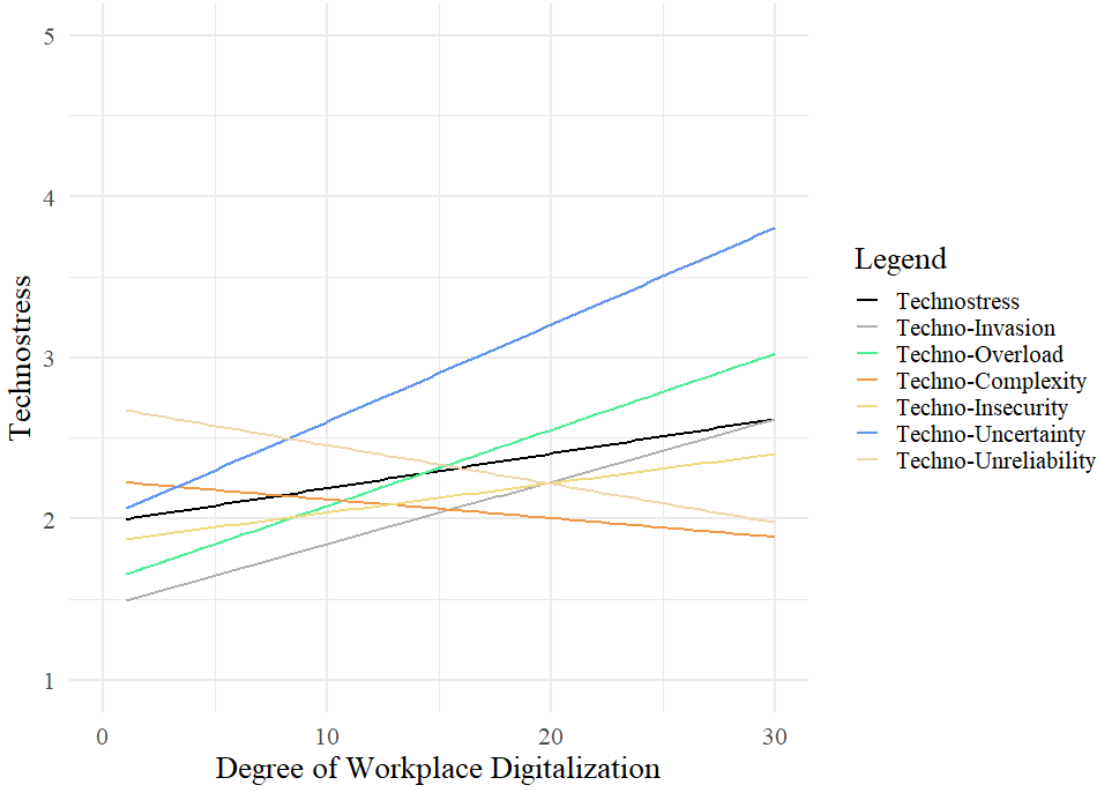


Figure 2.2-4: Linear effects of the degree of digitalization on technostress and its dimensions

For model 3, we find significant effects of degree of workplace digitalization on the three inhibitors (see Figure 2.2-3). This finding supports H3a-H3c. Concerning the moderating effects of the inhibitors, the effects differ between the three inhibitors. For literacy facilitation, the results show a significant and negative direct effect on technostress. Also, literacy facilitation's moderating effect on the relationship between the degree of workplace digitalization

on technostress is significant and negative, supporting H4a. Literacy facilitation attenuates the increasing effect of a higher degree of workplace digitalization on technostress. There is also a significant direct effect on technostress creators for involvement facilitation, but it is positive, meaning that involvement facilitation increases technostress. Further, no moderating effect as expected in H4b can be found. For technical support provision, the effect on technostress is found to be significant and negative. However, the moderating effect of technical support provision on the relationship of degree of workplace digitalization on technostress is not significant. Thus, H4c does not find support. Table 2.2-5 summarizes the hypotheses and their empirical support.

Theoretical Hypotheses				**Empirical Results**	**Support for Hypotheses**
Model 1	H1	pos.	Degree of Workplace Digitalization → Technostress Creators	+	✓
Model 2	H2a	pos.	Degree of Workplace Digitalization → Techno-Invasion	+	✓
	H2b	pos.	Degree of Workplace Digitalization → Techno-Overload	+	✓
	H2c	pos.	Degree of Workplace Digitalization → Techno-Complexity	-	X
	H2d	pos.	Degree of Workplace Digitalization → Techno-Insecurity	+	✓
	H2e	pos.	Degree of Workplace Digitalization → Techno-Uncertainty	+	✓
	H2f	pos.	Degree of Workplace Digitalization → Techno-Unreliability	-	X
Model 3	H3a	pos.	Degree of Workplace Digitalization → Literacy Facilitation	+	✓
	H3b	pos.	Degree of Workplace Digitalization → Involvement Facilitation	+	✓
	H3c	pos.	Degree of Workplace Digitalization → Technical Support Provision	+	✓
	H4a	neg.	Degree of Workplace Digitalization x Literacy Facilitation → Technostress Creators	-	✓
	H4b	neg.	Degree of Workplace Digitalization x Involvement Facilitation → Technostress Creators	n.s.	X
	H4c	neg.	Degree of Workplace Digitalization x Technical Support Provision→ Technostress Creators	n.s.	X

Note: plus signs indicate a significant and positive effect, minus signs a significant and negative effect, n.s. a non-significant effect at the 5 % level.

Table 2.2-5: Overview of hypotheses and empirical results

The heterogeneity of the technostress creators observed in model 2 suggests that the focus of H4a to H4c on technostress in general rather than individual technostress creators, and the corresponding estimation of model 3 might mask more nuanced effects of the technostress

inhibitors. Thus, we estimated a fourth model containing the three inhibitors and their moderating effect on the relationship between workplace digitalization and the six technostress creators. In a way, this model 4 is a blend of models 2 and 3. The key results are presented in Table 2.2-6. We present it as a table rather than a figure for the model's complexity. The satisfactory fit indices and an extended version of the table, including the control variables, are displayed in Appendix 2.2-5 and Appendix 2.2-6.

Relationship	**Estimate**	**Sig.**
Degree of Workplace Digitalization → Techno-Invasion	0.226	***
Degree of Workplace Digitalization → Techno-Overload	0.336	***
Degree of Workplace Digitalization → Techno-Complexity	0.010	
Degree of Workplace Digitalization → Techno-Insecurity	0.202	***
Degree of Workplace Digitalization → Techno-Uncertainty	0.291	***
Degree of Workplace Digitalization → Techno-Unreliability	-0.003	
Literacy Facilitation → Techno-Invasion	-0.085	*
Literacy Facilitation → Techno-Overload	-0.124	**
Literacy Facilitation → Techno-Complexity	-0.095	*
Literacy Facilitation → Techno-Insecurity	-0.129	**
Literacy Facilitation → Techno-Uncertainty	0.266	***
Literacy Facilitation → Techno-Unreliability	-0.162	***
Involvement Facilitation → Techno-Invasion	0.250	***
Involvement Facilitation → Techno-Overload	0.132	***
Involvement Facilitation → Techno-Complexity	-0.008	
Involvement Facilitation → Techno-Insecurity	0.185	***
Involvement Facilitation → Techno-Uncertainty	0.074	**
Involvement Facilitation → Techno-Unreliability	-0.156	***
Technical Support Provision → Techno-Invasion	-0.096	**
Technical Support Provision → Techno-Overload	-0.044	
Technical Support Provision → Techno-Complexity	-0.112	***
Technical Support Provision → Techno-Insecurity	-0.121	***
Technical Support Provision → Techno-Uncertainty	-0.074	*
Technical Support Provision → Techno-Unreliability	-0.275	***
Degree of Workplace Digi. x Literacy Facilitation → Techno-Invasion	-0.107	*
Degree of Workplace Digi. x Literacy Facilitation → Techno-Overload	-0.196	***
Degree of Workplace Digi. x Literacy Facilitation → Techno-Complexity	-0.069	
Degree of Workplace Digi. x Literacy Facilitation → Techno-Insecurity	-0.092	
Degree of Workplace Digi. x Literacy Facilitation → Techno-Uncertainty	-0.038	
Degree of Workplace Digi. x Literacy Facilitation → Techno-Unreliability	-0.065	
Degree of Workplace Digi. x Involvement Facilitation → Techno-Invasion	0.054	
Degree of Workplace Digi. x Involvement Facilitation → Techno-Overload	-0.012	
Degree of Workplace Digi. x Involvement Facilitation → Techno-Complexity	0.007	
Degree of Workplace Digi. x Involvement Facilitation → Techno-Insecurity	-0.034	
Degree of Workplace Digi. x Involvement Facilitation → Techno-Uncertainty	-0.041	
Degree of Workplace Digi. x Involvement Facilitation → Techno-Unreliability	-0.020	

Relationship	Estimate	Sig.
Degree of Workplace Digi. x Technical Support Provision → Techno-Invasion	-0.023	
Degree of Workplace Digi. x Technical Support Provision → Techno-Overload	0.047	
Degree of Workplace Digi. x Technical Support Provision → Techno-Complexity	-0.001	
Degree of Workplace Digi. x Technical Support Provision → Techno-Insecurity	-0.006	
Degree of Workplace Digi. x Technical Support Provision → Techno-Uncertainty	0.002	
Degree of Workplace Digi. x Technical Support Provision → Techno-Unreliability	0.017	

Note: *** p < 0.001, ** p < 0.01, * p < 0.05; full results including the control variables are in 0.

Table 2.2-6: Estimates for model 4

Model 4 suggests three key results: First, when including the technostress inhibitors, the significant and negative effect of degree of workplace digitalization on techno-complexity and techno-unreliability that surprisingly occurred in model 2 vanishes. In model 4, the degree of workplace digitalization is not significantly related to techno-complexity or techno-unreliability. The effects of the degree of workplace digitalization on the other four technostress creators are basically unaffected. Second, literacy facilitation and technical support provision have significant and negative direct effects on most technostress creators. Involvement facilitation has varying direct effects on the technostress creators. Third, the technostress inhibitors hardly moderate the effect of the degree of workplace digitalization on technostress creators. Only literacy facilitation attenuates the effect of the degree of workplace digitalization on techno-invasion and techno-overload.

2.2.5. Discussion

Digitalization of work leads to more digital technologies being part of employees' workplaces (Barley et al., 2011). At the same time, there is substantial heterogeneity among workplaces. Some workplaces might only have very few digital technologies. For example, employees filling the shelves in supermarkets might only have a radio with a headset. Other workplaces might have many digital technologies. For example, stockbrokers having multiple computers and phones, a printer, standard software like a web browser, advanced modeling and analysis software, security systems like a virtual private network, a smart card, and the like. In short, the degree of workplace digitalization differs between workplaces. One aim of our research was to understand the effect of this degree of workplace digitalization on technostress.

Further, like any other type of stress, technostress is highly individual. Nevertheless, there are technostress inhibitors an organization can put in place to prevent technostress (Ragu-Nathan et al., 2008; Tarafdar et al., 2010). Hence, a second aim was to study how these technostress inhibitors affect the relationship between the degree of workplace digitalization and workers'

technostress. Thus, we derived theoretical hypotheses and conducted a large-scale online survey.

Our results suggest that a higher degree of workplace digitalization increases technostress, but the relationship differs among the six technostress creators. While most technostress creators are more pronounced with a high rather than low degree of workplace digitalization, the opposite is the case for techno-complexity and techno-unreliability.

The complexity associated with digital technologies can force users to learn how to handle them (Ragu-Nathan et al., 2008). One might think (as in fact, we did in our hypothesis H2c) that an increasing degree of workplace digitalization leads to more complexity and more effort for learning. However, the data suggest otherwise. Hypotheses to explore in future research are that the selection of digitally savvy employees (either self-selection or selection by the supervisor or employer) is responsible for the surprising effect or that learning how to deal with a specific technology has positive side-effects for dealing with other technologies. In other words, competencies in handling digital technologies might not be fully technology-specific and, thus, exposure to a highly digital workplace may eventually lead to reduced perceived complexity.

The perception of techno-unreliability might be lower for a high degree of workplace digitalization, as some technologies might be substitutes. Take the example of an employee equipped with a landline phone, a smartphone, and a computer mainly used to browse the internet, access documents in cloud storage, and email. When one of the three devices is temporarily not operational, the other two in combination afford to perform basically the same work (likely with less convenience and lower productivity than the complete set of three devices). Testing whether such substitutability explains the surprising result regarding H2f is a matter for future research.

Despite these two counterintuitive effects, the overall picture is that a higher degree of workplace digitalization goes along with higher levels of technostress.

The degree of workplace digitalization is also positively associated with the three investigated technostress inhibitors. However, the effect of technostress inhibitors on technostress is not always as expected previously. Literacy facilitation behaves as expected as it decreases technostress and the positive relationship between the degree of workplace digitalization and technostress. This effect is in line with prior research suggesting that individual resources that are enhanced by literacy facilitation are of great importance in terms of technostress (Tarafdar et

al., 2019). Involvement facilitation has no moderating effect and increases instead of decreases technostress. This results contrasts with Tarafdar et al. (2010) finding a negative effect. Thus, further examination of this relationship is required. When looking at model 4, involvement facilitation has a significantly negative effect on techno-unreliability and a significantly positive effect on techno-invasion, techno-overload, techno-insecurity, and techno-uncertainty. This finding calls for further research to understand these relationships better. Technical support provision does not moderate the relationship between the degree of workplace digitalization and technostress but has a significantly negative direct effect on technostress and most individual technostress creators.

The results also highlight the double-edged effect of workplace digitalization on technostress. While the direct effect on technostress creators is positive – referring to an adverse outcome for individuals – the indirect effect over literacy facilitation and technical support provision is associated with a beneficial effect for the individuals since inhibitors are higher when workplace digitalization is high, and thus their inhibiting effect is stronger.

2.2.5.1. Theoretical contribution

We contribute to theory in three ways. First, we focus on the degree of overall workplace digitalization rather than analyzing specific digital technologies and their effect on technostress. This focus complements prior work of, for example, Maier, Laumer, and Weinert (2015) or Stich et al. (2019). It establishes the degree of workplace digitalization as an important characteristic of the working and technological environment.

Second, we find evidence for the link of the degree of workplace digitalization with technostress. Thereby, we find a significant effect on technostress overall and find significant effects on each of the six individual technostress creators. Prior research mostly builds a second-order factor of technostress based on the technostress creators. We contribute a more detailed understanding. We further show the importance of the individual consideration of technostress creators as we find that only four of the six technostress creators (techno-invasion, techno-overload, techno-insecurity, and techno-uncertainty) are positively affected by a higher degree of workplace digitalization as expected. Techno-complexity and techno-unreliability, however, have a negative relationship with the degree of workplace digitalization. This surprising result should inspire future research to consider different technostress creators individually rather than as one combined construct.

Third, we find evidence for the three-way relationship between the degree of workplace digitalization, technostress inhibitors, and technostress. Thereby, we find an effect of the degree

of workplace digitalization on technostress inhibitors, of technostress inhibitors on the emergence of technostress creators, and the moderating effect of literacy facilitation on the relationship between the degree of workplace digitalization and technostress. Since the effects differ between the three technostress inhibitors and the affected technostress creators, we further strengthen the need to consider them separately.

2.2.5.2. Practical implications

Our results also bring practical implications for organizations. With our large-scale study among German employees, we provide input on the existence and strength of the effect of the degree of workplace digitalization and technostress inhibitors on different technostress creators. Especially literacy facilitation can be an effective measure for organizations to mitigate the adverse effects of increasing workplace digitalization. This finding gives inspiration for mitigating the adverse effects of digitalization without slowing digitalization down. Our specific results for the six technostress creators and the three technostress inhibitors can impact IT and HR departments' decisions to design digital workplaces and leverage inhibitors better.

2.2.6. Limitations and conclusion

Our study has several limitations that leave room for future research. First, our study was conducted in Germany and thus limited to the German workforce. Future research can analyze the robustness of the findings across other nationalities. Second, we collected cross-sectional data. Future work should also consider the effect of an increasingly digitalized workplace on technostress over time. Third, we measured the degree of workplace digitalization by providing participants with a list of 40 technologies to choose from. Even though we believe that these technologies cover the digital technologies present at today's workplaces, we cannot control for completeness of the list as it may change over time.

In conclusion, our research makes an important contribution to knowledge on inhibiting the adverse effects of the ongoing digitalization of workplaces. While organizations will keep on adopting digital technologies and establishing work routines based on digital technologies to achieve the associated benefits, they also have to consider possible adverse outcomes for their employees, such as technostress. Our work shows that inhibitors like literacy facilitation, involvement facilitation, and technical support provision can be effective.

2.2.7. References

Adam, M. T. P., Gimpel, H., Mädche, A., & Riedl, R. (2017). Design blueprint for stress-sensitive adaptive enterprise systems. *Business & Information Systems Engineering*, *59*(4), 277–291. https://doi.org/10.1007/s12599-016-0451-3

Anderson, C. R. (1977). Locus of control, coping behaviors, and performance in a stress setting: A longitudinal study. *Journal of Applied Psychology*, *62*(4), 446–451. https://doi.org/10.1037/0021-9010.62.4.446

Ayyagari, R., Grover, V., & Purvis, R. (2011). Technostress: Technological antecedents and implications. *Management Information Systems Quarterly*, *35*(4), 831–858.

Bagozzi, R., & Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the Academy of Marketing Science*, *16*(1), 74–94. https://doi.org/10.1007/BF02723327

Barley, S. R., Meyerson, D. E., & Grodal, S. (2011). E-mail as a source and symbol of stress. *Organization Science*, *22*(4), 887–906.

Becker, J., Berger, M., Gimpel, H., Lanzl, J., & Regal, C. (2020). Considering characteristic profiles of technologies at the digital workplace: The influence on technostress. In *Proceedings of the 41st International Conference on Information Systems (ICIS)*, Hyderabad, India.

Bharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital business strategy: Toward a next generation of insights. *Management Information Systems Quarterly*, *37*(2), 471–482. https://doi.org/10.25300/MISQ/2013/37:2.3

Boomsma, A. (1982). The robustness of LISREL against small sample sizes in factor analysis models, 149–173.

Brod, C. (1984). *Technostress: The human cost of the computer revolution*. Addison-Wesley.

Colbert, A., Yee, N., & George, G. (2016). The digital workforce and the workplace of the future. *Academy of Management Journal*, *59*(3), 731–739. https://doi.org/10.5465/amj.2016.4003

D'Arcy, J., Herath, T., & Shoss, M. K. (2014). Understanding employee responses to stressful information security requirements: A coping perspective. *Journal of Management Information Systems*, *31*(2), 285–318. https://doi.org/10.2753/MIS0742-1222310210

Day, A., Paquet, S., Scott, N., & Hambley, L. (2012). Perceived information and communication technology (ICT) demands on employee outcomes: The Moderating Effect of

Organizational ICT Support. *Journal of Occupational Health Psychology*, *17*(4), 473–491. https://doi.org/10.1037/a0029837

Fitzgerald, M., Kruschwitz, N., Bonnet, D., & Welch, M. (2013). Embracing digital technology: A new strategic imperative. *MIT Sloan Management Review*, *55*(2), 1–12.

Fuglseth, A. M., & Sørebø, Ø. (2014). The effects of technostress within the context of employee use of ICT. *Computers in Human Behavior*, *40*, 161–170. https://doi.org/10.1016/j.chb.2014.07.040

Galluch, P. S., Grover, V., & Thatcher, J. B. (2015). Interrupting the workplace: Examining stressors in an information technology context. *Journal of the Association for Information Systems*, *16*(1), 1–47.

Gefen, D., Straub, D. W., & Boudreau, M.-C. (2000). Structural equation modeling and regression: Guidelines for research practice. *Communications of the Association for Information Systems*, *4*(1), Article 7. https://doi.org/10.17705/1CAIS.00407

Gimpel, H., Lanzl, J., Manner-Romberg, T., & Nüske, N. (2018). *Digitaler Stress in Deutschland. Eine Befragung von Erwerbstätigen zu Belastung und Beanspruchung durch Arbeit mit digitalen Technologien* (Working Paper Forschungsförderung No. 101). Hans Böckler Stiftung.

Hair, J. F., Sarstedt, M., Ringle, C. M., & Mena, J. A. (2012). An assessment of the use of partial least squares structural equation modeling in marketing research. *Journal of the Academy of Marketing Science*, *40*(3), 414–433. https://doi.org/10.1007/s11747-011-0261-6

Hess, T., Matt, C., Benlian, A., & Wiesböck, F. (2016). Options for formulating a digital transformation strategy. *Management Information Systems Quarterly Executive*, *15*(2), 123–139.

Köffer, S. (2015). Designing the digital workplace of the future: What scholars recommend to practitioners. In *Proceedings of the 36th International Conference on Information Systems (ICIS)*, Fort Worth, United States of America.

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. Springer Publishing Company. https://doi.org/10.4135/9781412952576.n198

Lee, Y.-K., Chang, C.-T., Lin, Y., & Cheng, Z.-H. (2014). The dark side of smartphone usage: Psychological traits, compulsive behavior and technostress. *Computers in Human Behavior*, *31*, 373–383. https://doi.org/10.1016/j.chb.2013.10.047

Lei, P.-W., & Wu, Q. (2007). Introduction to structural equation modeling: Issues and practical considerations. *Educational Measurement: Issues and Practice*, *26*(3), 33–43. https://doi.org/10.1111/j.1745-3992.2007.00099.x

Lindell, M. K., & Whitney, D. J. (2001). Accounting for common method variance in cross-sectional research designs. *The Journal of Applied Psychology*, *86*(1), 114–121. https://doi.org/10.1037//0021-9010.86.1.114

Maier, C., Laumer, S., & Weinert, C. (2015). Enterprise resource planning systems induced stress: A comparative empirical analysis with young and elderly SAP users. In *Proceedings of the 12th International Conference on Wirtschaftsinformatik,* Osnabrueck, Germany.

Maier, C., Laumer, S., Weinert, C., & Weitzel, T. (2015). The effects of technostress and switching stress on discontinued use of social networking services: A study of Facebook use. *Information Systems Journal*, *25*(3), 275–308. https://doi.org/10.1111/isj.12068

Neumeier, A., Wolf, T., & Oesterle, S. (2017). The manifold fruits of digitalization: Determining the literal value behind. In *Proceedings of the 13th International Conference on Wirtschaftsinformatik,* St. Gallen, Switzerland.

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory*. McGraw-Hill.

Pirkkalainen, H., Salo, M., Makkonen, M., & Tarafdar, M. (2017). Coping with technostress: When emotional responses fail. In *Proceedings of the 38th International Conference on Information Systems (ICIS),* Seoul, Korea.

Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879–903.

Ragu-Nathan, T. S., Tarafdar, M., Ragu-Nathan, B. S., & Tu, Q. (2008). The consequences of technostress for end users in organizations: Conceptual development and empirical validation. *Information Systems Research*, *19*(4), 417–433. https://doi.org/10.1287/isre.1070.0165

Reimann, M., Abendroth, A.-K., & Diewald, M. (2020). *How digitalized is work in large German workplaces, and how is digitalized work perceived by workers? A new employer-employee survey instrument* (IAB-Forschungsbericht 8/2020).

Richardson, H. A., Simmering, M. J., & Sturman, M. C. (2009). A tale of three perspectives: Examining post hoc statistical techniques for detection and correction of common

method variance. *Organizational Research Methods*, *12*(4), 762–800. https://doi.org/10.1177/1094428109332834

Riedl, R. (2013). On the biology of technostress: Literature review and research agenda. *DATA BASE for Advances in Information Systems*, *44*(1), 18–55. https://doi.org/10.1145/2436239.2436242

Srivastava, S. C., Chandra, S., & Shirish, A. (2015). Technostress creators and job outcomes: Theorising the moderating influence of personality traits. *Information Systems Journal*, *25*(4), 355–401. https://doi.org/10.1111/isj.12067

Stanko, T. L., & Beckman, C. M. (2014). Watching you watching me: Boundary control and capturing attention in the context of ubiquitous technology use. *The Academy of Management Journal*, *58*(3), 712–738. https://doi.org/10.5465/amj.2012.0911

Stich, J.-F., Tarafdar, M., Stacey, P., & Cooper, C. L. (2019). Appraisal of email use as a source of workplace stress: A person-environment fit approach. *Journal of the Association for Information Systems*, *20*(2), 132–160. https://doi.org/10.17705/1jais.00531

Tarafdar, M., Cooper, C. L., & Stich, J.-F. (2019). The technostress trifecta: Techno eustress, techno distress and design: Theoretical directions and an agenda for research. *Information Systems Journal*, *29*(1), 6–42. https://doi.org/10.1111/isj.12169

Tarafdar, M., Pullins, E. B., & Ragu-Nathan, T. S. (2015). Technostress: Negative effect on performance and possible mitigations. *Information Systems Journal*, *25*(2), 103–132. https://doi.org/10.1111/isj.12042

Tarafdar, M., Tu, Q., & Ragu-Nathan, T. S. (2010). Impact of technostress on end-user satisfaction and performance. *Journal of Management Information Systems*, *27*(3), 303–334. https://doi.org/10.2753/MIS0742-1222270311

Tarafdar, M., Tu, Q., Ragu-Nathan, B. S., & Ragu-Nathan, T. S. (2007). The impact of technostress on role stress and productivity. *Journal of Management Information Systems*, *24*(1), 301–328. https://doi.org/10.2753/MIS0742-1222240109

Tarafdar, M., Tu, Q., Ragu-Nathan, T. S., & Ragu-Nathan, B. S. (2011). Crossing to the dark side: Examining creators, outcomes, and inhibitors of technostress. *Communications of the ACM*, *54*(9), 113–120. https://doi.org/10.1145/1995376.1995403

Tu, Q., Wang, K., & Shu, Q. (2005). Computer-mediated technostress in china. *Communications of the ACM*, *48*(4), 77–81. https://doi.org/10.1145/1053291.1053323

van Knippenberg, D., Dahlander, L., Haas, M. R., & George, G. (2015). From the editors: Information, attention, and decision making. *Academy of Management Journal*, *58*(3), 649–657. https://doi.org/10.5465/amj.2015.4003

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *Journal of Strategic Information Systems*, *28*(2), 118–144. https://doi.org/10.1016/j.jsis.2019.01.003

Williams, S. P., & Schubert, P. (2018). Designs for the digital workplace. *Procedia Computer Science*, *138*, 478–485. https://doi.org/10.1016/j.procs.2018.10.066

2.2.8. Appendix

Appendix 2.2-1

Construct	Definition	Source
Techno-Invasion	"Techno-invasion describes the invasive effect of [digital technologies] in situations where employees can be reached anytime and feel the need to be constantly connected, thus blurring work-related and personal contexts."	Ragu-Nathan et al. 2008, p. 427
Techno-Overload	"Techno-overload describes situations where [digital technologies] force users to work faster and longer."	Ragu-Nathan et al. 2008, p. 427
Techno-Complexity	"Techno-complexity describes situations where the complexity associated with [digital technologies] leads users to feel inadequate with regard to their computer skills and forces them to spend time and effort in learning and understanding [digital technologies]."	Ragu-Nathan et al. 2008, p. 427
Techno-Uncertainty	"Techno-uncertainty refers to contexts where continuing [digital technology] changes and upgrades unsettle users and create uncertainty so that they must constantly learn and educate themselves about new [digital technologies]."	Ragu-Nathan et al. 2008, p. 427
Techno-Insecurity	"Techno-insecurity is associated with situations where users feel threatened about losing their jobs, either because of automation from [digital technologies] or to other people who have a better understanding of [digital technologies]."	Ragu-Nathan et al. 2008, p. 427
Techno-Unreliability	Techno-unreliability refers to the "degree to which features and capabilities provided by the [digital] technology are [not] dependable".	Ayyagari et al. 2011, p. 837
Literacy Facilitation	"Literacy facilitation describes mechanisms that encourage and foster the sharing of [digital technologies]-related knowledge within the organization."	Ragu-Nathan et al. 2008, p. 427
Involvement Facilitation	"Involvement facilitation helps alleviate technostress by keeping users informed about the rationale for introducing new [digital technologies], by letting them know about the effects of such introduction, and by encouraging them to use and experiment with new [digital technologies]."	Ragu-Nathan et al. 2008, p. 427
Technical Support Provision	"Technical support provision describes activities related to end-user support that reduce the effects of technostress by solving users' [digital technology] problems relating."	Ragu-Nathan et al. 2008, p. 427

Table 2.2-7: Definitions of latent variables

Appendix 2.2-2

(Groups of) Technologies	Examples
Laptops	
Stationary PCs	
Tablets	
Smartphones	
Mobile phones (no smartphones)	
Printers, scanners, and fax machines	
Headsets	
Stationary phones	
Text, spreadsheet, and presentation software	Microsoft Office applications
Document and knowledge management systems	Intranets, blogs, wikis
Visualization systems	Smartboards, digital positioning tables
Real-time communication systems	Web-conferencing, chats
Systems for social interaction and collaboration	Social networks, social collaboration
Email	
Background security systems without user interaction	Firewalls, encryption, VPN
Security systems involving user interaction	Password entry, authentication
Network hardware	Network systems, fieldbus systems
Wireless connections	Mobile networks, WiFi, radio devices
Cloud computing and virtual machines	Access to infrastructure for computing power or software via internet
World wide web	Access to information via browser or web applications
Data bases and data warehouses	Data storage and data management systems accessible locally or via internet
Medical software	Control systems for diagnostic and therapy devices
Modeling and simulation software	Mathematical modeling, physical simulations
Software for creativity and design	Software for editing images, videos, or audio for the entertainment industry
Software for product and software development	CAD/CAM systems, programming environments
Software for statistics and analysis	Software for the application of statistical methods for data mining
Content management systems	Software for website creation and website management
Cash register systems	Card readers, electronic cash register systems
Digital cash flow systems	Digital cash, online transactions
E-commerce systems	Software for web-shops or online auctions
Management information software	Project management software, business process modeling
Organizational administration software	Systems for financial controlling, ERP systems, administrative software
Decision support software	Decision support systems
Systems for production planning and production management	Software for purchasing and warehousing, production control units
Logistics systems	Systems for storage and transportation management
Automatic manufacturing systems	3D printers, CNC machines, robotics
Localization and distance measurement systems	Radar devices, devices for distance determination, navigation devices, GPS
Sensor systems	Sensor networks, mobile data acquisition devices

(Groups of) Technologies	Examples
Artificial intelligence	Machine learning
Augmented, virtual, and mixed reality	Smart glasses
Speech interaction	Voice control, software for speech-to-text conversion

Table 2.2-8: List of digital technologies for operationalization of degree of work-place digitalization

Appendix 2.2-3

Items		Mean	SD	Loadings
Techno-Invasion (source: Ragu-Nathan et al. 2008)		**1.961**	**1.161**	
TIV01	I have to be in touch with my work even during my vacation due to this technology.	2.222	1.296	0.693
TIV02	I have to sacrifice my vacation and weekend time to keep current on new technologies.	1.643	0.971	0.812
TIV03	I feel my personal life is being invaded by this technology.	2.019	1.118	0.745
Techno-Overload (source: Ragu-Nathan et al. 2008)		**2.348**	**1.231**	
TO01	I am forced to change my work habits to adapt to new technologies.	2.317	1.211	0.850
TO02	I have a higher workload because of increased technology complexity.	2.378	1.250	0.891
Techno-Complexity (source: Ragu-Nathan et al. 2008)		**2.085**	**1.109**	
TC01	I do not know enough about this technology to handle my job satisfactorily.	1.789	0.960	0.763
TC02	I need a long time to understand and use new technologies.	1.984	1.063	0.845
TC03	I do not find enough time to study and upgrade my technology skills.	2.131	1.111	0.746
TC04	I find new recruits to this organization know more about computer technology than I do.	2.366	1.206	0.708
TC05	I often find it too complex for me to understand and use new technologies.	2.155	1.109	0.850
Techno-Insecurity (source: Ragu-Nathan et al. 2008)		**1.869**	**1.050**	
TIS01	I feel constant threat to my job security due to new technologies.	1.988	1.094	0.704
TIS02	I am threatened by coworkers with newer technology skills.	1.804	0.998	0.798
TIS03	I feel there is less sharing of knowledge among coworkers for fear of being replaced.	1.815	1.044	0.644
Techno-Uncertainty (source: Ragu-Nathan et al. 2008)		**2.786**	**1.217**	
TUC01	There are always new developments in the technologies we use in our organization.	3.157	1.166	0.719
TUC02	There are constant changes in computer software in our organization.	2.921	1.228	0.863
TUC03	There are constant changes in computer hardware in our organization.	2.544	1.167	0.897
TUC04	There are frequent upgrades in computer networks in our organization.	2.522	1.189	0.880
Techno-Unreliability (source: Ayyagari et al. 2011)		**2.378**	**0.961**	
TUR01	The features provided by the digital technologies I use are dependable.*	2.361	0.957	0.899
TUR02	The capabilities provided by the digital technologies I use are reliable.*	2.388	0.981	0.935
TUR03	The digital technologies I use behave in a highly consistent way.*	2.385	0.943	0.900

Literacy Facilitation (source: Ragu-Nathan et al. 2008)		**3.052**	**1.262**	
LF01	Our organization emphasizes teamwork in dealing with new technology-related problems.	3.187	1.212	0.785
LF02	Our organization provides end-user training before the introduction of new technology.	2.973	1.322	0.795
LF03	Our organization fosters a good relationship between IT department and end-users.	3.020	1.260	0.863
LF04	Our organization provides clear documentation to end-users on using new technologies.	3.027	1.242	0.857
Involvement Facilitation (source: Ragu-Nathan et al. 2008)		**2.281**	**1.305**	
IF01	Our end-users are rewarded for using new technologies.	2.089	1.224	0.678
IF02	Our end-users are consulted before introduction of new technology.	2.270	1.318	0.904
IF03	Our end-users are involved in technology change and/or implementation.	2.482	1.340	0.909
Technical Support Provision (source: Ragu-Nathan et al. 2008)		**3.460**	**1.226**	
TSP01	Our end-user help desk is well staffed by knowledgeable individuals.	3.445	1.216	0.835
TSP02	Our end-user help desk is easily accessible.	3.496	1.243	0.924
TSP03	Our end-user help desk is responsive to end-user requests.	3.440	1.218	0.932

*reverse coded

Table 2.2-9: Measurement items of latent constructs

Appendix 2.2-4

Model	Relationship	Estimate	Sig.
Model 1	Technostress → Techno-Invasion	0.787	***
	Technostress → Techno-Overload	0.848	***
	Technostress → Techno-Complexity	0.553	***
	Technostress → Techno-Insecurity	0.791	***
	Technostress → Techno-Uncertainty	0.476	***
	Technostress → Techno-Unreliability	0.101	***
	Degree of Workplace Digitalization → Technostress	0.264	***
	Gender → Technostress	-0.059	**
	Age → Technostress	-0.100	***
	Occupational Activity → Technostress	-0.010	
	School Qualification → Technostress	0.007	
	Occupational Qualification → Technostress	0.071	**
Model 2	Degree of Workplace Digitalization → Techno-Invasion	0.231	***
	Degree of Workplace Digitalization → Techno-Overload	0.274	***
	Degree of Workplace Digitalization → Techno-Complexity	-0.073	**
	Degree of Workplace Digitalization → Techno-Insecurity	0.143	***
	Degree of Workplace Digitalization → Techno-Uncertainty	0.356	***
	Degree of Workplace Digitalization → Techno-Unreliability	-0.207	***
	Gender → Techno-Invasion	-0.069	**
	Gender → Techno-Overload	-0.050	*
	Gender → Techno-Complexity	-0.007	
	Gender → Techno-Insecurity	-0.032	
	Gender → Techno-Uncertainty	-0.038	*
	Gender → Techno-Unreliability	0.014	
	Age → Techno-Invasion	-0.227	***
	Age → Techno-Overload	-0.040	
	Age → Techno-Complexity	0.077	***
	Age → Techno-Insecurity	-0.066	**
	Age → Techno-Uncertainty	-0.045	*
	Age → Techno-Unreliability	-0.105	***
	Occupational Activity → Techno-Invasion	0.043	
	Occupational Activity → Techno-Overload	0.024	
	Occupational Activity → Techno-Complexity	-0.078	***
	Occupational Activity → Techno-Insecurity	-0.102	***
	Occupational Activity → Techno-Uncertainty	0.057	**
	Occupational Activity → Techno-Unreliability	-0.046	*
	School Qualification → Techno-Invasion	0.005	
	School Qualification → Techno-Overload	0.017	
	School Qualification → Techno-Complexity	-0.010	
	School Qualification → Techno-Insecurity	-0.003	
	School Qualification → Techno-Uncertainty	0.007	
	School Qualification → Techno-Unreliability	-0.018	
	Occupational Qualification → Techno-Invasion	0.114	***
	Occupational Qualification → Techno-Overload	0.070	**
	Occupational Qualification → Techno-Complexity	0.041	
	Occupational Qualification → Techno-Insecurity	-0.003	

Model	Relationship	Estimate	Sig.
	Occupational Qualification → Techno-Uncertainty	-0.018	
	Occupational Qualification → Techno-Unreliability	0.066	**
Model 3	Technostress → Techno-Invasion	0.790	***
	Technostress → Techno-Overload	0.848	***
	Technostress → Techno-Complexity	0.554	***
	Technostress → Techno-Insecurity	0.796	***
	Technostress → Techno-Uncertainty	0.473	***
	Technostress → Techno-Unreliability	0.110	***
	Degree of Workplace Digitalization → Technostress	0.314	***
	Degree of Workplace Digitalization → Literacy Facilitation	0.353	***
	Degree of Workplace Digitalization → Involvement Facilitation	0.377	***
	Degree of Workplace Digitalization → Technical Support Provision	0.294	***
	Literacy Facilitation → Technostress	-0.083	***
	Involvement Facilitation → Technostress	0.177	***
	Technical Support Provision → Technostress	-0.126	***
	Degree of Workplace Digitalization x Literacy Facilitation → Technostress	-0.159	***
	Degree of Workplace Digitalization x Involvement Facilitation → Technostress	-0.006	
	Degree of Workplace Digitalization x Technical Support Provision→ Technostress	0.013	
	Gender → Technostress	-0.048	*
	Age → Technostress	-0.085	***
	Occupational Activity → Technostress	-0.023	
	School Qualification → Technostress	0.007	
	Occupational Qualification → Technostress	0.049	

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

Table 2.2-10: Results for research models 1 to 3 including control variables

Appendix 2.2-5

Fit Measures	Threshold	Source of Threshold	Model 4	
χ^2			5,757	
Degrees of Freedom			869	
RMSEA	< 0.06	Lei and Wu (2007)	0.046	✓
SRMR	< 0.08	Gefen et al. (2000)	0.079	✓
NFI	> 0.90	Gefen et al. (2000)	0.932	✓
TLI	> 0.90	Gefen et al. (2000)	0.931	✓
CFI	> 0.90	Gefen et al. (2000)	0.942	✓
AGFI	> 0.80	Gefen et al. (2000)	0.891	✓

Note: ✓ indicates that a threshold is met, X indicates that it is not met.
Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), Normed Fit Index (NFI), Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), Adjusted Goodness of Fit Index (AGFI)

Table 2.2-11: Fit measures for research model 4

Appendix 2.2-6

Relationship	Estimate	Sig.
Degree of Workplace Digitalization → Techno-Invasion	0.223	***
Degree of Workplace Digitalization → Techno-Overload	0.335	***
Degree of Workplace Digitalization → Techno-Complexity	0.013	
Degree of Workplace Digitalization → Techno-Insecurity	0.201	***
Degree of Workplace Digitalization → Techno-Uncertainty	0.284	***
Degree of Workplace Digitalization → Techno-Unreliability	0.007	
Degree of Workplace Digitalization → Literacy Facilitation	0.353	***
Degree of Workplace Digitalization → Involvement Facilitation	0.377	***
Degree of Workplace Digitalization → Technical Support Provision	0.294	***
Literacy Facilitation → Techno-Invasion	-0.063	**
Literacy Facilitation → Techno-Overload	-0.096	***
Literacy Facilitation → Techno-Complexity	-0.093	***
Literacy Facilitation → Techno-Insecurity	-0.109	***
Literacy Facilitation → Techno-Uncertainty	0.236	***
Literacy Facilitation → Techno-Unreliability	-0.184	***
Involvement Facilitation → Techno-Invasion	0.234	***
Involvement Facilitation → Techno-Overload	0.116	***
Involvement Facilitation → Techno-Complexity	-0.012	
Involvement Facilitation → Techno-Insecurity	0.168	***
Involvement Facilitation → Techno-Uncertainty	0.091	***
Involvement Facilitation → Techno-Unreliability	-0.170	***
Technical Support Provision → Techno-Invasion	-0.100	***
Technical Support Provision → Techno-Overload	-0.061	**
Technical Support Provision → Techno-Complexity	-0.120	***
Technical Support Provision → Techno-Insecurity	-0.130	***
Technical Support Provision → Techno-Uncertainty	-0.038	
Technical Support Provision → Techno-Unreliability	-0.296	***
Degree of Workplace Digitalization x Literacy Facilitation → Techno-Invasion	-0.102	*
Degree of Workplace Digitalization x Literacy Facilitation → Techno-Overload	-0.188	***
Degree of Workplace Digitalization x Literacy Facilitation → Techno-Complexity	-0.067	
Degree of Workplace Digitalization x Literacy Facilitation → Techno-Insecurity	-0.086	
Degree of Workplace Digitalization x Literacy Facilitation → Techno-Uncertainty	-0.050	
Degree of Workplace Digitalization x Literacy Facilitation → Techno-Unreliability	-0.066	
Degree of Workplace Digitalization x Involvement Facilitation → Techno-Invasion	0.053	
Degree of Workplace Digitalization x Involvement Facilitation → Techno-Overload	-0.015	
Degree of Workplace Digitalization x Involvement Facilitation → Techno-Complexity	0.005	
Degree of Workplace Digitalization x Involvement Facilitation → Techno-Insecurity	-0.036	
Degree of Workplace Digitalization x Involvement Facilitation → Techno-Uncertainty	-0.036	
Degree of Workplace Digitalization x Involvement Facilitation → Techno-Unreliability	-0.024	
Degree of Workplace Digitalization x Technical Support Provision→ Techno-Invasion	-0.022	
Degree of Workplace Digitalization x Technical Support Provision→ Techno-Overload	0.045	
Degree of Workplace Digitalization x Technical Support Provision→ Techno-Complexity	0.000	

Relationship	Estimate	Sig.
Degree of Workplace Digitalization x Technical Support Provision→ Techno-Insecurity	-0.006	
Degree of Workplace Digitalization x Technical Support Provision→ Techno-Uncertainty	0.010	
Degree of Workplace Digitalization x Technical Support Provision→ Techno-Unreliability	0.022	
Gender → Techno-Invasion	-0.051	*
Gender → Techno-Overload	-0.044	*
Gender → Techno-Complexity	-0.010	
Gender → Techno-Insecurity	-0.022	
Gender → Techno-Uncertainty	-0.031	
Gender → Techno-Unreliability	-0.001	
Age → Techno-Invasion	-0.208	***
Age → Techno-Overload	-0.029	
Age → Techno-Complexity	0.084	***
Age → Techno-Insecurity	-0.051	*
Age → Techno-Uncertainty	-0.046	*
Age → Techno-Unreliability	-0.104	***
Occupational Activity → Techno-Invasion	0.015	
Occupational Activity → Techno-Overload	0.020	
Occupational Activity → Techno-Complexity	-0.061	**
Occupational Activity → Techno-Insecurity	-0.109	***
Occupational Activity → Techno-Uncertainty	0.025	
Occupational Activity → Techno-Unreliability	0.015	
School Qualification → Techno-Invasion	0.010	
School Qualification → Techno-Overload	0.015	
School Qualification → Techno-Complexity	-0.016	
School Qualification → Techno-Insecurity	-0.003	
School Qualification → Techno-Uncertainty	0.012	
School Qualification → Techno-Unreliability	-0.035	
Occupational Qualification → Techno-Invasion	0.100	***
Occupational Qualification → Techno-Overload	0.051	*
Occupational Qualification → Techno-Complexity	0.025	
Occupational Qualification → Techno-Insecurity	-0.023	
Occupational Qualification → Techno-Uncertainty	-0.015	
Occupational Qualification → Techno-Unreliability	0.036	

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

Table 2.2-12: Results for research model 4 including control variables

3. Digitalized individuals as customers

3.1. The upside of data privacy – Delighting customers by implementing data privacy measures

Abstract: The targeted analysis of customer data becomes increasingly important for data-driven business models. At the same time, the customers' concerns regarding data privacy have to be addressed properly. Existing research mostly describes data privacy as a necessary evil for compliance and risk management and does not propose specific data privacy measures which address the customers' concerns. We therefore aim to shed light on the upside of data privacy. In this paper, we derive specific measures to deal with customers' data privacy concerns based on academic literature, legislative texts, corporate privacy statements, and expert interviews. Next, we leverage the Kano model and data from two internet-based surveys to analyze the measures' evaluation by customers. From a customer perspective, the implementation of the majority of measures is obligatory as those measures are considered as basic needs of must-be quality. However, delighting measures of attractive quality do exist and have the potential to create a competitive advantage. In this, we find some variation across different industries suggesting that corporations aiming to improve customer satisfaction by superior privacy protection should elicit the demands of their specific target customers.

Keywords: Privacy concerns; Privacy measures; Customer data; Customer satisfaction; Survey research

Authors: Henner Gimpel, Dominikus Kleindienst, Niclas Nüske, Daniel Rau, Fabian Schmied

Status[5]**:** This article is published in Electronic Markets, Volume 28(4), pp. 437-452 (2018).

[5] Reprinted by permission from Springer Nature. Springer Nature Electronic Markets – The International Journal on Networked Business: The upside of data privacy – delighting customers by implementing data privacy measures. Henner Gimpel, Dominikus Kleindienst, Niclas Nüske, and Fabian Schmied. Copyright 2022.

3.1.1. Introduction

In the future, the ability to analyze customer data will be a growing source of competitive advantage (Morey et al., 2015). With the growing amount of data generated worldwide, digital business models emerge which are based on insights gained from customer data (Matthing et al., 2004; Saarijärvi et al., 2014). At the same time, trust in data privacy is becoming more relevant for customers (Berendt et al., 2005; Preibusch et al., 2013) which is amplified by several data privacy scandals in the recent past. For instance, a serious incident occurred when the credit card information of 56 million Home Depot customers was stolen (Inman & Nikolova, 2017; Morey et al., 2015). Other examples are Ashley Madison, an online dating portal which lost user data of 37 million registered married men and women to the public (BBC, 2015); Apple which was accused of collecting location data on iPhones and iPads without authorization from and without notifying their customers (The Guardian, 2011); and Facebook which was discovered to be collecting data from user profiles and transmitting these data to advertising companies and others (The Telegraph, 2010). For companies, such publicly exploited scandals cause economic damage (Acquisti et al., 2006; Muntermann & Roßnagel, 2009) and competitive disadvantages in brand image and customer satisfaction. Conversely, it might be possible that companies which perform well in terms of data privacy could increase customer satisfaction and gain a competitive advantage. For instance, companies such as DuckDuckGo or Silent Circle already try to differentiate themselves by providing privacy friendly services (Tanner, 2013). DuckDuckGo is a search engine which differs substantially from many conventional search engines. The company collects neither personal information nor behavioral data about its users. Silent Circle is a company which provides solutions for secure communication. For instance, the company developed a smartphone which ensures private and encrypted communication. However, many companies see data privacy as necessary evil. As such, data privacy limits the opportunities to gain valuable customer insights and its implementation binds valuable resources (Culnan & Armstrong, 1999). In addition to this downside perspective, an integrated management of data privacy requires an upside perspective. Moreover, practitioners should be aware of specific available data privacy measures which go beyond the mere application of laws and regulations and, thus, enable their companies to differentiate themselves from their competitors.

Also in academic literature, data privacy management is mostly seen from a risk perspective which focusses on corporate data (e.g., from internal research departments) without considering customers' concerns regarding the protection of their personal information. For instance,

Buhl (2013) states that privacy protection measures which address threats such as technology spying and obstruction should be implemented only if the risk-reducing effects outweigh the related costs. Acquisti et al. (2006) link a company's privacy incidents to the negative impacts on its market value. Only to a small extent does the literature consider an upside perspective on data privacy, such as Preibusch et al. (2013) who found that customers who bought a DVD at a privacy-friendly but more expensive online retailer are more satisfied than customers of cheaper but privacy-unfriendly online retailers. Even so, specific data privacy measures which might be implemented to generate customer delight are yet to be considered in the literature. Thus, we raise the following two research questions:

RQ1: Which data privacy measures can companies take?

RQ2: Are some of these measures perceived as attractive measures that delight customers?

To answer these research questions, we first develop an overview of data privacy measures by investigating and consolidating academic literature, legislative texts, company privacy statements, and findings from expert interviews. Second, using the Kano model, we evaluate the customers' perception of these different measures, that is, whether measures are considered to be of must-be, one-dimensional, attractive, or indifferent quality. This paper is organized as follows: We discuss the context of the problem and related work. We outline our methodical approach, derive measures which can be taken by companies to address data privacy concerns and analyze the customers' perceptions of these measures on the basis of the results of two surveys. The discussion provides an overview of the theoretical contribution and managerial implications as well as the paper's limitations. Lastly, we conclude with a summary and an outlook on potential areas of future research.

3.1.2. Problem context

As previously motivated, public attention regarding data privacy issues is growing. This attention is reflected in different scientific disciplines, such as philosophy, psychology, economics, marketing, law, and information systems (Ahmad & Mykytyn, 2012; Pavlou, 2011). Moreover, privacy incidents such as the scandals previously mentioned as well as their prevention are the subject of numerous research projects[6]. Privacy incidents appear regularly and have consequences for both companies and customers. They are defined by Acquisti et al.

[6] Examples: Acquisti et al. (2006); Ahmad and Mykytyn (2012); Campbell et al. (2003); Cavusoglu et al. (2004); Dhasarathan et al. (2015); Hovav and D'Arcy (2003); Mamonov and Koufaris (2014); Moshki and Barki (2016); Nicholas-Donald et al. (2011); Nofer, Hinz, Muntermann, and Roßnagel (2014).

(2006) as events "involving misuses of individuals' personal information." Consequently, customers might become victims of fraud or identity theft (Acquisti et al., 2006). Furthermore, the misuse of personal information might have negative effects on personal relationships, job applications, insurance contracts, and credit decisions.

Smith et al. (1996) elaborated seven major data privacy concerns of customers relating to Data Collection (storage of large amounts of personal customer data), Data Combination (combination of customer data from different databases to gain additional information about a customer), Internal Secondary Usage (usage of customer data for an unauthorized secondary purpose within the company), External Secondary Usage (disclosure of customer data for an unauthorized secondary purpose outside the company), Errors (deliberate or accidental errors in customer data), Improper Access (unauthorized views and edits of customer data), and Reduced Judgment (automated decision-making based on customer data). The work of Smith et al. (1996) is described as the first and most influential work in the field of data privacy concerns (Preibusch, 2013). Though some publications adapt the concerns (e.g., Hong & Thong, 2013; Malhotra et al., 2004), mostly to better measure the concerns with multi-item survey scales and factor analysis, recent publications also refer to Smith et al. (1996) without any modification of the privacy concerns (e.g., Eastin et al., 2016; Keith et al., 2013).

Academic literature provides recommendations for customers themselves as well as public authorities responsible for protecting customers' privacy rights through laws and regulations (Buchmann et al., 2008; Klingspor, 2016). From a company perspective, privacy incidents may be caused by technical, managerial, organizational, or human failures (Acquisti et al., 2006). Companies might suffer direct economic damage, such as punishment by penalties or loss of market value, as well as indirect effects, such as increasing insurance fees or decreasing customer satisfaction (Acquisti et al., 2006; Nicholas-Donald et al., 2011). The effect of privacy breaches on a firm's market value is considered in several papers. Cavusoglu et al. (2004) investigate the effect of internet security breach announcements on the market value of publicly traded US firms. A similar study was conducted by Campbell et al. (2003). The authors investigate the effect of public announcements of information security breaches on the market value of publicly traded US firms. Within their analysis, Campbell et al. (2003) differentiate between security breaches which involve unauthorized access to confidential data and security breaches which do not involve confidential data. Interestingly, significant effects can only be shown in the case of the involvement of confidential data (Campbell et al., 2003). In contrast,

Nofer, Hinz, Muntermann, and Rossnagel (2014) investigate the direct effect of privacy violations and security breaches on consumers' investment behavior, which was examined in a laboratory experiment.

Consequently, companies must decide on how to deal with data privacy issues and the related risks. In line with this issue, articles which address companies' handling of data privacy focus on potential threats and how to avoid their occurrence. Occasionally, the management of data privacy is considered as a part of corporate data governance which can be seen as a "framework for assigning decision-related rights and duties in order to be able to adequately handle data as a company asset" (Otto, 2011). As an example, Khatri and Brown (2010) propose to define the role of a data security officer as a part of the data governance in order to specify and monitor access requirements to data. Also, Culnan and Armstrong (1999) argue that companies need to implement a comprehensive governance structure in order to manage data privacy appropriately.

Many authors describe a trade-off between the use of personal data to improve the customer experience, e.g., by personalizing customer services, and the implementation of data privacy measures which are often considered as obstacles to profitability (Schneider et al., 2017). Only a limited set of articles considers data privacy measures as an opportunity to create a competitive advantage. For instance, Preibusch et al. (2013) show that appropriate management of data privacy issues may have positive implications on customer satisfaction. By conducting an experiment, the article examined the effects of different levels of data privacy in online retail. With regard to online retail, the authors state that privacy becomes a competitive factor. Sarathy and Robertson (2003) provide a framework which assists companies in implementing a data privacy strategy which considers ethical aspects. The authors propose strategies which exceed the level of data privacy required by laws and regulations. Within a research-in-progress paper, Lyons et al. (2016) propose to examine the effects of different privacy protection approaches on customer trust. In this regard, the authors distinguish organizational privacy protection approaches which are driven by control values and such which are driven by justice values.

However, neither article provides recommendations for specific data privacy measures which can be implemented to address customers' data privacy concerns and increase customer satisfaction. Although the importance of customer satisfaction for long-term customer relationships is commonly accepted, using data privacy to delight customers to gain a competitive

advantage or to implement different pricing strategies has yet to be comprehensively examined. To the best of our knowledge, related work does not provide insights into addressing customers' different privacy concerns using concrete measures and the extent to which such measures affect customer satisfaction.

As customer satisfaction has a positive impact on customer loyalty (Gronholdt et al., 2000) and the value of a company (Matzler & Stahl, 2000), many companies strive to achieve a high level of customer satisfaction. Due to this well-supported relation, the literature provides numerous methods of measuring customer satisfaction and its antecedents. In this context, a commonly used method to measure the quality of service attributes is SERVQUAL (Ladhari, 2009; Parasuraman et al., 1985). As part of a causal structure, the concept of customer satisfaction can be analyzed with the help of structural equation modeling and neural networks (Hackl & Westlund, 2000). Bartikowski and Llosa (2004) analyze further methods, namely Penalty Reward Contrast Analysis, Correspondence Analysis, Dual Importance Mapping, and the Kano model which was originally proposed by Kano et al. (1984). The Kano model has been discussed and applied in many theoretical and empirical research projects (Füller & Matzler, 2008; Löfgren & Witell, 2008) as it provides a comprehensive presentation of attributes of products or services which influence the degree of customer satisfaction. For instance, the model has been used by Lai and Wu (2011) in order to gain insights in the customers' needs of a public transport company and by Arbore and Busacca (2009) who studied determinants of customer satisfaction for a retail bank.

3.1.3. Research method

To answer the research questions, we first identify and structure the field of possible data privacy measures and then use the Kano model and data from two online surveys to evaluate customers' perceptions regarding different data privacy measures.

3.1.3.1. Identification of data privacy measures

As a basis for identifying data privacy measures, we conducted a comprehensive search for relevant statements, that is, any piece of information on any type of action which addresses customers' data privacy concerns. Therefore, our sources are legislative texts in particular (European General Data Protection Regulation (EU-GDPR), German Bundesdatenschutzgesetz (BDSG), and Telemediengesetz (TMG)) but also scientific literature. Beyond using the pertinent literature known to us from prior research on data privacy, we conducted a structured literature search in the databases AISeL, EBSCOhost, and JSTOR. In these databases, we used

the following search term: (“data privacy”) AND (“concern” OR “issue”) AND (“measure” OR “protection” OR “policy”). As interactions between companies and customers and also the amount of generated customer data changed tremendously with the emergence of smartphones and other digital channels, we decided to consider articles which were published within the last ten years (2008-2017). The search was limited to peer-reviewed articles. In total, we found 128 articles. By conducting an abstract screening, we identified four potentially relevant articles (Bélanger & Crossler, 2011; Clement & Obar, 2016; Keith et al., 2016; Payne et al., 2015). The in-depth analysis resulted in two papers that contain concrete statements for deriving feasible data privacy measures: Clement and Obar (2016), who examine the data privacy transparency of Canadian internet carriers and Payne et al. (2015), who focus on a list of different laws, regulations, and frameworks and attempt to reconcile the conflicting agendas of companies and customers. Practical recommendations from Audatis Consulting (2016) were used to complement the statements from a practitioner-oriented perspective. Furthermore, we analyzed nine corporate privacy statements across industries: Amazon (2017), Apple (2017), Deutsche Bank (2017), Dropbox (2017), easyJet (2017), Facebook (2017), Telekom DE-Mail (2017), Tesla Motors (2017), and Zalando (2017). We aimed to sample these privacy statements from corporations in different industries, partially known for a strong reliance on gathering and analyzing customer data or a strong obligation to protect customer data. Additionally, we conducted three expert interviews, each lasting approximately 30 to 60 minutes. In the first interview, we talked to an in-house data privacy officer of a German automotive company in order to gain an overview of existing and potential data privacy measures as well as the challenges and difficulties entailed. To verify existing statements and to check whether we had covered all relevant aspects, we conducted a second interview with a researcher who was working on a project with the goal of developing a long-term data privacy strategy for a German bank. For instance, this interviewee mentioned that customers may want to know which personal data a company stores about them. This statement was later considered to develop a data privacy measure that allows customers to easily get a copy of all their personal data stored and processed by a company. To complement our research with input from a legal perspective, we interviewed a lawyer who works for a renowned German business law office and consults on data privacy. Therefore, he possesses expertise in European privacy laws and regulations.

The examination of the different sources resulted in 202 statements. All statements were then grouped by semantic similarity. In doing so, the authors jointly decided on the grouping of the statements. Without having pre-defined groups, each statement was either used to create a

new group with a particular data privacy measure or mapped to an existing group. In the rare case of disagreement between the authors, every author firstly explained the reasons for his preferred grouping then the team of authors discussed the different aspects and repeated the grouping process for the respective measure. The procedure resulted in 32 groups, each consisting of one or several statements regarding a particular data privacy measure. From each of the groups of statements, we derived a single measure which addresses all statements within the group. After the formulation of the measures, we assigned each of the measures to one or more specific customer data privacy concerns. To validate the mapping of all measures to the seven concerns, eleven aviation and retail customers were asked for their assessment in an ex-post quality check. The majority of customers mapped 27 out of all 32 measures to the same concern as the team of authors. For almost all of the remaining five measures, customers' second most frequent classification was congruent with the authors' mapping and the measure had content-related similarity with both the authors' and the customers' mapping. As only slight differences in customers' and experts' assessment can be observed, this ex-post quality check suggests adequate data quality.

3.1.3.2. Evaluation of customers' perceptions

After the derivation of data privacy measures and their assignment to specific data privacy concerns, we now focus on determining their effect on customer satisfaction. As the context at hand requires the possibility of individual investigation of each measure and applicability to hypothetical cases, we decided to use the Kano model. To evaluate customers' perceptions regarding the identified data privacy measures, we conducted two online surveys.

3.1.3.2.1. Kano model

The Kano model describes customer satisfaction on the basis of the degree of implementation or availability of certain attributes of products or services (Kano et al., 1984; Matzler et al., 1996). Thereby, the perceived degree of implementation or availability depends on the customers' expectations. The model differentiates between four major types of factors. We list these factors in Table 3.1-1 and illustrate their nature in Figure 3.1-1.

Factor	*Customers' expectations*	*Effect on satisfaction*	
		if implemented	*if not implemented*
Attractive quality (delighter)	Customers do not expect implementation of measure	positive	none
One-dimensional quality (performance need)	Customers explicitly demand implementation of measure	positive	negative
Must-be quality (basic need)	Customers implicitly demand implementation of measure	none	negative
Indifferent quality	Customers are indifferent to implementation of measure	none	none

Table 3.1-1: List of the Kano model factors as described by Matzler et al. (1996) and applied to the data privacy context

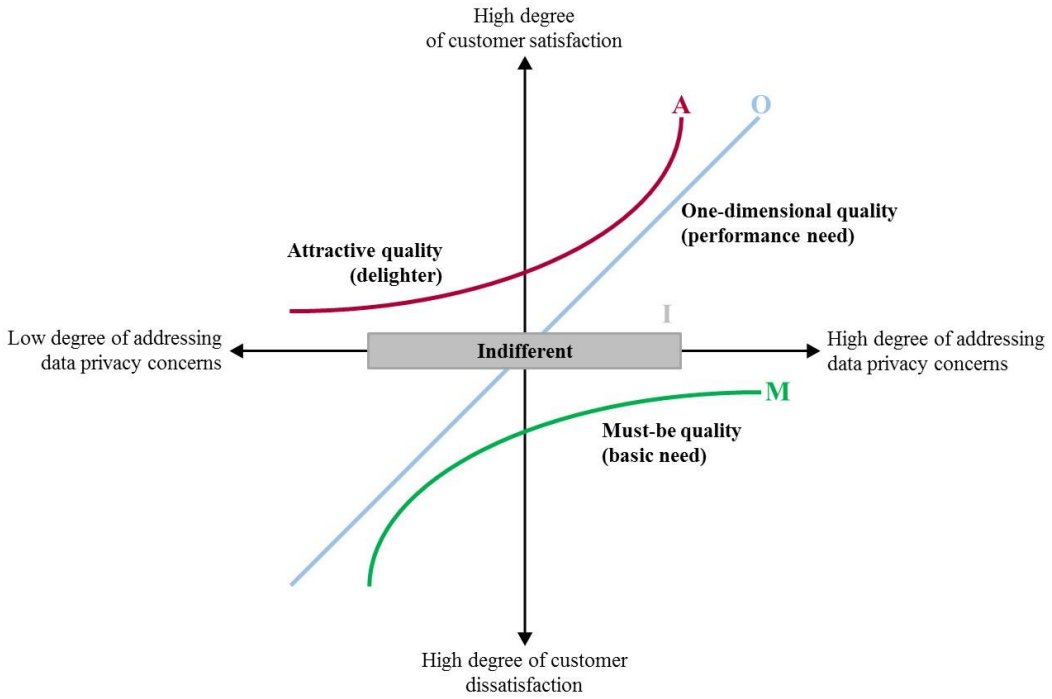
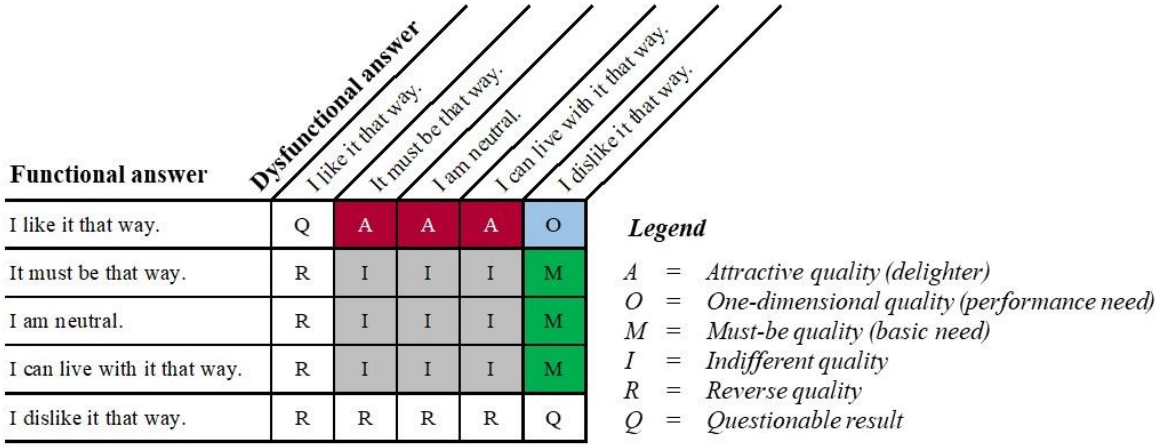


Figure 3.1-1: Illustration of the Kano model factors as described by Matzler et al. (1996) and applied to the data privacy context

The classification of a measure as a certain factor depends on customers' answers to both a functional and a dysfunctional question (Kano et al., 1984; Matzler et al., 1996). That is, customers are asked about their evaluation of the hypothetical case in which a measure is implemented and a case in which it is not. Each time, they can choose one of five possible answers: "I like it that way," "It must be that way," "I am neutral," "I can live with it that way," and "I dislike it that way." The different answers do not stand for a level of acceptance and there is no ordinal scale. Each possible combination of answers can be interpreted in an individual manner and leads to a certain pre-defined classification (Kano et al., 1984; Matzler et al., 1996), as shown in Figure 3.1-2.



Functional answer \ Dysfunctional answer	I like it that way.	It must be that way.	I am neutral.	I can live with it that way.	I dislike it that way.
I like it that way.	Q	A	A	A	O
It must be that way.	R	I	I	I	M
I am neutral.	R	I	I	I	M
I can live with it that way.	R	I	I	I	M
I dislike it that way.	R	R	R	R	Q

Legend

A = *Attractive quality (delighter)*
O = *One-dimensional quality (performance need)*
M = *Must-be quality (basic need)*
I = *Indifferent quality*
R = *Reverse quality*
Q = *Questionable result*

Figure 3.1-2: Derivation of Kano model factors based on Matzler et al. (1996)

The easiest and most intuitive way to determine the final classification of a measure as one of the Kano model factors for the overall sample is to choose the classification which appeared the most often, that is, the mode (Berger et al., 1993). However, determining and presenting the results solely based on the mode leads to a lack of further information about other frequently chosen categorizations. This is especially disadvantageous if the shares of participants who evaluated the measures as one of the other frequently chosen categorizations are of similar size (Schaule, 2014). There are numerous ways to determine whether a categorization based on the mode is significant as compared to other frequently chosen ones. Lee and Newcomb (1996) use the variable category strength, which is calculated as the difference between the shares of the most and second most frequently chosen categorizations. If the category strength is higher than six percent, they conclude that assigning the attribute to only one category is justified. If it is below six percent, they assign the attribute to a mixed category. A more sophisticated approach to decide whether the frequencies of the most and second most frequently chosen categorizations are significantly different is the test proposed by Fong (1996). It assumes significance if the category strength is higher than a reference value calculated based on the observed frequencies and the sample size. If determining a result based on the mode is not reasonable, Berger et al. (1993) propose to apply the (A, O, M) < > (I, R, Q) rule. Thereby, categorizations as attractive, one-dimensional, or must-be ((A, O, M) group) mean that an attribute has an influence on customer satisfaction. Categorizations as indifferent, reverse, or questionable ((I, R, Q) group) mean that an attribute has no influence on satisfaction. If one of the most and second most frequently chosen categorizations belong to one group and the remaining one to the other group, the (A, O, M) < > (I, R, Q) rule is applicable. It is executed by determining the group with the highest share of categorizations of the overall sample and then selecting the most frequently chosen categorization within this group. In the

current work, we will use the following approach for the determination of the final classification of our measures as one of the Kano model factors: we assign a category based on the mode if the category strength is significant at a ten-percent level according to the Fong test.[7] If the category strength is not significant and the (A, O, M) < > (I, R, Q) rule is applicable, we execute this rule. If it is not applicable, we assign the measure to a mixed category following Lee and Newcomb (1996). Additionally, we list all categorizations which do not exhibit a significant difference according to the Fong test as compared to the most frequently chosen one.

An alternative, continuous approach which avoids assigning categories to attributes altogether is the calculation of satisfaction ("better") and dissatisfaction ("worse") coefficients (Berger et al., 1993; Schaule, 2014). The satisfaction coefficient is calculated as the sum of all participants who categorized an attribute as a factor which has the power to increase their satisfaction (attributes of attractive and one-dimensional quality) over the sum of all participants who categorized the attribute as attractive, one-dimensional, must-be, or indifferent. The satisfaction coefficient's possible values range from 0 to 1. Reversely, the dissatisfaction coefficient is calculated as the sum of all participants who categorized the attribute as a factor which has the power to decrease their satisfaction (measures of must-be and one-dimensional quality) over the same denominator. Its value range is -1 to 0. The coefficients thus state the mean importance of attributes over all survey participants with regard to their power to both improve customer satisfaction and avoid customer dissatisfaction. In particular, it can be used to prioritize the implementation of measures (Berger et al., 1993). We will additionally use satisfaction and dissatisfaction coefficients to graphically represent and verify the results of our surveys.

3.1.3.2.2. Surveys

To determine the customers' evaluation of the identified data privacy measures, we conducted two Internet-based surveys. To enable the participants to assume a perspective as natural as possible and to illustrate the situation, we decided to use specific, well-known, and simple scenarios which relate to an exemplary industry sector for which data privacy is a considerable issue. That is, the sectors should feature a business-to-consumer market with a significant occurrence of processed customer data. To be able to consider the possible exchange of customer data between companies, cooperation agreements should exist between major actors in

[7] Unfortunately, due to a misreading of the underlying source, an incorrect significance level for the Fong test was stated in the published version of this research article. The significance level was 10 % instead of 5 %. The error has been corrected in this dissertation. The journal has been notified.

the industry. Furthermore, companies should provide loyalty programs because they are typically based on gathering data on a customer's behavior over a long period.

All of these requirements are fulfilled by the aviation sector. A considerable amount of customer data is collected at different interaction points (Clayton & Hilz, 2015). Data are transmitted to public authorities, airport operators, or other airlines which are partners in global alliances (Harris, 2007). Furthermore, airlines often provide loyalty programs (e.g., Miles & More, Emirates Skywards). Finally, the aviation sector is a commonly known industry. Therefore, we decided to face the participants with a typical customer process from the aviation sector.

To ensure high quality results, we first ran a pretest followed by the main survey. In the pretest, we asked 85 German-speaking participants to imagine booking a flight through an airline's website. Each participant was asked a functional and a dysfunctional question for each of the measures. Using the insights of the pretest, we made several modifications to the main survey: for improving the response rate, we mixed the questions with invitations to guess the correct answers to fun-fact questions about the aviation sector. For improving understandability, we grouped the questions with regard to the data privacy concerns they address and preceded them by short explanations of these concerns. The following example of an explanation, a functional, and a dysfunctional question demonstrates the survey's design. The example refers to a measure which addresses the concern External Secondary Usage (see measure D1 in Table 3.1-2 for detail). In the survey, the questions regarding this measure were preceded by the following explanation to acquaint the participants with the concern: "Your customer data may be used by a third party outside of the company for a purpose not previously agreed upon. The company implements the following measures:" The functional question directly related to the measure then read: "Information. If your customer data are passed on to external third parties, you are informed." The dysfunctional question was: "If your customer data are passed on to external third parties, you are not informed." Afterwards, the participants were asked a functional and a dysfunctional question each for every remaining measure which addresses the concern External Secondary Usage. To answer the functional and the dysfunctional question, the participants can choose one of the five previously mentioned possible answer options. In this way, we asked the participants about each of the 32 identified measures, resulting in 32 pairs of questions, each of them addressing one of the data privacy concerns.

227 German-speaking participants completed the main survey, 219 of whom correctly answered a control question. The participants were recruited via social media and email and

incentivized through a lottery of vouchers for an online retailer. The sample mostly consists of students (78%) and employees (16%). The age of the participants is between 18 and 57 years (average age 25.4 years). The survey was completed by both women (55%) and men (45%). The majority of the participants is well-educated. The share of participants holding a university degree is 51%. Another 42% of the participants achieved degrees with the matriculation standard.

In order to verify the initial results, we subsequently conducted a second survey. To ensure the comparability of both surveys, we used the same questionnaire as in the first survey. However, to take a step towards a generalizability of the results, the participants of the second survey were faced with a modified scenario. Due to its growing importance and the vast amount of customer data which is collected and processed within a purchase process, we decided to consider the online retail sector. Most of the customers create personal accounts. Furthermore, leading online retailers provide own loyalty programs (Mohammed, 2014). Usually, customer data are transferred to external logistics service providers in order to ship the products to the customers. Therefore, the online retail sector fulfills the previously defined requirements. In this context, the participants of the second survey were asked to imagine ordering a smartphone on the website of an internationally renowned online retailer.

299 German-speaking participants completed the second survey, 270 of whom correctly answered a control question. As in the first survey, participants were recruited via social media and email and incentivized through a lottery of vouchers for an online retailer. Most of the participants are students (77%) or employees (17%). The age of the participants ranges between 18 and 59 years (average age 24.6 years). The majority of the participants is well-educated. The share of participants holding a university degree is 50%. Another 45% of the participants achieved degrees with the matriculation standard. The majority of the participants (86%) stated that they have not completed a similar survey before, indicating that the set of participants differs significantly from the first survey.

3.1.4. Results

In the first part of this section, we present the overview of possible data privacy measures for companies which resulted from the research process previously described. This overview forms the basis of the presentation of the survey results in the second part of this section, that is, the perceptions which customers have of the identified privacy measures.

3.1.4.1. Data privacy concerns and measures

As described above, the overview of possible data privacy measures is compiled from academic literature, legislative texts, practical recommendations, corporate privacy statements, and expert interviews. From all sources, we collected 202 statements merged to 32 groups. From these groups, we derived particular data privacy measures and mapped them to the seven privacy concerns described by Smith et al. (1996). The measures are presented in Table 3.1-2, numbered and grouped according to the seven concerns. Each measure's detailed explanation is preceded by a short description printed in bold. Some of these short descriptions show recurring themes across concerns, e.g., "empowerment" taking on different facets with respect to most concerns. In the last column, we present the references from which we derived the measures and their detailed descriptions. In summary, Table 3.1-2 represents a comprehensive list of actions which can be taken by companies to mitigate the risk of displeasing customers and to create the potential for delighting customers regarding data privacy.

#	*Detailed description*	*Reference(s)*
A	**Data Collection**	
A1	**Information.** The purpose, scope, and storage time of the data collection and the involved advantages, risks, resulting rights, and obligations are clearly explained to the customer.	§33 (1) BDSG; §13 (1) TMG; 5 (1.a), 12 (1), 14 (1), 15 EU-GDPR, Facebook (2017), Telekom DE-Mail (2017), Tesla Motors (2017), Zalando (2017)
A2	**Anonymization.** Customer data are, as good as is possible, stored anonymously to prevent backtracking of individual customers.	§3a BDSG; §13 (6) TMG; 23, 30 (1), 30 (1.a), 30 (2.b) EU-GDPR, Apple (2017), Deutsche Bank (2017)
A3	**Restraint.** Only the customer data absolutely necessary to provide the agreed service are collected. The data are deleted as soon as the purpose of their collection no longer applies.	§3a BDSG; §14 (1), §15 (1) TMG; 5 (1.b), 5 (1.c), 23 EU-GDPR, Deutsche Bank (2017), Dropbox (2017), Facebook (2017)
A4	**Empowerment.** The customer can extend, limit or revoke the permission to store and use his data easily, quickly, free of charge and at any time.	6 (1.a), 6 (1.b), 7 (3), 12 (1.a), 17, 17a, 19 (1) EU-GDPR, Amazon (2017), Apple (2017), Deutsche Bank (2017), Tesla Motors (2017), Zalando (2017)
A5	**Data release.** At the request of the customer and without a long delay, the company provides a set of his personal data free of charge in an easily readable form. Furthermore, the customer has the right to pass these data on to other companies.	12 (1.a), 12 (2), 12 (4), 18 (2) EU-GDPR, Deutsche Bank (2017), easyJet (2017), Facebook (2017), Telekom DE-Mail (2017), Zalando (2017)
B	**Data Combination**	
B1	**Information.** The customer is informed if the company combines his data from various internal and external sources.	5 (1.a), 12 (1), 14a, 15 EU-GDPR, Facebook (2017), Tesla Motors (2017)
B2	**Anonymization.** If the company combines customer data from various internal and external sources, combination and storage are carried out using anonymous data to prevent backtracking of individual customers.	§13 (4), §15 (3) TMG; 23, 30 (1), 30 (1.a), 30 (2.b) EU-GDPR
B3	**Restraint.** If customer data are collected for different purposes, the data sets are stored in different databases and are not combined.	Attachment to §9 (1) BDSG; 13 (4) TMG; 23 EU-GDPR, Deutsche Bank (2017)
B4	**Empowerment.** The customer decides whether the company is allowed to combine data from various internal and external sources and can change his decision at any time.	17a EU-GDPR

#	*Detailed description*	*Reference(s)*
C	**Internal Secondary Usage**	
C1	**Information.** The customer is informed whether and what data are passed on within the company or group of companies and for what purposes.	§13 (5) TMG; 5 (1.a), 12 (1), 14 (1), 15 EU-GDPR, Facebook (2017), Tesla Motors (2017)
C2	**Deletion.** Customer data are deleted as soon as the original reason for the collection no longer applies or the customer withdraws his permission to use his data.	§35 (2) BDSG; §13 (4), §15 (7) TMG; 5 (1.e), 17 EU-GDPR, Deutsche Bank (2017), Dropbox (2017), Facebook (2017)
C3	**Tracking.** Entering, viewing, altering, and deleting customer data are recorded to make it possible to retrace who changed the data when, and in what manner at any time. The customer can either directly view the log file or is informed about any alterations of his personal data.	Attachment to §9 (1) BDSG; 17b, 23 EU-GDPR
C4	**Restraint.** If customer data are collected for different purposes, the data sets are stored in different databases and are not combined.	Attachment to §9 (1) BDSG; 13 (4) TMG; 23 EU-GDPR, Deutsche Bank (2017)
C5	**Empowerment.** Customers have the opportunity to easily decide which of their personal data are shared with other departments of the company and/or used for other purposes.	6 (1.a), 6 (1.b), 12 (1.a), 17a EU-GDPR, Facebook (2017)
D	**External Secondary Usage**	
D1	**Information.** If customer data are passed on to external third parties, the customer is informed.	§13 (5) TMG; 5 (1.a), 12 (1), 14 (1), 15 EU-GDPR, Amazon (2017), Clement and Obar (2016), Facebook (2017), Telekom DE-Mail (2017), Tesla Motors (2017)
D2	**Guidelines.** If customer data are passed on to external third parties, the company ensures that the data are only used in the manner agreed on with the customer through contracts or binding commitments to data protection regulations.	§11 (1) (2) BDSG; 5 (1.a), 26 (1), 26 (1.a), 26 (2), 26 (2.a), 27, 40, 42 (1), 43 EU-GDPR, Amazon (2017), Dropbox (2017), Clement and Obar (2016), easyJet (2017), Facebook (2017), Telekom DE-Mail (2017), Tesla Motors (2017)
D3	**Compliance check.** If customer data are passed on to external third parties, the company or an independent certification organization regularly checks the external third party's compliance with data privacy regulations.	26 (1), 26 (1.a) EU-GDPR, Deutsche Bank (2017), Telekom DE-Mail (2017)
D4	**Codification.** If customer data are passed on to external third parties, data are only forwarded in aggregated or codified form (e.g. income class instead of exact yearly income).	Tesla Motors (2017)
D5	**Anonymization.** If customer data are passed on to external third parties, the data are forwarded anonymously.	§30 (1) BDSG; §15 (5) TMG, Amazon (2017)
D6	**Restraint.** The company does not pass on customer data to external third parties.	Tesla Motors (2017)
D7	**Empowerment.** The customer has the choice to easily permit or deny sharing his data with external parties.	7 (3), 12 (1.a), 17, 17a EU-GDPR, Amazon (2017), Apple (2017), Morey et al. (2015), Payne et al. (2015), Zalando (2017)
E	**Errors**	
E1	**Reviews.** Customer data are checked regularly by the company for completeness, accuracy, and being up-to-date.	5 (1.d) EU-GDPR, Payne et al. (2015), Tesla Motors (2017)
E2	**Protective measures.** The company ensures that no customer data are destroyed or lost by technical and organizational means (e. g., double data storage).	Attachment to §9 (1) BDSG; §13 (7) TMG; 22 (1), 23, 30 (1), 30 (1.a), 30 (2.b) EU-GDPR, Telekom DE-Mail (2017), Tesla Motors (2017), Zalando (2017)
E3	**Employee supervision.** Employees with access to customer data are selected carefully, their behavior is checked regularly, and they are held responsible for malpractice.	30 (1.a), 30 (2.b) EU-GDPR, Tesla Motors (2017)
E4	**Tracking.** Entering, viewing, altering, and deleting customer data are recorded to make it possible to retrace who changed the data when, and in what manner at any time. The customer can either directly view the log file or is informed about any alterations to his personal data.	Attachment to §9 (1) BDSG; 17b, 23 EU-GDPR

#	*Detailed description*	*Reference(s)*
E5	**Empowerment.** The customer has access to his data to correct errors, make alterations, or delete data. If he is not provided with direct access to edit his data, they are changed by the company on request.	16 EU-GDPR, Amazon (2017), Apple (2017), Deutsche Bank (2017), Payne et al. (2015), Tesla Motors (2017)
F	**Improper Access**	
F1	**Information.** If the protection of customer data was violated and their security is at risk, the company immediately informs the customer and the authorities.	31 (1), 31 (2), 32 (1) EU-GDPR
F2	**Protective measures.** Storage and transmission of customer data are protected by technical (e.g., password protection, encryption) and organizational means (e.g., access control, dual control principle).	§9 BDSG; Attachment to §9 (1) BDSG; §13 (4), §13 (7) TMG; 5 (1.b), 22 (1), 23, 30 (1.a), 30 (2.b) EU-GDPR, Amazon (2017), Apple (2017), Deutsche Bank (2017), Dropbox (2017), easyJet (2017), Payne et al. (2015), Telekom DE-Mail (2017), Tesla Motors (2017), Zalando (2017)
F3	**Secure server location.** The company ensures that customer data are stored and processed only on its own servers within the European Union or countries trusted by the European Commission.	41 (1) EU-GDPR, Clement and Obar (2016), Telekom DE-Mail (2017)
G	**Reduced Judgment**	
G1	**Information.** The customer is informed whether a decision was made by an automated system or by an employee of the company. At the customer's request, the reasons for the decision are communicated and explained.	§6a BDSG; 5 (1.a), 12 (1), 15 EU-GDPR
G2	**Reviews.** Automated decision processes are continuously tested and checked for deviations.	20 (1), 20 (1.b) EU-GDPR
G3	**Restraint.** Decisions which entail legal consequences (e.g., granting a credit) are never made only on the basis of automated systems.	§6a BDSG; 20 (1), 20 (1.b) EU-GDPR

Table 3.1-2: Measures addressing the seven privacy concerns

3.1.4.2. Customers' evaluation of data privacy measures

Companies need to be aware of the customers' evaluation of these data privacy measures which forms the basis for deriving implications for companies' data privacy policies. To determine the customers' view regarding the different identified data privacy measures, we applied the Kano model in two empirical studies as described in the previous research method section. Table 3.1-3 shows the results. Thereby, the measures are numbered and grouped according to the addressed concerns and named with the short descriptions presented in Table 3.1-2. For both the aviation and the retail survey, we present the category strength and the final categorization of each measure as one of the Kano model factors. The final categorizations were determined following the approach which we described in the previous Kano model section. To illustrate this approach, we use measure A3 as an example. For the aviation survey, the difference between the share of the most and second most frequently chosen factor is 12%, a category strength which is significant at a ten-percent level according to the Fong test. The final categorization thus is the most frequently chosen factor which is of a must-be quality. For the retail survey, the differences between the share of the most (one-dimensional quality)

and second most (attractive quality) frequently as well as the most and third most (must-be quality) frequently chosen factor are not significant according to the Fong test. The (O + A + M) < > (I + R + Q) rule is not applicable as both the most and second most frequently chosen factor belong to the (O + A + M) group. Consequently, the measure is assigned to the mixed category and all three categorizations are listed.

#	Short description	Aviation survey (n = 219)		Retail survey (n = 270)		Accordance
		Category strength	*Categorization*	*Category strength*	*Categorization*	
A	**Data Collection**					
A1	Information	21% *	M	30% *	M	yes
A2	Anonymization	10% *	A	11% *	A	yes
A3	Restraint	12% *	M	3% [2]	Mixed (O, A, M)	partially
A4	Empowerment	18% *	M	3% [2]	Mixed (M, A, O)	partially
A5	Data release[8]	4% [2]	Mixed (M, A, O)	3% [1]	A	partially
B	**Data Combination**					
B1	Information	11% *	I	4% [1]	M	no
B2	Anonymization	8% *	M	11% *	M	yes
B3	Restraint	18% *	I	30% *	I	yes
B4	Empowerment	13% *	A	14% *	A	yes
C	**Internal Secondary Usage**					
C1	Information	21% *	M	20% *	M	yes
C2	Deletion	20% *	M	21% *	M	yes
C3	Tracking	17% *	A	4% [2]	Mixed (A, O, I, M)	partially
C4	Restraint	16% *	A	23% *	I	no
C5	Empowerment	13% *	A	13% *	A	yes
D	**External Secondary Usage**					
D1	Information	49% *	M	46% *	M	yes
D2	Guidelines	58% *	M	45% *	M	yes
D3	Compliance check	17% *	M	22% *	M	yes
D4	Codification	4% [2]	Mixed (M, A, I)	3% [1]	M	partially
D5	Anonymization	34% *	M	24% *	M	yes
D6	Restraint	1% [2]	Mixed (A, O)	6% [2]	Mixed (A, O)	yes
D7	Empowerment	14% *	M	8% *	M	yes
E	**Errors**					
E1	Reviews	60% *	I	64% *	I	yes
E2	Protective measures	49% *	I	32% *	I	yes
E3	Employee supervision	37% *	M	40% *	M	yes
E4	Tracking	4% [1]	A	1% [2]	Mixed (M, A, O, I)	partially
E5	Empowerment	11% *	M	13% *	M	yes
F	**Improper Access**					
F1	Information	42% *	M	43% *	M	yes
F2	Protective measures	40% *	M	44% *	M	yes
F3	Secure server location	4% [1]	A	4% [1]	A	yes
G	**Reduced Judgment**					
G1	Information	11% *	I	17% *	I	yes
G2	Reviews	4% [1]	M	4% [1]	M	yes
G3	Restraint	1% [1]	M	10% *	M	yes

Legend: * = Categorization significant at a ten-percent level according to Fong test
[1] = (O + A + M) < > (I + R + Q) rule applicable
[2] = (O + A + M) < > (I + R + Q) rule not applicable
A = Attractive quality (delighter)
O = One-dimensional quality (performance need)
M = Must-be quality (basic need)
I = Indifferent quality

Table 3.1-3: Empirical results of the data privacy measures' evaluation via the Kano model in two surveys

The results of both the aviation and the retail survey show that in both scenarios, five measures are considered by the participants to be of indifferent quality. These measures do not allow

[8] Due to technical complications in the process of revising and providing the retail survey online, the questions regarding measure A5 were answered by 143 instead of 270 participants.

distinctive interpretations toward any direction. In each scenario, 17 out of 32 measures are categorized as basic needs (must-be quality). Furthermore, the categorization as basic need is the most frequent one for two measures belonging to the mixed category in each survey. The realization of these measures is not rewarded. Instead, it is a basic prerequisite when engaging in business with the company. An example for a measure of must-be quality is D2 which addresses the concern External Secondary Usage: if customer data are passed on to external third parties, the company ensures that the data are only used in the manner agreed on with the customer through contracts or binding commitments to data protection regulations. Basic needs can be predominantly found among measures addressing the concerns External Secondary Usage (5-6 measures out of 7 categorized as a basic need in both scenarios), Improper Access (2/3), and Reduced Judgment (2/3). They are also frequently found among measures addressing the concern Data Collection (3/5) in the aviation scenario. These basic needs can be considered a necessary evil because they have downside risks if not implemented but offer no upside opportunities if implemented. In both surveys, no measure is considered to be a performance need. However, this factor occurs among the most frequent categorizations in the mixed category for two measures in the aviation and four measures in the retail scenario. The constituting properties of a performance need are, in addition to having a negative impact if not implemented, that it also might increase customer satisfaction when implemented properly.

Seven measures are categorized as delighters in the aviation scenario and five in the retail scenario. Furthermore, three delighters occur among the most frequent categorizations in the mixed category in the aviation scenario and five in the retail scenario. The implementation of these measures is not required by the customers but may please them. Not implementing these measures has no negative impact. These measures go beyond the data privacy measures which customers expect. In the aviation scenario, delighters can be predominantly found among measures addressing the concern Internal Secondary Usage (3 measures out of 5 categorized as a delighter). In the retail scenario, the delighters are distributed over measures addressing four different concerns and there is no concentration observable. In both scenarios, customers can be delighted by storing their data in an anonymized form (A2), empowering them with regard to the combination of their data (B4) and data sharing within the company (C5), and storing their data on servers with a secure location (F3).

Overall, there are eight (25%) measures which exhibit different categorizations in the aviation scenario as compared to the retail scenario. They address five different concerns and include

all Kano model factors with the previously mentioned exception of performance needs. For three of these measures, the categorization in one of the scenarios corresponds to the most frequent result of the mixed category categorization in the other scenario. That is, these categorizations are not equal but the tendencies are similar. The remaining 24 measures are categorized in the same way by participants of the aviation and the retail survey. These measures address all seven concerns and include all Kano model factors. All measures addressing the concerns Improper Access and Reduced Judgment exhibit the same results. To assess the reliability of the measure categorizations across the two different scenarios, we conducted a test of inter rater reliability with two raters. Thereby, the categorizations of measures in the aviation scenario as shown in Table 3.1-3 were interpreted as the choice of the first rater and those of the retail scenario as the choice of the second rater. The percent agreement is 0.75 and the Cohen's Kappa is 0.61, indicating a substantial strength of agreement according to Landis and Koch (1977).

The similarity of the measures' categorizations is also reflected in Figure 3.1-3. It represents a satisfaction-dissatisfaction diagram of the results of both surveys. The x-coordinate indicates the satisfaction coefficient, the y-coordinate states the dissatisfaction coefficient. We present the data points for both scenarios and connect them with a line. Few measures exhibit relatively large differences between the aviation and the retail surveys' results (e.g., A4, C3 and C4) while the data points for the majority of measures are in rather close proximity to their counterparts. The indication of high reliability of the 32 measures' satisfaction and dissatisfaction coefficients across the two scenarios is confirmed by their high and highly significant Pearson's correlations: 0.91 (p-value << 0.001) for the satisfaction coefficients and 0.96 (p-value << 0.001) for the dissatisfaction coefficients.

We limited the range of the axes to the actually occurring values for better readability. The fact that the dissatisfaction coefficient's axis exhibits a broader range than the satisfaction coefficient's axis as well as the relatively high concentration of measures in the bottom left quadrant emphasize the dominance of measures of must-be quality. They will decrease the overall customer satisfaction if not implemented but will only moderately increase it if implemented. However, the opposite case can be observed as well. Implementing measure B4, for example, has the potential to increase the overall satisfaction of a notable share of survey participants while not implementing it will have a relatively small negative effect.

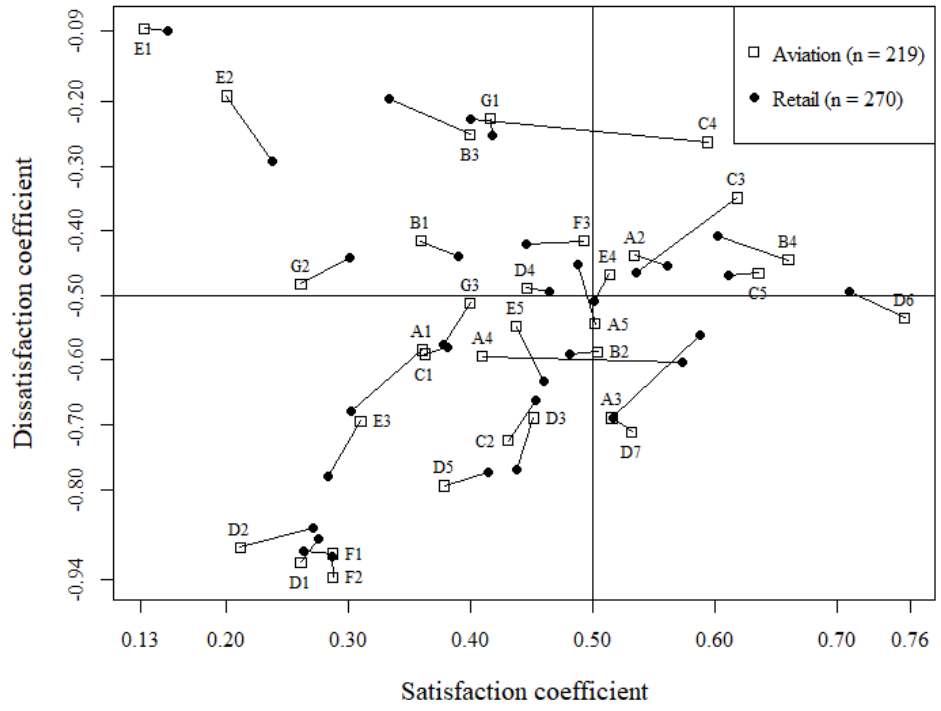


Figure 3.1-3: Joint satisfaction-dissatisfaction diagram of the results of both surveys

These results are underlined by a more detailed look at the categorization of measures on the participant-level. For both scenarios, Table 3.1-4 presents the minimum, median, mean and maximum count of categorizations as a specific Kano model factor per survey participant. It also indicates the share of participants who categorized zero and at least ten measures as the specific Kano model factor. Measures of must-be quality are dominant: more than 60% of the participants of both surveys categorized more than 10 of our 32 measures as such basic needs. However, only 8% of participants of the aviation survey and 9% of participants of the retail survey evaluated none of the measures as attractive. This implies that data privacy has the overall potential to improve the satisfaction of a very large share of customers: 92% (aviation) and 91% (retail) see at least one data privacy measure as delighter, that is, as a measure with upside potential only. 32% (aviation) and 29% (retail) categorized more than 10 measures as such delighters. All but one (99.5%, aviation) and all but six (97.8%, retail) survey participants categorized at least one measure as performance need or delighter, that is, as a measure with upside potential.

	Aviation survey (n = 219)						Retail survey (n = 270)					
	min	*med*	*mean*	*max*	*none*	*>= 10*	*min*	*med*	*mean*	*max*	*none*	*>= 10*
Attractive quality	0	7	7,4	21	8%	32%	0	6	6,7	25	9%	29%
One-dimensional quality	0	5	6,2	28	7%	20%	0	5	6,4	30	9%	21%
Must-be quality	0	11	11,1	29	3%	60%	0	11	10,7	30	5%	62%
Indifferent quality	0	6	7,0	28	5%	26%	0	6	7,3	30	3%	28%
Reverse quality	0	0	0,3	4	78%	0%	0	0	0,3	10	84%	0%
Questionable result	0	0	0,1	5	95%	0%	0	0	0,1	7	93%	0%

Table 3.1-4: regarding the number of categorizations per Kano model factor and survey participant

3.1.5. Discussion

3.1.5.1. Theoretical contribution

This paper contributes to the body of knowledge about data privacy. Most scientific and practitioner-oriented literature describes data privacy as necessary evil that organizations have to deal with in order to mitigate risks. We shed light on the upside of data privacy beyond mere risk management. Our paper consists of two main contributions. First, we created a set of 32 specific data privacy measures that address the customers' seven main data privacy concerns. We derived these measures from several legislative texts of the German and European law system as well as from scientific and practitioner-oriented literature and corporate privacy statements. With the consideration of the European General Data Protection Regulation (EU-GDPR) which will become applicable law in May 2018, we took a future-oriented perspective and incorporated the most recent legislation into our research. The consolidated and enriched set of measures from several sources was evaluated in discussions with data privacy experts. It can serve as a basis for the development of further data privacy concepts and strategies. Second, we provided an evaluation of these data privacy measures by customers. Via two online surveys, we empirically captured customers' perceptions of the identified data privacy measures as must-be, one-dimensional, attractive, or as indifferent. A similar classification of most measures across both surveys showed a consistent and reliable picture of customer sentiment. A further analysis of the survey responses with a satisfaction-dissatisfaction diagram strengthened the dominating assertion of data privacy measures as necessary evil. However, among both industry scenarios, we showed that the implementation of certain data privacy measures has the potential to delight customers. The vast majority of participants could be delighted with data privacy measures and almost a third of all participants could be delighted by 10 or more measures. Our research specifically highlights the upside of data privacy. In summary, the customers' evaluation of data privacy measures as presented in this paper is a

starting point for all researchers who try to understand customer sentiment toward specific measures and data privacy in general.

3.1.5.2. Limitations

Researchers and practitioners should be aware of the limitations of this research. First, the derivation of data privacy measures focused on Germany and Europe. Other regions with different cultures and legislative systems might yield other or further measures. Second, the results of the empirical part of this research should only be interpreted in a company- and customer-specific manner. We selected the booking process for a flight and the online purchase of a product to present realistic scenarios to our survey participants who were predominantly students, that is, potential customers of the present and future. To verify the validity of the conclusions for other industry scenarios and customer groups, the survey and analyses have to be rerun as presented in this paper. Third, in the field of data privacy, statements of customers in empirical surveys do not necessarily match their actions in the real world. The so-called privacy paradox describes the discrepancy between customers' intentions to protect their own privacy and their real-world behavior (Acquisti & Grossklags, 2005; Norberg et al., 2007). The survey answers may be further biased as all data privacy measures were introduced with a description of the concern they address. This concern may not always be present to customers in real life. To take into account this limitation, the results of the survey should be verified in real-world situations not specifically referring to privacy concerns. Fourth, in general, the classification of delighters is less clear than the classification of basic needs. That is, when interpreting this paper's results, implications should be challenged according to the principle of prudence. Future research could follow Matzler et al. (1996) who state that unclear results spread out over several categories can be a starting point for market segmentation.

3.1.5.3. Managerial implications

This paper provides advice to practitioners working in the field of data privacy and thinking about the implementation of certain data privacy measures and an overarching data privacy strategy. Our paper provides practitioners with an overview of possible data privacy measures specifically addressing customers' concerns regarding data privacy. Practitioners also get first insights into the measures' contribution to customer satisfaction and potential for a competitive advantage. Based on the measures' categorization, companies may implement different pricing strategies which take into account the level of data privacy related to a certain product.

For instance, companies may offer a basic product which merely comprises the implementation of basic and performance needs and a more expensive luxury product which additionally entails the implementation of all privacy measures that are categorized as delighters.

Overall, our research indicates that companies can delight the vast majority of customers with appropriate data privacy measures. Though companies might not want to implement every measure that delights customers, they can lever our research in the trade-off between customer excitement, economic value, regulatory requirements, and technical feasibility when deciding between the implementation of individual measures. To establish a generic and systematic "privacy by design" process which goes beyond mere technical solutions (Danezis et al., 2015), companies could follow the procedure of our research. A rational first step could be the derivation of a data privacy strategy that aligns with the overarching company strategy. Companies could gather their existing and potential future customers' concerns with regard to data privacy leveraging the work of Smith et al. (1996). Furthermore, companies could use our set of data privacy measures as a starting point and elaborate measures that specifically address the concerns of their customers. As demonstrated in this paper, companies could get insights into the relationship between individual data privacy measures and customer satisfaction by asking for their customers' evaluation. Considering their data privacy strategy and their customers' evaluation, companies could implement respective measures and measure their performance. Results from the performance measurement could serve as an input for adjustments of the company's data privacy strategy. To decide on the implementation of a data privacy strategy and particular measures, companies should nevertheless employ an interdisciplinary team which works on data privacy related topics and particularly includes a customer perspective besides a legal one.

3.1.6. Conclusion and further research

Answering the first research question, this paper provides an overview of data privacy measures collected from scientific and practitioner-oriented literature, legislative texts, and corporate privacy statements and evaluated by expert interviews. In addition, this paper provides first insights into customers' perceptions of the identified data privacy measures. By using the Kano model to design two online surveys, each with more than 200 participants, we could show that the majority of data privacy measures must be considered as necessary evils for companies. Nevertheless, both surveys highlighted the upside of data privacy, as almost all potential customers could be delighted with at least one measure. Thus, this paper positively answers the research question whether some measures are perceived as attractive and

can delight customers. Their implementation might even lead to a competitive advantage for companies. Accordingly, researchers and practitioners may use our approach as an inspiration when deriving a data privacy strategy. The list of measures may be useful. Evaluating customers' perception may assist in prioritizing the implementation of data privacy measures.

As every research endeavor, our paper leaves room for future research. Firstly, future research could focus on the evaluation of the general validity of our research in other industries than aviation and retail and with other customer groups. Secondly, researchers could segment customers by age, career, education, and other criteria in order to isolate groups that can be especially delighted with data privacy and derive strategies for those customers who do not. Thirdly, a decomposition of single data privacy measures in its individual components could shed light on the influence of individual aspects of a data privacy measure on customers' satisfaction. Fourth, researchers could further investigate the reasons why an individual data privacy measure is classified as one of the factors of the Kano model to better understand customers' sentiment towards data privacy in general.

3.1.7. References

Acquisti, A., Friedman, A., & Telang, R. (2006). Is there a cost to privacy breaches? An event study. In *Proceedings of the 27th International Conference on Information Systems (ICIS)*, Milwaukee, United States of America.

Acquisti, A., & Grossklags, J. (2005). Privacy and rationality in individual decision making. *IEEE Security & Privacy*, *3*(1), 26–33.

Ahmad, A., & Mykytyn, P. (2012). Perceived privacy breach - The construct, the scale, and its antecedents. In *Proceedings of the 18th Americas Conference on Information Systems (AMCIS)*, Seattle, United States of America.

Amazon. (2017). *Amazon.de-Datenschutzerklärung*. https://www.amazon.de/gp/help/customer/display.html?nodeId=3312401. Accessed on 2017-10-23.

Apple. (2017). *Apple Datenschutzrichtlinie*. https://www.apple.com/legal/privacy/de-ww/. Accessed on 2017-10-23.

Arbore, A., & Busacca, B. (2009). Customer satisfaction and dissatisfaction in retail banking: Exploring the asymmetric impact of attribute performances. *Journal of Retailing and Consumer Services*, *16*(4), 271–280.

Audatis Consulting. (2016). *Checkliste: Technische und organisatorische Maßnahmen*. https://www.audatis.de/wp-content/uploads/Checkliste_Datenschutz_TOM_nach_9_BDSG.pdf. Accessed on 2016-08-18.

Bartikowski, B., & Llosa, S. (2004). Customer satisfaction measurement: Comparing four methods of attribute categorisations. *The Service Industries Journal*, *24*(4), 67–82.

BBC. (2015). *Ashley Madison infidelity site's customer data 'leaked'*. http://www.bbc.com/news/business-33984017. Accessed on 2017-05-10.

Bélanger, F., & Crossler, R. E. (2011). Privacy in the digital age: A review of information privacy research in information systems. *MIS Quarterly*, *35*(4), 1017–1041.

Berendt, B., Günther, O., & Spiekermann, S. (2005). Privacy in e-commerce: Stated preferences vs. actual behavior. *Communications of the ACM*, *48*(4), 101–106.

Berger, C., Blauth, R., Boger, D., Bolster, C., Burchill, G., DuMouchel, W., Pouliot, F., Richter, R., Rubinoff, A., Shen, D., Timko, M., & Walden, D. (1993). Kano's methods for understanding customer-defined quality. *Center for Quallity Management Journal*, *2*(4), 3–36.

Buchmann, E., Böhm, K., & Raabe, O. (2008). Privacy 2.0: Towards collaborative data-privacy protection. In Y. Karabulut, J. Mitchell, P. Herrmann, & C. D. Jensen (Chairs), *Proceedings of IFIPTM 2008*.

Buhl, H. U. (2013). IT as curse and blessing. *Business & Information Systems Engineering*, *5*(6), 377–381.

Campbell, K., Gordon, L. A., Loeb, M. P., & Zhou, L. (2003). The economic cost of publicly announced information security breaches: Empirical evidence from the stock market. *Journal of Computer Security*, *11*(3), 431–448.

Cavusoglu, H., Mishra, B., & Raghunathan, S. (2004). The effect of internet security breach announcements on market value: Capital market reactions for breached firms and internet security developers. *International Journal of Electronic Commerce*, *9*(1), 69–104.

Clayton, E., & Hilz, A. (2015). *2015 aviation trends*. http://www.strategyand.pwc.com/perspectives/2015-aviation-trends. Accessed on 2016-08-18.

Clement, A., & Obar, J. A. (2016). Keeping internet users in the know or in the dark: An analysis of the data privacy transparency of Canadian internet carriers. *Journal of Information Policy*, *6*, 294–331.

Culnan, M. J., & Armstrong, P. K. (1999). Information privacy concerns, procedural fairness, and impersonal trust: An empirical investigation. *Organization Science*, *10*(1), 104–115.

Danezis, G., Domingo-Ferrer, J., Hansen, M., Hoepman, J.-H., Métayer, D. Le, Tirtea, R., & Schiffner, S. (2015). *Privacy and data protection by design - From policy to engineering*. Athens. https://www.enisa.europa.eu/publications/privacy-and-data-protection-by-design. Accessed on 2017-04-25.

Deutsche Bank. (2017). *Datenschutz*. https://www.deutsche-bank.de/pfb/content/pk-datenschutz.html. Accessed on 2017-10-23.

Dhasarathan, C., Thirumal, V., & Ponnurangam, D. (2015). Data privacy breach prevention framework for the cloud service. *Security and Communication Networks*, *8*(6), 982–1005.

Dropbox. (2017). *Dropbox-Datenschutzrichtlinie*. https://www.dropbox.com/privacy. Accessed on 2017-10-23.

Eastin, M. S., Brinson, N. H., Doorey, A., & Wilcox, G. (2016). Living in a big data world: Predicting mobile commerce activity through privacy concerns. *Computers in Human Behavior*, *58*, 214–220.

easyJet. (2017). *Datenschutzerklärung*. https://www.easyjet.com/de/politik/datenschutzerklarung. Accessed on 2017-10-23.

Facebook. (2017). *Datenrichtlinie*. Facebook. https://de-de.facebook.com/about/privacy. Accessed on 2017-10-23.

Fong, D. (1996). Using the self-stated importance questionnaire to interpret Kano questionnaire results. *Center for Quallity Management Journal*, *5*(3), 21–23.

Füller, J., & Matzler, K. (2008). Customer delight and market segmentation: An application of the three-factor theory of customer satisfaction on life style groups. *Tourism Management*, *29*(1), 116–126.

Gronholdt, L., Martensen, A., & Kristensen, K. (2000). The relationship between customer satisfaction and loyalty: Cross-industry differences. *Total Quality Management*, *11*(4-6), 509–514.

The Guardian. (2011). *iPhone keeps record of everywhere you go*. https://www.theguardian.com/technology/2011/apr/20/iphone-tracking-prompts-privacy-fears. Accessed on 2017-05-10.

Hackl, P., & Westlund, A. H. (2000). On structural equation modelling for customer satisfaction measurement. *Total Quality Management*, *11*(4-6), 820–825.

Harris, E. C. (2007). Personal data privacy tradeoffs and how a Swedish church lady, Austrian public radio employees, and transatlantic air carriers show that Europe does not have the answer. *American University International Law Review*, *22*(5), 745–799.

Hong, W., & Thong, J. Y. L. (2013). Internet privacy concerns: An integrated conceptualization and four empirical studies. *MIS Quarterly*, *37*(1), 275–298.

Hovav, A., & D'Arcy, J. (2003). The impact of denial-of-service attack announcements on the market value of firms. *Risk Management and Insurance Review*, *6*(2), 97–121.

Inman, J. J., & Nikolova, H. (2017). Shopper-facing retail technology: A retailer adoption decision framework incorporating shopper attitudes and privacy concerns. *Journal of Retailing*, *93*(1), 7–28.

Kano, N., Seraku, N., Takahashi, F., & Tsuji, S. i. (1984). Attractive quality and must-be quality. *The Journal of the Japanese Society for Quality Control*, *14*(2), 147–156.

Keith, M. J., Babb, J., Furner, C., Abdullat, A., & Lowry, P. B. (2016). Limited information and quick decisions: Consumer privacy calculus for mobile applications. *AIS Transactions on Human-Computer Interaction*, *8*(3), 88–130.

Keith, M. J., Thompson, S. C., Hale, J., Lowry, P. B., & Greer, C. (2013). Information disclosure on mobile devices: Re-examining privacy calculus with actual user behavior. *International Journal of Human-Computer Studies*, *71*(12), 1163–1173.

Khatri, V., & Brown, C. V. (2010). Designing data governance. *Communications of the ACM*, *53*(1), 148.

Klingspor, V. (2016). Why do we need data privacy? In S. Michaelis, N. Piatkowski, & M. Stolpe (Eds.), *Solving Large Scale Learning Tasks: Challenges and Algorithms* (pp. 85–95). Springer.

Ladhari, R. (2009). A review of twenty years of SERVQUAL research. *International Journal of Quality and Service Sciences*, *1*(2), 172–198.

Lai, H.-J., & Wu, H.-H. (2011). A case study of applying Kano's model and ANOVA technique in evaluating service quality. *Information Technology Journal*, *10*(1), 89–97.

Landis, R. J., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, *33*, 159–174.

Lee, M. C., & Newcomb, J. (1996). Applying the Kano methodology in managing NASA's science research program. *Center for Quallity Management Journal*, *5*(3), 13–20.

Löfgren, M., & Witell, L. (2008). Two decades of using Kano's theory of attractive quality: A Literature Review. *The Quality Management Journal*, *15*(1), 59–75.

Lyons, V., van der Werff, L., & Lynn, T. (2016). Ethics as pacemaker: Regulating the heart of the privacy-trust relationship. A proposed conceptual model. In *Proceedings of the 37th International Conference on Information Systems (ICIS),* Dublin, Ireland.

Malhotra, N. K., Kim, S. S., & Agarwal, J. (2004). Internet users' information privacy concerns (IUIPC): The construct, the scale, and a causal model. *Information Systems Research*, *15*(4), 336–355.

Mamonov, S., & Koufaris, M. (2014). The impact of perceived privacy breach on smartphone user attitudes and intention to terminate the relationship with the mobile carrier. *Communications of the Association for Information Systems*, *34*(60).

Matthing, J., Sandén, B., & Edvardsson, B. (2004). New service development: Learning from and with customers. *International Journal of Service Industry Management*, *15*(5), 479–498.

Matzler, K., Hinterhuber, H. H., Bailom, F., & Sauerwein, E. (1996). How to delight your customers. *Journal of Product & Brand Management*, *5*(2), 6–18.

Matzler, K., & Stahl, H. K. (2000). Kundenzufriedenheit und Unternehmenswertsteigerung. *Die Betriebswirtschaft*, *60*, 626–641.

Mohammed, R. (2014). *Why Amazon should unbundle Prime*. https://hbr.org/2014/02/why-amazon-should-unbundle-prime. Accessed on 2017-10-12.

Morey, T., Forbath, T., & Schoop, A. (2015). Customer data: Designing for transparency and trust. *Harvard Business Review*(May), 96–105.

Moshki, H., & Barki, H. (2016). Coping with information privacy breaches: An exploratory framework. In *Proceedings of the 37th International Conference on Information Systems (ICIS)*, Dublin, Ireland.

Muntermann, J., & Roßnagel, H. (2009). On the effectiveness of privacy breach disclosure legislation in Europe: Empirical evidence from the US stock market. In A. Jøsang, T. Maseng, & S. J. Knapskog (Chairs), *Nordic Conference on Secure IT Systems: Identity and Privacy in the Internet Age*.

Nicholas-Donald, A., Matus, J. F., Ryu, S., & Mahmood, A. M. (2011). The economic effect of privacy breach announcements on stocks: A comprehensive empirical investigation. In *Proceedings of the 17th Americas Conference on Information Systems (AMCIS)*, Detroit, United States of America.

Nofer, M., Hinz, O., Muntermann, J., & Roßnagel, H. (2014). The economic impact of privacy violations and security breaches. *Business & Information Systems Engineering*, *6*(6), 339–348.

Nofer, M., Hinz, O., Muntermann, J., & Rossnagel, H. (2014). The economic impact of privacy violations and security breaches. *Business & Information Systems Engineering*, *6*(6), 339–348.

Norberg, P. A., Horne, D. R., & Horne, D. A. (2007). The privacy paradox: Personal information disclosure intentions versus behaviors. *The Journal of Consumer Affairs*, *41*(1), 100–126.

Otto, B. (2011). Organizing data governance: Findings from the telecommunications industry and consequences for large service providers. *Communications of the Association for Information Systems*, *29*(3), 45–66.

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1985). A conceptual model of service quality and its implications for future research. *Journal of Marketing*, *49*(4), 41–50.

Pavlou, P. A. (2011). State of the information privacy literature: Where are we now and where should we go? *MIS Quarterly*, *35*(4), 977–988.

Payne, D., Landry, B. J. L., & Dean, M. D. (2015). Data mining and privacy: An initial attempt at a comprehensive code of conduct for online business. *Communications of the ACM*, *37*, Article 34.

Preibusch, S. (2013). Guide to measuring privacy concern: Review of survey and observational instruments. *International Journal of Human-Computer Studies*, *71*(12), 1133–1143.

Preibusch, S., Kübler, D., & Beresford, A. R. (2013). Price versus privacy: An experiment into the competitive advantage of collecting less personal information. *Electronic Commerce Research*, *13*(4), 423–455.

Saarijärvi, H., Grönroos, C., & Kuusela, H. (2014). Reverse use of customer data: Implications for service-based business models. *Journal of Services Marketing*, *28*(7), 529–537.

Sarathy, R., & Robertson, C. J. (2003). Strategic and ethical considerations in managing digital privacy. *Journal of Business Ethics*, *46*(2), 111–126.

Schaule, M. (2014). *Anreize für eine nachhaltige Immobilienentwicklung: Nutzerzufriedenheit und Zahlungsbereitschaft als Funktion von Gebäudeeigenschaften bei Büroimmobilien* [Doctoral thesis]. Fakultät für Bauingenieur- und Vermessungswesen, Munich.

Schneider, M. J., Jagpal, S., Gupta, S., Li, S., & Yu, Y. (2017). Protecting customer privacy when marketing with second-party data. *International Journal of Research in Marketing*, *34*(3), 593–603.

Smith, H. J., Milberg, S. J., & Burke, S. J. (1996). Information privacy: Measuring individuals' concerns about organizational practices. *MIS Quarterly*, *20*(2), 167–196.

Tanner, A. (2013). *Here are some of America's most privacy friendly companies*. http://www.forbes.com/sites/adamtanner/2013/09/11/here-are-some-of-americas-most-privacy-friendly-companies/. Accessed on 2016-11-02.

The Telegraph. (2010). *Facebook admits 'inadvertent' privacy breach*. http://www.telegraph.co.uk/technology/facebook/8070513/Facebook-admits-inadvertent-privacy-breach.html. Accessed on 2017-05-07.

Telekom DE-Mail. (2017). *Datenschutzhinweise für De-Mail der Telekom Deutschland GmbH*. http://www.telekom.de/dlp/agb/pdf/42734.pdf. Accessed on 2017-10-23.

Tesla Motors. (2017). *Datenschutzerklärung*. https://www.tesla.com/sites/default/files/pdfs/de_DE/tmi_privacy_statement_external_6-14-2013_v2.pdf. Accessed on 2017-10-23.

Zalando. (2017). *Datenschutzerklärung und Einwilligung zur Datennutzung*. https://www.zalando.de/zalando-datenschutz/. Accessed on 2017-10-23.

3.2. Digital nudging in online grocery stores – Towards ecologically sustainable nutrition

Abstract: A major driver of global environmental challenges is our current food system. More sustainable practices on the supply side depend on pressure from the demand side: Every individual can contribute to a greener food system by making sustainable food choices. Digital nudging represents a promising approach to foster desirable consumer behavior. Research in the growing online food context is scarce and lacks a comparative analysis of digital nudging elements and their effectiveness regarding different consumer groups. We transferred three nudging elements to the digital choice environment of an online grocery store and conducted a field experiment with 291 participants. Parametric, nonparametric, regression, and cluster analyses showed that default rules are effective for a broad consumer base and simplification for environmentally-conscious consumers to promote ecologically sustainable behavior, while social norms had no effect. The results inform research and practice regarding the potential of digital nudging to foster ecologically sustainable food choices.

Keywords: Digital nudging; Green IS; Ecological sustainability; Food system; Consumer behavior; Green society; Online grocery store

Authors: Michelle Berger, Niclas Nüske, Chiara Müller

Status: This article is published in the proceedings of the 41st International Conference on Information Systems (ICIS) in Hyderabad, India (2020).

3.2.1. Introduction

Environmental deterioration has become one of the biggest concerns of our times (Plumer and Popovic, 2018). Its severe threat is acknowledged and battled in worldwide cooperation and can be observed, for example, in the sustainable development goals proposed by the United Nations (2015). Most of the environmental deterioration is human-induced, meaning that we ourselves are damaging our basis of existence (Dunlap et al., 2000; Schubert, 2017; Schultz et al., 2005). Information Systems (IS) is seen as an important weapon to address this challenge (Melville, 2010) due to its remarkable influence and ubiquitousness in all areas of our lives. IS researchers have been called upon to apply "the transformative power of IS to create an environmentally sustainable society" (Watson et al., 2010, p. 24). Prior research suggests focusing on IS design approaches that influence human behavior to protect the environment (Melville, 2010). The use of digital nudging elements (DNEs) has proven to be an effective design approach for unconscious and automatic every-day decisions to influence individuals' behaviors in a positive way (Weinmann et al., 2016). Nudging aims to help making better choices by modifying the choice environment without limiting the number of choices through laws, orders, or fiscal methods (Ferrari et al., 2019; Lehner et al., 2016; Thaler & Sunstein, 2009). It has been demonstrated that nudging elements (NEs) have a remarkable potential to enable pro-environmental behavior (Schubert, 2017) and to influence human behavior regarding food consumption decisions in particular (Lehner et al., 2016). DNEs can be implemented quicker, faster, and cheaper than in an offline, physical environment and can be personalized since online environments offer tools to track and analyze individuals' preferences (Weinmann et al., 2016).

Food is a main consumption area that has tremendous negative effects on the environment (Noleppa, 2012). The production and transportation of food cause land depletion, the exhaustion of natural resources, and are responsible for about 26% of the global greenhouse gas (GHG) emissions (Poore & Nemecek, 2018). It is not sufficient to rely on the proactivity of food producers to turn to more conscious and pro-environmental practices. The integration of ecological sustainability aspects into daily food consumption decisions by consumers is of importance as well (Ferrari et al., 2019). Pressure from the demand side must be significantly increased in order to accelerate changes towards ecologically sustainable production and transportation on the supply side (Mont et al., 2014). Consumers struggle when it comes to evaluating the environmental impacts of products (Hoek et al., 2017). But, common informational strategies like displaying numerical information about the product's GHG emissions

have not proven to be successful (Spaargaren et al., 2013). Food decisions are mainly based on impulsivity (Mirsch et al., 2017) and given the fact that the consumers' point of contact with the food system is increasingly shifted to online areas, online food suppliers like delivery services or grocery stores as well as policymakers should consider implementing DNEs as a way to influence food choices in an ecologically sustainable manner (Weinmann et al., 2016). Grocery stores especially hold a large responsibility to the society including the support of an ecologically sustainable food system (Pulker et al., 2018). They have the power to stimulate environmentally friendly behavior of consumers and can, therefore, help fighting environmental deterioration (Hawkes, 2008; Oosterveer et al., 2007).

Prior research on NEs in the food domain mainly focuses on coping with obesity and promoting healthy diets (Friis et al., 2017; Oullier et al., 2010; Schwartz, 2007; Wansink, 2004). Some research analyzes the effectiveness of single NEs focusing on the environmental dimension of food, including the NE default rules (Campbell-Arvai et al., 2014; Torma et al., 2018; Vandenbroele et al., 2018), changes to the physical environment (Vandenbroele et al., 2020; Wansink & Cheney, 2005), simplification (also referred to priming or salience) (Bacon & Krpan, 2018; Shearer et al., 2017), and social norms (Demarque et al., 2015; Kallbekken & Sælen, 2013; Linder et al., 2018), however, focusing mainly on eating out or reducing food waste (Ferrari et al., 2019). These NEs furthermore have mostly been applied in an offline, physical context. A separate consideration of DNEs in the online food domain promoting ecologically sustainable shopping behavior is necessary since consumers behave differently online, which is why Weinmann et al. (2016) and Mirsch et al. (2017) called for research about the effect of different DNEs in online environments. To our knowledge, only Demarque et al. (2015) analyzed one of the four named NEs, social norms, as a DNE in an online grocery store to promote ecologically sustainable behavior, without comparing it to other DNEs. Additionally, digital functionalities like tracking the browsing behavior of consumers allow individualizing the DNEs presented to the consumers based on individual characteristics (Benartzi & Lehrer, 2017; Weinmann et al., 2016). We still lack understanding of how effective DNEs are regarding different target groups to consider and implement individualized digital nudging (Mirsch et al., 2017). As a consequence, we aim to answer the following research questions:

Which of the DNEs default rules, simplification, and social norms are effective in online food shopping contexts regarding the promotion of ecologically sustainable food choices?

Do the DNEs differ in their influence on different consumer groups?

To answer our research questions, we conducted a field experiment including an online grocery shopping task in which we implemented the DNEs in different treatment groups. We analyzed and compared the effectiveness of the different DNEs on ecologically sustainable food choices using parametric and nonparametric statistics and regression analyses. Additionally, we used cluster analysis to determine consumer groups and again employed parametric and nonparametric statistics to examine in which ways the effects of the DNEs differed.

This paper proceeds as follows: We first present the theoretical background compiled from various literature streams such as IS and behavioral science. Subsequently, the methodology and the results are presented. We conclude with a summary, implications, limitations, and proposals for future research.

3.2.2. Theoretical background

In the following, we present the definition and influencing factors of food sustainability and elaborate on the origin and rising relevance of online grocery stores. Next, we introduce the theoretical background from behavioral science and the concept of nudging. We summarize prior research made in offline and digital nudging (DN) focusing on sustainable food consumption.

3.2.2.1. The need for ecologically sustainable food consumption

The current global food system is in many respects far from sustainable in the sense that it ensures nutrition for everyone without compromising economic, social, and environmental bases for future generations (HLPE, 2014). It causes negative impacts on the environment including GHG emissions as well as land, water, and energy exploitation. This leads to a loss in biodiversity, ozone depletion, terrestrial acidification, and contaminated groundwater (Meybeck & Gitz, 2017; Tukker et al., 2011). A growing food demand caused by an increasing world population is leading to an expansion in food production. However, the limited amount of available resources stays constant which emphasizes the need to reorient the current practices towards a more sustainable food system (Ferrari et al., 2019).

Regarding the sustainability of a single product, the environmental impacts of it depend on how and where its components have been produced (Meybeck & Gitz, 2017). Regional production, for example, causes lower pollutant emissions and consumes less energy and raw materials due to shorter transport distances, and fewer requirements for storing, cooling, and packing (Koerber & Kretschmer, 2000; Specht et al., 2016). Whereas organic farming is based on the balance of soil, animals, and plants (Koerber & Kretschmer, 2000) and is seen in the

European organic label, which considers animal welfare, environmental pollution, biological diversity, and renewable energy, chemical, and synthetic inputs (Council regulation (EC) No 834/2007 of 28.06.2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91, 2007). Restrictions of chemical fertilizers and pesticides in organic farming reduce nitrate pollution in water and groundwater. Through organic fertilization and the carefully coordinated cultivation of changing plants, the fertility of the soil is maintained, thus reducing soil erosion and promoting biodiversity. Additionally, organic farming produces less GHG emissions and consumes up to 40% less energy (Koerber & Kretschmer, 2000). Generally speaking, organically produced and regional products are in sum more sustainable than conventional food products and should be primarily consumed on the demand side to transform the supply-side system towards a more sustainable one (Koerber & Kretschmer, 2000; Schlich & Fleissner, 2005). These decisions about food consumption are increasingly made online.

3.2.2.2. Rising relevance of online food shopping as choice environment for nudging

With the emergence of the internet, electronic commerce (e-commerce) started to grow in the 1990s (Wigand, 1997). E-commerce describes "the process of buying and selling products or services using electronic data transmission via the Internet" (Grandon & Pearson, 2004, p. 197) and includes, but is not limited to, products and services in the segments of fashion, electronics, furniture, and groceries (Striapunina, 2020). Especially through improved payment systems and mobile applications, e-commerce developed quickly, starting in 2005 (Rokicki, 2018). Grocery purchases made online increased since 2006, when only 1% of German consumers bought groceries online, whereas in 2017, already 21% did so (Centraal Bureau voor de Statistiek, 2019). The developments in Asia, where more than 88% of Chinese and 87% of Thais plan to purchase groceries online in the next 12 months (PWC 2018), leave no doubt about online grocery shopping becoming an important pillar of the food retail sector in the future (Centraal Bureau voor de Statistiek, 2019). Major advantages of e-commerce, especially related to grocery purchases made online, include time-savings due to avoid travel to a traditional store or standing in queues, but also higher convenience because of flexibility due to 24h availability and accessibility from different places (Moagar-Poladian et al., 2017; Morganosky & Cude, 2000). Especially in times of uncertainty like the COVID-19 pandemic in 2020, online grocery shopping has become a useful and safe alternative to physical shopping (Gassmann, 2020).

Two different kinds of online grocery stores can be distinguished: virtual supermarkets that only exist online and traditional grocery stores that offer an additional online shop (Morganosky & Cude, 2000). Next to online grocery stores, online food delivery services have emerged, representing restaurants themselves who offer a delivery service, such as Pizza Hut, or intermediaries between multiple consumers and restaurants, like delivery.com (Yeo et al., 2017). Online delivery has increased tremendously starting in 2011 and accounted for 36% of all food orders in 2016 (Hirschberg et al., 2016). Lastly, online platforms also offer subscriptions of meal boxes, like Hello Fresh, which have become popular in the last years (Wunsch, 2019). Online grocery stores, delivery services, and subscription services all represent choice environments in which consumers decide between different food products. These choice environments can be modified by the use of DNE.

3.2.2.3. Digital nudging towards more ecologically sustainable food choices

3.2.2.3.1. Behavioral science and the concept of nudging

Nudging describes ways to influence choices by modifying the environment in which choices are presented and framed (Münscher et al., 2016). NEs aim to help individuals make better choices, elicit certain behaviors, and improve life without limiting the freedom of choice or manipulating incentives (Thaler & Sunstein, 2009). NEs should remain transparent and open as they have no manipulative or prohibitive nature (Sunstein, 2014). The concept of nudging is based on the dual process theory of behavioral economics, which suggests that human decision making occurs in an intuitive system 1 or a reason-based system 2 (Stanovich & West, 2000). System 1 is responsible for rather effortless, intuitive, emotional, automatic, and fast decisions, whereas in system 2, slower, controlled, rule-governed, and more effortful decisions develop (Kahneman, 2003). Kahneman (2011) showed that every-day decisions like deciding whether to take the elevator or the stairs could be attributed to system 1, whereas important decisions about one's life occur in system 2. System 1 protects the deliberate system 2 to prevent cognitive overload and turns familiar tasks into automatic routines. For non-automatic routines, information is quickly sorted through and shortcuts are taken which makes every-day intuitive decisions prone to heuristics and cognitive biases like a rule of thumb or gut feelings (Kahneman, 2011; Tversky & Kahneman, 1974). Combined with time pressure or limited cognitive capacity, this leads to faster, but also potentially undesirable decisions (Campbell-Arvai et al., 2014). This is the starting point for nudging. NEs can positively influence the decision-making process for the individual and the society in general by making use

of counteracts of these heuristics and cognitive biases caused by psychological effects that might lead to mistakes in decision-making processes (Thaler & Sunstein, 2009).

3.2.2.3.2. The use of nudging in food contexts to promote ecologically sustainable choices

Food behavior is highly habitual, making traditional educational approaches to enhance knowledge insufficient when it comes to changing the behavior (van't Riet et al., 2011). Hence, food choices can mainly be attributed to system 1 as automatic, emotional and intentional decisions with lower amounts of cognitive effort (Kahneman, 2011). This makes food choices prone to nudging. Research provides evidence that nudging is effective in influencing individuals' food behaviors (Schwartz, 2007; Vandenbroele et al., 2020; Wansink, 2004). Lehner et al. (2016) and Ferrari et al. (2019) reviewed a wide range of research focusing on the effect of NEs to leverage healthier and ecologically sustainable food choices. Lehner et al. (2016) found four NEs to be effective in promoting sustainable behavior concerning energy use, food, and personal transport. These are default rules, changes to the physical environment, simplification and framing of information, and the use of social norms. Ferrari et al. (2019) found similar NEs to be effective regarding consumers' environmentally-friendly behavior in physical areas like restaurants, canteens, hotels, and supermarkets.

The NE default rules describes a setting in which the preferred option is pre-selected and will be maintained if the person does nothing (Thaler & Sunstein, 2009). It is based on the need for maintaining the status quo (Kahneman, 2011), and the drive to procrastinate due to the dislike and time consumption of making active decisions (Sunstein, 2014). Regarding default rules in food contexts, Campbell-Arvai et al. (2014) found evidence that default meat-free options promote the choice of vegetarian meals when eating out and Kallbekken and Sælen (2013), as well as Vandenbroele et al. (2018), demonstrated that reduced plate size leads to less food waste.

The NE simplification represents the transportation of condensed information about a complex construct and comes along with framing of information to activate certain values (Sunstein, 2014; Thaler & Sunstein, 2009). Framing means that the different choice options are presented in ways that intentionally evoke certain associations of the decision-maker (Thaler & Sunstein, 2009). Information can, for example, be simplified and framed through descriptive labels, or by visualizing consequences (Lehner et al., 2016; Mirsch et al., 2017). Prior research in food contexts focused on redesigning menus in restaurants to promote environmentally-friendly choices (Bacon & Krpan, 2018; Kurz, 2018). Also, Van Gilder Cooke (2012) used GHG emission labels for burgers and increased sales of lower-carbon-footprint

burgers. Linder et al. (2018) proofed the effectiveness of visual cues and information flyers to reduce food waste.

Lastly, social norms are "an individual's beliefs about the typical and condoned behavior in a given situation" (Kormos et al., 2015, p. 480). The NE social norms utilizes the effect of social pressure and social conformity (Aldrovandi et al., 2015) by giving information about appropriate behavior within a group (Kormos et al., 2015). Injunctive and descriptive norms exist (Cialdini et al., 1990). Injunctive norms describe a generally desired behavior, for example leaving a tip in a restaurant, and proved to be effective in contexts like alcohol use (LaBrie et al., 2010) or gambling (Neighbors et al., 2007). Descriptive norms instrumentalize the behavior of other individuals (Cialdini et al., 1990) by conveying, for example, the following information: "70% bought at least one ecological product" (Demarque et al., 2015, p. 169). Especially in ambiguous or uncertain situations, descriptive norms function well as a heuristic, because they provide the decision-maker with information about socially-accepted behavior (Higgs, 2015). Melnyk et al. (2010) found in their meta-analysis that descriptive norms are effective in influencing the consumers' behavior in general, and Robinson et al. (2014) confirmed their results regarding eating behavior, also by conducting a meta-analysis. Other research showed an improved ecologically sustainable behavior by the use of descriptive norms, for example by promoting less towel use in hotels (Goldstein et al., 2008) or supporting recycling (Nigbur et al., 2010). In terms of promoting ecologically sustainable behavior related to food, Linder et al. (2018) Kameke and Fischer (2018) used descriptive norms to reduce food waste and Demarque et al. (2015) promoted ecologically sustainable products in an online grocery store. In the following, we, therefore, refer to descriptive norms when talking about the DNE social norms.

3.2.2.3.3. Digital nudging for ecologically sustainable food choices in online choice environments

Making desirable ecologically sustainable daily food choices is hard. Additionally, people tend to be overwhelmed by information overload simply resulting in inaction (Mont et al., 2014). Especially online, people tend to fail to process all relevant data needed to make informed decisions, leading to automated and hurried choices (Benartzi & Lehrer, 2017). The three discussed NEs default rules, simplification, and social norms all have the potential to be transferred to online choice environments and support the decision processes of consumers. We exclude changes to the physical environment for obvious reasons of non-applicability.

Default rules and simplification are not evaluated in online food shopping contexts yet. Research regarding DNEs in online food shopping contexts to promote ecologically sustainable food choices is to our knowledge limited to the work of Demarque et al. (2015) which focusses on the design possibilities of social norms. Consequently, no comparison of the effects of these DNEs exists so far. Due to the rise of online grocery shopping, further research on the effectiveness of different DNEs is needed, especially with the potential of individualizing the usage of DNEs in online choice environments (Mirsch et al., 2017; Weinmann et al., 2016).

3.2.3. Research process

The development of DNE in online decision environments can be structured along a five-step process consisting of the steps (1) define, (2) diagnose, (3) select, (4) implement and (5) measure according to Weinmann et al. (2016). To answer our research questions, we focus on steps 4 and 5. We perform an online field experiment to demonstrate a cause-and-effect relationship between the independent variable (here: implementation of the DNEs) and the dependent variable (here: ecologically sustainable food shopping behavior (Gravetter & Forzano, 2016). We, therefore, design and implement the three DNEs default rules, simplification, and social norms in an online grocery store. Subsequently, we evaluate their effectiveness considering control variables that might influence the online grocery shopping behavior of individuals.

3.2.3.1. Design and implementation of the digital nudging elements

The three DNEs were embedded in the decision environment of an online grocery store (see Figure 3.1-1). While implementing the field experiment, the priority was to provide a situation as close to real life and as easy to use as possible (Gravetter & Forzano, 2016). The online grocery store was implemented as a single-page website structured into the columns shopping list, products, and shopping cart. The shopping list indicated which and how many products were to purchase by the participants. The product area contained a scrollable list of different products with three items per row and occupied the largest and most prominent middle column. The entry for each item consisted of a picture of the product, its name and weight or volume, its price per unit, its scaled price per kilogram or liter, and a button to add the item to the shopping cart. The information and depiction of the product data thus match the standards found in real-life online grocery stores of familiar German retail chains. All product data, including product pictures and prices, are based on real-life examples found in the online grocery stores of those chains. The shopping cart column comprised the name and weight or volume, the adaptable quantity, and the price per unit of each added product.

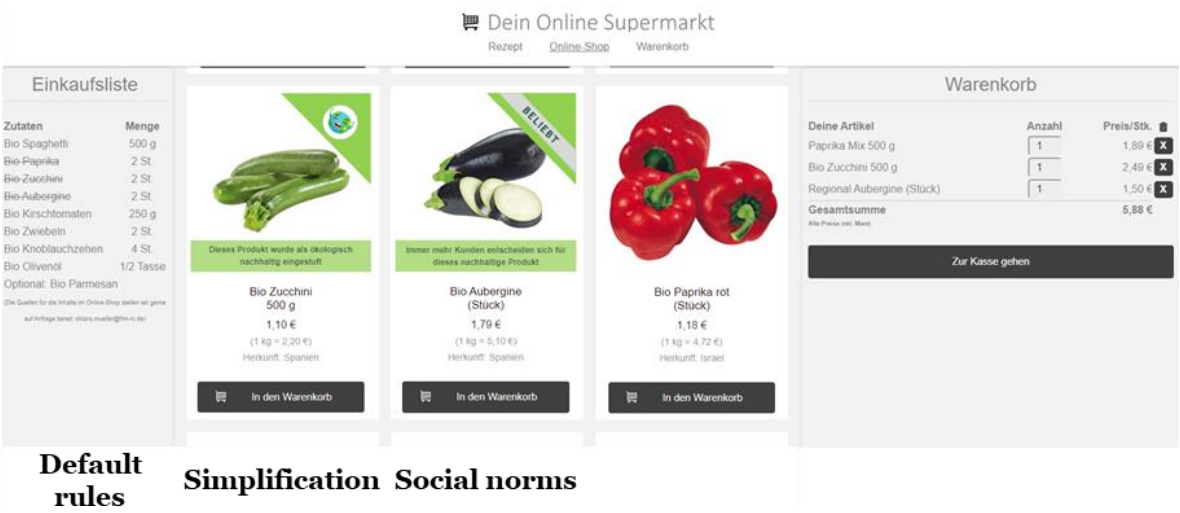


Figure 3.2-1: Online grocery store design with the areas shopping list (left), products (middle), and shopping cart (right)

We implemented the three DNEs as follows. Default rules as a way to provide consumers who are not willing, aware, or able to make decisions with pre-selected options, was realized in the shopping list: we added the marker "Bio" (German for "organic") in front of each item that the participants were asked to purchase (see left column in Figure 3.2-1). Since products of organic origin are in general more sustainable (Koerber & Kretschmer, 2000; Schlich & Fleissner, 2005), participants were thus nudged to choose products in a more environmentally-friendly fashion. Simplification is meant to comprise complex information in a significantly shorter description or framed depiction. We aim at fostering ecologically sustainable food purchasing behavior, therefore we implemented simplification as an icon of a smiling world and provided the additional short statement "This product was classified as ecologically sustainable" when participants hovered over the picture of the product in question (see icon on red pepper in Figure 3.2-1). Lastly, the DNE social norms was implemented as a banner reading "popular" and the statement "More and more customers choose this sustainable product" was displayed when hovering over the product in question (see eggplant in Figure 3.2-1). The intention was to make the participants aware of the behavior of the masses to stimulate socially-conforming sustainable food shopping behavior. Figure 3.2-1 illustrates the online grocery store's design and examples of the three DNEs. For illustrative purposes, all DNEs are displayed at once in Figure 3.2-1 which differs from the implementation in the field experiment. For the procedure in the field experiment, please see the following section.

3.2.3.2. Design and implementation of the field experiment

To acquire the necessary data to answer our research questions, we created a field experiment that combined a shopping task in the online grocery store described above with an online survey. The field experiment was conducted in German. Prior to the execution of the field experiment, four people took part in a pretest and their feedback regarding, e.g., understandability of the included texts and usability of the online grocery store, was adopted. Subsequently, we administered a participation invitation via several social media channels and email. After clicking on the included link, an introduction informed the participants about the setting of the field experiment as well as our data protection policy which needed to be accepted before continuing. To keep the experiment as realistic and comprehensible as possible, we proceeded as follows. Participants were asked to imagine a scenario in which they planned to cook a meal the next evening following a specific recipe and needed to order the ingredients online. Additionally, we provided the following incentive: we announced that each participant could dispose freely of a fixed amount of thirty euros. By participating in a voluntary price draw, they got the chance to win a) the content of the shopping cart after completion of the shopping task and b) the remaining difference to the total of thirty euros as cash transferal. The aim of presenting the opportunity to win the products as well as the remaining amount of cash was to guarantee a shopping behavior as close to the real preferences of food quality and monetary benefits as possible.

In the next step, participants were transferred to our online grocery store environment. The first page contained an overview of the planned recipe including a picture, a list of nine ingredients, and the cooking instructions. To allow for a maximum number of participants to be able to relate to the scenario and not to exclude individuals with diverse nutritional preferences, we chose an inherently vegan dish with eight required plant-based and one optional vegetarian ingredient (parmesan cheese). The second page displayed the online grocery store as exemplarily presented in Figure 3.2-1. For each of the nine ingredients, there were three products to choose differing in the level of ecological sustainability. The participants were randomly assigned to one of four groups: (1) a control group which shopped without any DNEs, (2) a group with the DNE default rules implemented in the shopping list, (3) one that shopped in an environment that had the DNE simplification, and (4) one with the DNE social norms implemented for the most sustainable product of each ingredient. In the following, we term the groups C (control group), DR (group with DNE default rules), S (group with DNE simplification), and SN (group with DNE social norms), respectively. All participants could

only choose one of the three products for each ingredient, and could freely decide on the quantity. They were able to proceed to checkout only after one product of each of the required eight ingredients had been added to the shopping cart.

After checkout, participants were transferred to a concluding survey regarding their food choice and consumption behavior as well as demographic characteristics. The standard single-item Food Choice Questionnaire (FCQ) developed by Onwezen et al. (2019) based on Steptoe et al. (1995) contains twelve questions regarding the motives underlying an individual's typical daily selection of food such as healthiness, price, and ethical concerns. Measurement occurs on a seven-point Likert scale ranging from 1 indicating no importance at all and 7 indicating great importance of the twelve included attributes of food. Following Onwezen et al. (2014, 2019), we created a Self-reported Consumption (SRC) questionnaire which queries the frequency of consumption of food from the categories vegetables, fruit, dairy, fish, and meat in the last month on a seven-point Likert scale ranging from 1 indicating "not this month" to 7 indicating "6-7 times a week". Given the fact that nudging is a subtle way of directing decisions in more favorable directions, it is unlikely that it is the only influence explaining the online grocery shopping behavior of individuals. It most likely depends on individual factors like price sensitivity, general attitude towards sustainable food, and typical food consumption behavior as well, all of which and more are covered by the FCQ and SRC. Thus, we included both questionnaires in our field experiment and as control variables in the following analyses. An overview of the items can be found in Table 3.2-1. Both questionnaires were translated into German. Thereby, two German native speakers translated the English items into German in parallel. They afterward resolved discrepancies and agreed on the most suitable translation. Lastly, a non-involved English native speaker translated the German items back into English, thus doublechecking for correctness. Lastly, we included socio-demographic questions based on our own development as well as the German census of 2011 (Statistische Ämter des Bundes und der Länder, 2015). 291 participants completed the field experiment and answered both included control questions correctly. 44.0% of participants were female, 55.5% male. 0.5% identified as diverse. The age of the participants ranged from 15 to 77 with a mean of 29.[9]

The field experiment described above was resumed after five months to take the effect of salience nudging into account. The NE salience means that "[n]ovel, personally relevant or vivid examples and explanations are used to increase attention to [a] particular choice" and is

[9] Unfortunately, due to a technical error on the part of the service provider of the employed survey software, the socio-demographic information of 102 participants was only partially recorded so that these numbers are based on the data of 189 participants. All further analyses are based on all 291 participants.

often a part of or blurs with other NEs (Blumenthal-Barby & Burroughs, 2012; Wilson et al., 2016). Specifically, in our work, the mere graphical emphasis of the sustainable product options itself as shown in Figure 3.2-1 can be interpreted as a salience DNE. Therefore, the question arose whether possible effects of the three focused DNEs can be attributed to increased participant attention alone (salience) or their sustainability-related content as well (S, SN, and, to a limited extent, DR). We consequently reran the field experiment with a fifth group SL (group with DNE salience) where we merely highlighted the most sustainable product options to catch the participants' attention but removed any thematical relation to sustainability. The DNE salience was implemented as an emoji licking its lips to symbolize great taste and the statement "This product is a pleasure" was displayed when hovering over the product in question. We collected 78 additional data sets in this second run. As this data was collected at a different point in time and covered a slightly different population (48% of participants were female, 52% male. The age of the participants ranged from 19 to 76 with a mean of 41.), we only marginally include the SL group in our analyses described below and discuss the implications for our results and further research.

3.2.3.3. Data analysis

Our paper's focus is on the effectiveness of the three presented DNEs on ecologically sustainable food choices in online grocery stores. To answer our research questions, first a measure for ecologically sustainable food choice behavior needs to be defined. To this end, we assign sustainability ratings to each of the three products for the eight required ingredients. The ratings are based on extensive online research for each product considering, among others, seasonality, organic farming, GHG emissions, and distance travelled to point of sale. Each of the three options of the eight ingredients either obtains a rating of 2 (most environmentally sustainable choice), 1 (second best), or 0 (last). We aggregate the ratings of all eight chosen product options in a measure termed Sustainability Score (SC) for each participant. The SC thus reflects the individual's extent of environmentally sustainable choices made in our field experiment. Its possible value range is 0 to 16.

To answer our first research question which DNEs are how effective in promoting sustainable food shopping behavior in online grocery stores, we first conduct parametric ANOVA as well as nonparametric Kruskal-Wallis tests comparing the SCs of the different treatment groups. Although the treatment groups each consist of more than 30 participants and thus assuming normally distributed data following the Central Limit Theorem is warranted, in the further analyses described below we have to rely on nonparametric tests. We apply both types of tests

for all analyses for reasons of consistency and transparency. We proceed to perform a more sophisticated multiple regression analysis with SC as the dependent variable which additionally allows for controlling for the participants' FCQ and SRC.

Regarding the second research question whether the effectiveness of the three DNEs differs between consumer groups, we first partition our participants into subsamples employing two-stage cluster analysis and using FCQ and SRC as input characteristics. Following recommendations from research, we combined hierarchical and partitioning (k-means) techniques which should lead to more accurate clustering compared to the results of the individual approaches alone (Balijepally et al., 2011; Milligan & Cooper, 1987; Punj & Stewart, 1983). We conducted the hierarchical clustering with Ward's minimum variance method and squared Euclidian distances. The Ward's minimum variance algorithm is shown to have superior performance compared to other algorithms (Milligan & Cooper, 1987). Its results are then used as input for partitioning to pre-specify the number of clusters and the starting points for the k-means algorithm. We subsequently compare the FCQ and SRC values between clusters and the SCs between treatments for each identified cluster, again using parametric ANOVA and pairwise post-hoc t-tests as well as nonparametric Kruskal-Wallis and pairwise post-hoc Mann-Whitney-U tests.

3.2.4. Results

The mean and median SCs as well as their standard deviations and interquartile ranges of the control group (C) and the default rules (DR), simplification (S), and social norms (SN) groups differ only slightly. This applies to a comparison to each other as well as the total sample. Shapiro-Wilk tests reject the null hypothesis that the SCs are normally distributed for the treatment groups C, S, and SN. A Bartlett test does not reject the null hypothesis that the SC variance is the same in all treatment groups. Considering the Central Limit Theorem, we apply an ANOVA between the four groups as well as a Kruskal-Wallis test. Both do not reject the null-hypotheses that the SC means or medians of the four groups are the same, rendering pairwise post-hoc tests unnecessary and indicating that there was no effect of the DNEs in promoting sustainable food shopping behavior in online grocery stores. Table 3.2-1 presents the descriptive statistics of the sample and the four treatment groups and the significance levels of the applied tests' p-values. Non-significant test results were excluded for reasons of readability.

		Total	C	DR	S	SN	Shapiro-Wilk normality	Bartlett variance	ANOVA	Kruskal-Wallis	Pairw. t-tests	Pairw. Mann-Whitney-U
	N	291	73	74	68	76						
SC	Mean	9.35	9.29	9.55	9.53	9.04	C .					
	Standard deviation	2.92	2.71	3.16	2.97	2.86	S *					
	Median	10	9	10	10	10	SN .					
	Interquartile range	4	4	3	4	4						

*p-value significance codes: *** for < 0.001, ** for < 0.01, * for < 0.05, + for < 0.1*

Table 3.2-1: Descriptive SC statistics of the treatment groups and significance levels of parametric and nonparametric tests for differences between treatment groups

The mean SC of the additional salience (SL) group is 8.38 with a standard deviation of 2.68, a median of 8.5, and an interquartile range of 4. Taking the SL group into account, both the ANOVA and the Kruskal-Wallis test indicate differences between the groups at a 10% significance level. Pairwise t-tests indicate differences between SL and C, DR, and S at a 5 % significance level. Pairwise Mann-Whitney-U tests indicate differences between SL and C and SN at a 10% and DR and S at a 5% significance level. We thus observe hints at a negative effect of the DNE salience on the SV as compared to most of the other groups.

Variable	Description	Estimate	p-value	
Intercept		6.05	0.000	***
Group DR	Default rules	0.80	0.094	.
Group S	Simplification	0.71	0.136	
Group SN	Social norms	0.07	0.876	
FCQ1	Healthy	0.00	0.998	
FCQ2	Enables mood monitoring	0.00	0.969	
FCQ3	Convenient	-0.07	0.568	
FCQ4	Provides pleasurable sensations	0.06	0.669	
FCQ5	Natural	0.17	0.379	
FCQ6	Affordable	-0.33	0.005	**
FCQ7	Helps control weight	-0.06	0.483	
FCQ8	Familiar	0.06	0.574	
FCQ9	Environmentally friendly	0.25	0.195	
FCQ10	Animal friendly	0.03	0.857	
FCQ11	Fairly traded	0.27	0.193	

Variable	Description	Estimate	p-value
SRC1	Vegetables	0.25	0.120
SRC2	Fruit	-0.12	0.330
SRC3	Dairy	0.02	0.785
SRC4	Fish	0.05	0.736
SRC5	Meat	-0.18	0.101

*p-value significance codes: *** for < 0.001, ** for < 0.01, * for < 0.05, + for < 0.1*

Table 3.2-2: Estimates and p-values of linear regression

Next, we perform a multiple linear regression analysis with SC as the dependent variable. The allocation to the treatment groups and the set of FCQ and SRC items were included as independent variables. This allows us to consider a multitude of important explanatory factors as control variables which, alongside the DNEs, might have influenced the sustainable food shopping behavior of our field experiment's participants. The VIFs of all 16 items were lower than 2.84, thus indicating that multicollinearity was not to be dealt with. Controlling for both the participants' FCQ and SRC, the DNE default rules had a minor significant positive effect in promoting sustainable food shopping behavior. We find a significantly negative effect of the participant's priority that food be affordable (see Table 3.2-2).

To address our second research question, we perform a two-step cluster analysis with the FCQ and SRC items as input variables. We first apply the hierarchical Ward's minimum variance method with squared Euclidian distances. An elbow plot, the gap statistic as well as ten out of thirty calculated indices recommend three as the optimal number of clusters. We therefore proceed to partition our sample into three groups using k-means clustering. To verify the validity of the division of participants into three groups, we a) thoroughly discussed the three-cluster solution and its interpretation within the research team and compared it to solutions with different numbers of clusters. We b) tested the groups for differences between each other regarding their SCs and all FCQ and SRC items using ANOVA and Kruskal-Wallis tests and, if indicated by their results, pairwise post-hoc t-tests and Mann-Whitney-U tests. The full set of SC, FCQ, and SRC values for each cluster as well as the test results can be found in Appendix 3.2-1. Based on these analyses, we conclude that a three-cluster solution is the most suitable one and that each cluster represents a unique consumer group which can be specified as follows.

		Total	C	DR	S	SN	Shapiro-Wilk normality	Bartlett variance	ANOVA	Kruskal-Wallis	Pairw. t-tests	Pairw. Mann-Whitney-U
C1	N	95	32	18	21	24						
SC	Mean	10.30	10.00	10.11	11.52	9.75						
	Standard deviation	2.60	2.89	2.70	1.97	2.42			.	.	C-S *	C-S *
	Median	10	10	10	11	10						
	Interquartile range	3	4	2	3	3						
C2	N	90	16	31	23	20						
SC	Mean	8.36	8.50	9.90	8.13	7.65						
	Standard deviation	2.84	1.75	3.04	3.01	3.03	S *					
	Median	8	8	9	8	7						
	Interquartile range	3	1	4	4	3						
C3	N	106	25	25	24	32						
SC	Mean	9.34	8.88	9.96	9.13	9.38						
	Standard deviation	3.00	2.83	3.57	2.80	2.84						
	Median	10	9	10	10	10						
	Interquartile range	4	3	4	4	3						

Cluster codes: C1 - environmentally-conscious, C2 - environmentally-unconscious, C3 - pragmatic

*p-value significance codes: *** for < 0.001, ** for < 0.01, * for < 0.05, + for < 0.1*

Table 3.2-3: Descriptive SC statistics of the treatment groups within clusters and results of parametric and nonparametric tests for differences between treatment groups

Cluster 1 - environmentally-conscious participants. These individuals are driven by pro-environmental motives. They score highest in food choice motives regarding naturalness, environmental and animal friendliness, and fair trade (mean cluster scores > 6.01 on seven-point Likert scale). They consume plant-based products most (vegetables and fruit > 6.03) and non-vegetarian animal products least (fish and meat < 1.86) frequently. Environmentally-conscious participants exhibit the highest mean SC of 10.30.

Cluster 2 - environmentally-unconscious participants. These participants exhibit the lowest scores regarding the above-mentioned food choice motives (< 4.85) and consume the least plant-based products (< 5.26) compared to the other clusters. Their mean SC is the lowest (8.36).

Cluster 3 - pragmatic participants. Pragmatic participants occupy the middle of the score spectrum of the different clusters regarding the above-mentioned food choice motives (> 5.97) and

simultaneously place the highest value on convenience, price, and familiarity (> 4.49). Their mean SC is 9.34.

A Shapiro-Wilk test rejects the null hypothesis that the SCs are normally distributed for the treatment group S in the environmentally-unconscious cluster. Bartlett tests do not reject the null hypothesis that the SC variance is the same in all treatment groups. Considering the rather small numbers of participants in the different treatment groups within each cluster, we apply a Kruskal-Wallis test between the four groups as well as an ANOVA. Both reject the null-hypotheses that the SC medians or means of the different treatment groups are the same within the environmentally-conscious cluster. Pairwise post-hoc tests specify that there was a significant difference between the control group and the group with the DNE simplification. Regarding our second research question, we find that the DNE simplification has a significant positive effect on sustainable food shopping behavior in the cluster of environmentally-conscious participants. Table 3.2-3 presents the descriptive statistics of the clusters and the comprised four treatment groups and the significance levels of the applied tests' p-values. Non-significant test results were excluded for reasons of readability.

3.2.5. Discussion and conclusion

Digital technologies are promising tools to address societal problems, including those related to sustainability (Watson et al., 2010). The world's current food system has tremendous detrimental effects on the environment. Changing the ways in which we produce and transport food is a major factor in shaping a sustainable global future. The demand side has the power to accelerate these changes on the supply side by demanding more ecologically sustainable food (Mont et al., 2014). Due to the rising interaction with technologies, the potential of improving individuals' behavior to address societal problems has risen (Melville, 2010). Demand-side food choices are increasingly made online in the context of online grocery stores, delivery services, and food or grocery subscription services. Besides the elimination and restriction of choices through laws or fiscal methods, nudging is a promising tool to influence the individual's behavior in an ecologically sustainable manner (Ferrari et al., 2019; Lehner et al., 2016; Schubert, 2017).

In this study, we tested the effectiveness of the three DNEs default rules, simplification, and social norms to promote ecologically sustainable food choices by conducting an online field experiment with 291 participants. We compared the impact of the different DNEs with each other (RQ1) as well as regarding different consumer groups (RQ2).

We found that the DNE default rules was effective (with a moderate effect size and statistical significance) in an online food context to promote ecologically sustainable food products controlling for their food choice motives and their typical food consumption behavior. For many consumers, daily food choices are likely to occur as automatic and intuitive decision-making processes in system 1 (Kahneman, 2011). Some participants might have subconsciously wanted to maintain the status quo of product selection which was indicated in the shopping list by adding the marker "Bio" in front of each item. Others might have automatically gone with the selection of products nudged in the shopping list because they dislike making decisions or wanted to save time (Sunstein, 2014). The aspect of time-saving as a major advantage of e-commerce (Moagar-Poladian et al., 2017) in the dynamic digital age might have positively interacted with and fostered the effectiveness of the DNE default rules.

The DNE simplification had a significant positive effect on the sustainable shopping behavior of the subgroup of environmentally-conscious participants. These individuals place a high value on naturalness, environmental and animal friendliness, and fair trade. They also consume significantly more plant-based products as compared to the members of the other two identified clusters. Still, the environmentally-conscious participants might generally have difficulties in determining the correct choice regarding ecological sustainability (Spaargaren et al., 2013). The simple summary of the required information as well as a positive framing in the form of a smiling world icon might thus have been highly appreciated, leading the participants to more informed, ecologically sustainable product choices.

Unexpectedly and contradictory to prior research by Demarque et al. (2015), the DNE social norms showed no influence on the sustainable shopping behavior of our field experiment's participants. Providing them with information about the trend that more and more customers bought sustainable products and flagging the products as popular did not have any effect. This might be due to the low level of uncertainty regarding the choices in our experiment. Higgs (2015) found that the usage of social norms is especially effective in situations with high uncertainty in which following the crowd is perceived as a safe option. The presented products were standard ingredients with which most participants can be expected to be familiar. The DNE social norms might work better for nudging ecologically sustainable new products which are not yet known to a broad customer base.

Lastly, we included the fourth DNE salience in our considerations in order to sort out whether possible observed effects of our three focused DNEs should be attributed to mere attention catching or their thematic relation to sustainability. Based on the limited analyses that we

could perform which we will address in the limitations and further research section, we found that solely emphasizing sustainable product options based on a topic which is unrelated to sustainability had an adverse effect on sustainable shopping behavior. The graphical emphasis might have drawn the attention of our field experiments participants, but the thematic focus on taste most likely irritated them or even made them feel manipulated, resulting in the selection of other, less sustainable products. We conclude that based on our results, nudging sustainable choices requires more than flashy ways to draw attention and needs a relation of its content to sustainability.

3.2.5.1. Theoretical contribution

Our work contributes to the existing literature regarding nudging, digital nudging, and the promotion of ecologically sustainable choices in online food contexts in three ways. (1) Complementing the research by Demarque et al. (2015) about the DNE social norms, we transferred two additional major NEs from the physical to the digital world. Default rules and simplification have been evaluated in physical contexts by Lehner et al. (2016) and Ferrari et al. (2019), but to the best of our knowledge have not yet been applied online regarding the promotion of ecologically sustainable food choices. The concrete design and implementation examples of the DNEs in the field experiment might inform further research in this area. (2) While prior research focused mainly on the implementation and configuration of single (D)NEs, we gathered empirical data about the effectiveness of all three DNEs default rules, simplification, and social norms in a field experiment with 291 participants. This enabled us to compare different DNEs and shed new light on possible differences in their impacts. Regarding the whole sample, we found minor significance for default rules to have succeeded in promoting ecologically sustainable shopping behavior in the context of an online grocery store while simplification and social norms showed no effect. Default rules are thus a suitable one-size-fits-all solution for fostering sustainable food shopping. (3) By considering individual food choice motives (FCQ) and consumption patterns (SRC) and employing clustering techniques, we identified three typical consumer types in our field experiment: environmentally-conscious, environmentally-unconscious, and pragmatic consumers. This enabled us to examine the effectiveness of the different DNEs in different consumer groups. While there were no effects observable in the environmentally-unconscious and the pragmatic clusters, simplification proved to be effective in the environmentally-conscious cluster. This highlights the potential of using online individual consumer data to provide individualized choice environ-

ments based on personal characteristics and preferences. Simplification, although not effective regarding the complete consumer base, might be a powerful tool to promote sustainable food shopping behavior in the target group of environmentally-conscious consumers. The same might apply to other DNEs and other consumer groups identified using different individual characteristics and behavior patterns.

3.2.5.2. Practical implications

Online grocery stores, delivery services, and food or grocery subscription services are on the rise. They are gaining ever more relevance regarding our food consumption and increasingly have the power to influence our food choices towards more ecologically sustainable ones. In our study, the DNE default rules proved to be an effective instrument regarding a broad customer base. Regarding online grocery stores that offer buckets for specific meals or weekly grocery shopping, the DNE could be implemented by pre-selecting only ecologically sustainable products which then can easily be added directly to the shopping cart. Online grocery stores and grocery subscription services could focus on ecologically sustainable products when presenting the ingredients of recipes similar to the implementation in our field experiment. Subscription services could also pre-select ecologically friendly options and require customers to actively decide against them in case they prefer other products. Depending on the data available to online grocery stores, delivery services, and food or grocery subscription services, they might also target environmentally-conscious customers with the DNE simplification which proved to be effective for this specific consumer group in our field study. By providing condensed information about the sustainability of products, dishes, or other offers using labels, icons, or other means of displaying the relevant information, they might provide environmentally-conscious customers with just the nudge they need to transfer their good intentions into concrete choices. If successful, food suppliers might announce rising sales of ecologically sustainable products as part of their marketing campaigns. This can lead to competitive advantages because the environmental awareness of customers has risen and will continue to rise, hence sustainability has become a real business issue for food retailers (Claro et al., 2013).

As a result, consumers could profit from time savings due to reduced decision-making efforts when shopping for groceries as well as health benefits that ecologically sustainable products might bring along. Moreover, the implementation of DNEs supports consumers who wish to follow their societal responsibility to counteract environmental deterioration by choosing products with higher ecological sustainability.

However, we found that the customers' price sensitivity has a negative influence on their SCs. The higher the participants of our field study valued that food is affordable, the less sustainable products they purchased. This is due to the fact that generally, sustainable products are more expensive than conventional products. This relationship needs to be dissolved in order to ensure a global sustainable future. We, therefore, call on legislators and regulators to start or enforce the conversation about how sustainable products can become comparatively cheaper in the future, e.g., through tax instruments or subsidies.

3.2.5.3. Limitations and further research

Like all research, this paper is limited regarding several aspects that require further work and development. First, the consideration of DNEs is limited to the three most common ones in the consumption domain. Further, DNEs like feedback or reminders should prospectively be examined and tested in online field experiments. This includes the analysis of and comparison with other NEs such as salience based on data acquired from the same population and the same point in time. Second, the design of the individual DNEs should be analyzed and refined in the future, especially for social norms, which did not show any significant influence on sustainable food shopping behavior in our filed experiment. Similar to Demarque et al. (2015), different levels from weak to strong forms of social norms could be evaluated. The considerations of products with higher consumer uncertainty (Higgs, 2015) like new, more sustainable substitutes for traditional food should also be taken into account regarding social norms. As a positive side effect, the findings of Demarque et al. (2015), who focused on students, could be enriched as students might be more sensitive to social norms compared to other age and social groups. Third, even though we provided an incentive to guarantee a shopping behavior as close to real-life behavior as possible by balancing food sustainability and price, the analysis of real observations from online grocery stores that implemented DNEs would yield important insight about the applicability and effectiveness of the DNEs as well as possible intention-behavior gaps. Fourth, our limited sample size resulted in a limited statistical power. Future research might consider a field experiment in collaboration with food delivery services or supermarkets to, on the one hand, observe real-life shopping behavior, and, on the other hand, increase the sample size. Additionally, different and more specific consumer groups can be identified by collecting more individual characteristics and behavioral data. Lastly, we determined the sustainable product options in our field experiment by mainly relying on information about organic or non-organic origins. Different studies about the ecological sustainability of organic vs. conventional food exist, and science does not yet agree (Clark & Tilman,

2017). However, our results can be adapted to any new findings regardless of the specific definition of ecologically sustainable products.

Overall, we have linked the need for global sustainability with the promising IS tool of digital nudging in the highly relevant online food context. We call on research to further transfer NEs from physical to digital contexts and consider further individualization of DNEs to promote ecologically sustainable food choices.

3.2.6. References

Aldrovandi, S., Brown, G. D. A., & Wood, A. M. (2015). Social norms and rank-based nudging: Changing willingness to pay for healthy food. *Journal of Experimental Psychology: Applied*, *21*(3), 242–254. https://doi.org/10.1037/xap0000048

Bacon, L., & Krpan, D. (2018). (Not) eating for the environment: The impact of restaurant menu design on vegetarian food choice. *Appetite*, *125*, 190–200.

Balijepally, V., Mangalaraj, G., & Iyengar, K. (2011). Are we wielding this hammer correctly? A reflective review of the application of cluster analysis in information systems research. *Journal of the Association for Information Systems*, *12*(5), 375–413.

Benartzi, S., & Lehrer, J. (2017). *The smarter screen: Surprising qays to influence and improve online behavior* (Paperback edition). Penguin.

Blumenthal-Barby, J. S., & Burroughs, H. (2012). Seeking better health care outcomes: The ethics of using the "nudge". *The American Journal of Bioethics*, *12*(2), 1–10. https://doi.org/10.1080/15265161.2011.634481

Campbell-Arvai, V., Arvai, J., & Kalof, L. (2014). Motivating sustainable food choices: The role of nudges, value orientation, and information provision. *Environment and Behavior*, *46*(4), 453–475. https://doi.org/10.1177/0013916512469099

Centraal Bureau voor de Statistiek. (2019). *Share of consumers who purchased food or groceries online in selected countries in Europe from 2006 to 2018: Belgium, France, Germany, Italy, Netherlands, United Kingdom*. https://www.statista.com/statistics/915391/e-commerce-purchase-rate-of-food-or-groceries-in-europe-by-country/. Accessed on 2020-04-12.

Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology*, *58*(6), 1002–1014.

Clark, M., & Tilman, D. (2017). Comparative Analysis of Environmental Impacts of Agricultural Production Systems, Agricultural Input Efficiency, and Food Choice. *Environmental Research Letters*, *12*(6). https://doi.org/10.1088/1748-9326/aa6cd5

Claro, D. P., Laban Neto, S. A., & Oliveira Claro, P. B. de (2013). Sustainability drivers in food retail. *Journal of Retailing and Consumer Services*, *20*(3), 365–371. https://doi.org/10.1016/j.jretconser.2013.02.003

Council regulation (EC) No 834/2007 of 28.06.2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91, June 28, 2007.

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32007R0834. Accessed on 2020-04-05.

Demarque, C., Charalambides, L., Hilton, D. J., & Waroquier, L. (2015). Nudging sustainable consumption: The use of descriptive norms to promote a minority behavior in a realistic online shopping environment. *Journal of Environmental Psychology, 43*, 166–174. https://doi.org/10.1016/j.jenvp.2015.06.008

Dunlap, R. E., van Liere, K. D., Mertig, A. G., & Jones, R. E. (2000). New trends in measuring environmental attitudes: Measuring endorsement of the new ecological paradigm: A revised NEP scale. *Journal of Social Issues, 56*(3), 425–442.

Ferrari, L., Cavaliere, A., Marchi, E. de, & Banterle, A. (2019). Can nudging improve the environmental impact of food supply chain? A systematic review. *Trends in Food Science & Technology, 91*, 184–192. https://doi.org/10.1016/j.tifs.2019.07.004

Friis, R., Skov, L. R., Olsen, A., Appleton, K. M., Saulais, L., Dinnella, C., Hartwell, H., Depezay, L., Monteleone, E., Giboreau, A., & Perez-Cueto, F. J. A. (2017). Comparison of three nudge interventions (priming, default option, and perceived variety) to promote vegetable consumption in a self-service buffet setting. *PloS One, 12*(5). https://doi.org/10.1371/journal.pone.0176028

Gassmann, M. (2020). *Das Coronavirus wird Einkaufen dauerhaft verändern.* Welt. https://www.welt.de/wirtschaft/article206541365/Coronavirus-Einkaufen-wird-sich-dauerhaft-veraendern.html. Accessed on 2020-03-23.

Goldstein, N. J., Cialdini, R. B., & Griskevicius, V. (2008). A room with a viewpoint: Using social norms to motivate environmental conservation in hotels. *Journal of Consumer Research, 35*(3), 472–482. https://doi.org/10.1086/586910

Grandon, E. E., & Pearson, J. M. (2004). Electronic commerce adoption: An empirical study of small and medium US businesses. *Information & Management, 42*(1), 197–216. https://doi.org/10.1016/j.im.2003.12.010

Gravetter, F. J., & Forzano, L.-A. B. (2016). *Research methods for the behavioral sciences* (5ed.). Cengage Learning.

Hawkes, C. (2008). Dietary implications of supermarket development: A global perspective. *Development Policy Review, 26*(6), 657–692. https://doi.org/10.1111/j.1467-7679.2008.00428.x

Higgs, S. (2015). Social norms and their influence on eating behaviours. *Appetite, 86*, 38–44.

Hirschberg, C., Rajko, A., Schumacher, T., & Wrulich, M. (2016). *The changing market for food delivery*. https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/the-changing-market-for-food-delivery. Accessed on 2020-04-26.

HLPE. (2014). *Food losses and waste in the context of sustainable food systems: A report by the high level panel of experts on food security and nutrition of the committee on world food security*. FAO.

Hoek, A. C., Pearson, D., James, S. W., Lawrence, M. A., & Friel, S. (2017). Shrinking the Food-print: Food Behaviours: A qualitative study into consumer perceptions, experiences and attitudes towards healthy and environmentally friendly. *Appetite*, *108*, 117–131. https://doi.org/10.1016/j.appet.2016.09.030

Kahneman, D. (2003). Maps of bounded rationality: Psychology for behavioral economics. *American Economic Review*, *93*(5), 1449–1475.

Kahneman, D. (2011). *Thinking, fast and slow* (First edition). Farrar Straus and Giroux.

Kallbekken, S., & Sælen, H. (2013). 'Nudging' hotel guests to reduce food waste as a win–win environmental measure. *Economics Letters*, *119*(3), 325–327.

Kameke, C. von, & Fischer, D. (2018). Preventing household food waste via nudging: An exploration of consumer perceptions. *Journal of Cleaner Production*, *184*, 32–40.

Koerber, K. von, & Kretschmer, J. (2000). Sustainable nutrition: Health, environmental, economic and social compatibility in the food sector. *Zeitschrift Für Ernährungsökologie*, *1*, 39–46.

Kormos, C., Gifford, R., & Brown, E. (2015). The influence of descriptive social norm information on sustainable transportation behavior: A field experiment. *Environment and Behavior*, *47*(5), 479–501.

Kurz, V. (2018). Nudging to reduce meat consumption: Immediate and persistent effects of an intervention at a university restaurant. *Journal of Environmental Economics and Management*, *90*, 317–341. https://doi.org/10.1016/j.jeem.2018.06.005

LaBrie, J. W., Hummer, J. F., Neighbors, C., & Larimer, M. E. (2010). Whose opinion matters? The relationship between injunctive norms and alcohol consequences in college students. *Addictive Behaviors*, *35*(4), 343–349. https://doi.org/10.1016/j.addbeh.2009.12.003

Lehner, M., Mont, O., & Heiskanen, E. (2016). Nudging – A promising tool for sustainable consumption behaviour? *Journal of Cleaner Production*, *134*, 166–177. https://doi.org/10.1016/j.jclepro.2015.11.086

Linder, N., Lindahl, T., & Borgström, S. (2018). Using behavioural insights to promote food waste recycling in urban households - Evidence from a longitudinal field experiment. *Frontiers in Psychology*, *9*, 352. https://doi.org/10.3389/fpsyg.2018.00352

Melnyk, V., van Herpen, E., & Trijp, H. (2010). The influence of social norms in consumer decision making: A meta-analysis. In Campbell, M.C., Inman, J. & R. Pieters (Eds.), *NA - Advances in Consumer Research* (Vol. 37, pp. 463–464). Association for Consumer Research.

Melville, N. P. (2010). Information systems innovation for environmental sustainability. *Management Information Systems Quarterly*, *34*, 1–21.

Meybeck, A., & Gitz, V. (2017). Sustainable diets within sustainable food systems. *The Proceedings of the Nutrition Society*, *76*(1), 1–11. https://doi.org/10.1017/S0029665116000653

Milligan, G. W., & Cooper, M. C. (1987). Methodology review: Clustering methods. *Applied Psychological Measurement*, *11*(4), 329–354. https://doi.org/10.1177/014662168701100401

Mirsch, T., Lehrer, C., & Jung, R. (2017). Digital nudging: Altering user behavior in digital environments. In J. M. Leimeister & W. Brenner (Chairs), *Proceedings of the 13th Conference on Wirtschaftsinformatik*, St. Gallen, Switzerland.

Moagar-Poladian, S., Dumitrescu, G.-C., & Tanase, I. A. (2017). Retail e-commerce (E-tail) - Evolution, characteristics and perspectives in China, the USA and Europe. *Global Economic Observer*, *5*(1), 167–178.

Mont, O., Lehner, M., & Heiskanen, E. (2014). *Nudging - A tool for sustainable behaviour?* The Swedish Environmental Protection Agency.

Morganosky, M. A., & Cude, B. J. (2000). Consumer response to online grocery shopping. *International Journal of Retail & Distribution Management*, *28*(1), 17–26. https://doi.org/10.1108/09590550010306737

Münscher, R., Vetter, M., & Scheuerle, T. (2016). A review and taxonomy of choice architecture techniques. *Journal of Behavioral Decision Making*, *29*(5), 511–524. https://doi.org/10.1002/bdm.1897

Neighbors, C., Lostutter, T. W., Whiteside, U., Fossos, N., Walker, D. D., & Larimer, M. E. (2007). Injunctive norms and problem gambling among college students. *Journal of Gambling Studies*, *23*(3), 259–273. https://doi.org/10.1007/s10899-007-9059-3

Nigbur, D., Lyons, E., & Uzzell, D. (2010). Attitudes, norms, identity and environmental behaviour: Using an expanded theory of planned behaviour to predict participation in a

kerbside recycling programme. *British Journal of Social Psychology*, *49*(Pt 2), 259–284. https://doi.org/10.1348/014466609X449395

Noleppa, S. (2012). *Climate change on your plate*. Berlin. https://mobil.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/Climate_change_on_your_plate.pdf. Accessed on 2020-03-23.

Onwezen, M. C., Bartels, J., & Antonides, G. (2014). The self-regulatory function of anticipated pride and guilt in a sustainable and healthy consumption context. *European Journal of Social Psychology*, *44*(1), 53–68. https://doi.org/10.1002/ejsp.1991

Onwezen, M. C., Reinders, M. J., Verain, M., & Snoek, H. M. (2019). The development of a single-item food choice questionnaire. *Food Quality and Preference*, *71*, 34–45. https://doi.org/10.1016/j.foodqual.2018.05.005

Oosterveer, P., Guivant, J., & Spaargaren, G. (2007). Shopping for green food in globalizing supermarkets: Sustainability at the consumption junction. In J. Pretty, A. S. Ball, T. Benton, J. S. Guivant, D. R. Lee, D. Orr, M. J. Pfeffer, & H. Ward (Eds.), *The SAGE Handbook of Environment and Society* (pp. 411–428). SAGE.

Oullier, O., Cialdini, R., Thaler, R. H., & Mullainathan, S. (2010). Improving public health prevention with a nudge. In O. Oullier & S. Sauneron (Eds.), *Improving public health Prevention with behavioural, cognitive and neuroscience* (pp. 38–46).

Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. *Science*, *360*(6392), 987–992. https://doi.org/10.1126/science.aaq0216

Pulker, C. E., Trapp, G. S. A., Scott, J. A., & Pollard, C. M. (2018). Global supermarkets' corporate social responsibility commitments to public health: A content analysis. *Globalization and Health*, *14*(1), 121. https://doi.org/10.1186/s12992-018-0440-z

Punj, G., & Stewart, D. W. (1983). Cluster analysis in marketing research: Review and suggestions for application. *Journal of Marketing Research*, *20*(2), 134–148. https://doi.org/10.1177/002224378302000204

Robinson, E., Thomas, J., Aveyard, P., & Higgs, S. (2014). What everyone else is eating: A systematic review and meta-analysis of the effect of informational eating norms on eating behavior. *Journal of the Academy of Nutrition and Dietetics*, *114*(3), 414–429. https://doi.org/10.1016/j.jand.2013.11.009

Rokicki, T. (2018). E-commerce market in Europe in B2C. *Information Systems in Management*, *7*(2), 133–140. https://doi.org/10.22630/ISIM.2018.7.2.12

Schlich, E., & Fleissner, U. (2005). The ecology of scale: assessment of regional energy turnover and comparison with global food. *The International Journal of Life Cycle Assessment*, *10*(3), 219–223. https://doi.org/10.1065/lca2004.09.180.9

Schubert, C. (2017). Green nudges: Do they work? Are they ethical? *Ecological Economics*, *132*, 329–342. https://doi.org/10.1016/j.ecolecon.2016.11.009

Schultz, P. W., Gouveia, V. V., Cameron, L. D., Tankha, G., Schmuck, P., & Franěk, M. (2005). Values and their relationship to environmental concern and conservation behavior. *Journal of Cross-Cultural Psychology*, *36*(4), 457–475. https://doi.org/10.1177/0022022105275962

Schwartz, M. B. (2007). The influence of a verbal prompt on school lunch fruit consumption: A pilot study. *The International Journal of Behavioral Nutrition and Physical Activity*, *4*, 6. https://doi.org/10.1186/1479-5868-4-6

Shearer, L., Gatersleben, B., Morse, S., Smyth, M., & Hunt, S. (2017). A problem unstuck? Evaluating the effectiveness of sticker prompts for encouraging household food waste recycling behaviour. *Waste Management (New York, N.Y.)*, *60*, 164–172. https://doi.org/10.1016/j.wasman.2016.09.036

Spaargaren, G., van Koppen, C. K., Janssen, A. M., Hendriksen, A., & Kolfschoten, C. J. (2013). Consumer responses to the carbon labelling of food: A real life experiment in a canteen practice. *Sociologia Ruralis*, *84*(3), 432-453. https://doi.org/10.1111/soru.12009

Specht, K., Weith, T., Swoboda, K., & Siebert, R. (2016). Socially acceptable urban agriculture businesses. *Agronomy for Sustainable Development*, *36*(1), 131.

Stanovich, K. E., & West, R. F. (2000). Individual differences in reasoning: Implications for the rationality debate? *The Behavioral and Brain Sciences*, *23*(5), 645-726.

Statistische Ämter des Bundes und der Länder. (2015). *Zensus 2011: Methoden und Verfahren*. Wiesbaden. Statistisches Bundesamt. https://www.zensus2011.de/SharedDocs/Downloads/DE/Publikationen/Aufsaetze_Archiv/2015_06_MethodenUndVerfahren.pdf;jsessionid=64CB5E1797D2309E5EE73DC7B58256E9.2_cid389?__blob=publicationFile&v=6. Accessed on 2020-05-01.

Steptoe, A., Pollard, T. M., & Wardle, J. (1995). Development of a measure of the motives underlying the selection of food: The food choice questionnaire. *Appetite*(25), 267–284.

Striapunina, K. (2020). *Prognose zum Umsatz im E-Commerce-Markt nach Segmenten in Deutschland bis 2024*. https://de.statista.com/statistik/daten/studie/487985/umfrage/prognose-der-umsaetze-im-e-commerce-nach-segmenten-in-deutschland/. Accessed on 2020-04-12.

Sunstein, C. R. (2014). Nudging: A very short guide. *Journal of Consumer Policy, 37*(4), 583–588.

Thaler, R. H., & Sunstein, C. R. (2009). *Nudge: Improving decisions about health, wealth, and happiness* (Rev. and expanded ed., with a new afterword and a new chapter). Penguin.

Torma, G., Aschemann-Witzel, J., & Thøgersen, J. (2018). I nudge myself: Exploring 'self-nudging' strategies to drive sustainable consumption behaviour. *International Journal of Consumer Studies, 42*(1), 141–154. https://doi.org/10.1111/ijcs.12404

Tukker, A., Goldbohm, R. A., Koning, A. de, Verheijden, M., Kleijn, R., Wolf, O., Pérez-Domínguez, I., & Rueda-Cantuche, J. M. (2011). Environmental impacts of changes to healthier diets in Europe. *Ecological Economics, 70*(10), 1776–1788. https://doi.org/10.1016/j.ecolecon.2011.05.001

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 185*(4157), 1124–1131. https://doi.org/10.1126/science.185.4157.1124

United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development.* United Nations. https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf. Accessed on 2020-03-20.

Van Gilder Cooke, S. (2012, April 9). Why going green can mean big money for fast-food chains. *Time,* 2012. http://content.time.com/time/world/article/0,8599,2111372,00.html. Accessed on 2020-05-01.

van't Riet, J., Sijtsema, S. J., Dagevos, H., & Bruijn, G.-J. de (2011). The importance of habits in eating behaviour. An overview and recommendations for future research. *Appetite, 57*(3), 585–596.

Vandenbroele, J., Slabbinck, H., van Kerckhove, A., & Vermeir, I. (2018). Curbing portion size effects by adding smaller portions at the point of purchase. *Food Quality and Preference, 64*, 82–87. https://doi.org/10.1016/j.foodqual.2017.10.015

Vandenbroele, J., Vermeir, I., Geuens, M., Slabbinck, H., & van Kerckhove, A. (2020). Nudging to get our food choices on a sustainable track. *The Proceedings of the Nutrition Society, 79*(1), 133–146. https://doi.org/10.1017/S0029665119000971

Wansink, B. (2004). Environmental factors that increase the food intake and consumption volume of unknowing consumers. *Annual Review of Nutrition*, *24*, 455–479.

Wansink, B., & Cheney, M. M. (2005). Super bowls: Serving bowl size and food consumption. *Jama*, *293*(14), 1727–1728. https://doi.org/10.1001/jama.293.14.1727

Watson, Boudreau, & Chen (2010). Information systems and environmentally sustainable development: Energy informatics and new directions for the IS community. *Management Information Systems Quarterly*, *34*(1), 23. https://doi.org/10.2307/20721413

Weinmann, M., Schneider, C., & Vom Brocke, J. (2016). Digital nudging. *Business & Information Systems Engineering*, *58*(6), 433–436. https://doi.org/10.1007/s12599-016-0453-1

Wigand, R. T. (1997). Electronic commerce: Definition, theory, and context. *The Information Society*, *13*(1), 1–16. https://doi.org/10.1080/019722497129241

Wilson, A. L., Buckley, E., Buckley, J. D., & Bogomolova, S. (2016). Nudging healthier food and beverage choices through salience and priming. Evidence from a systematic review. *Food Quality and Preference*, *51*, 47–64. https://doi.org/10.1016/j.foodqual.2016.02.009

Wunsch, N.-G. (2019, May 20). *Food delivery services in Europe - Statistics and facts*. https://www.statista.com/topics/3425/food-delivery-services-in-europe/. Accessed on 2020-04-24.

Yeo, V. C. S., Goh, S.-K., & Rezaei, S. (2017). Consumer experiences, attitude and behavioral intention toward online food delivery (OFD) services. *Journal of Retailing and Consumer Services*, *35*, 150–162.

3.2.7. Appendix

Appendix 3.2-1

Dimension	Cluster			Significance tests					
	C1 n = 95	C2 n = 90	C3 n = 106	Normality tests [a]	Variance test [b]	ANOVA [c1]	Kruskal-Wallis-Test [c2]	Pairwise post-hoc t-tests [d1]	Pairwise post-hoc Mann-Whitney-U-Tests [d2]
SC	10.295	8.356	9.340	C3*		10.9 ***	20.074 ***	C1-C2***; C1-C3*; C2-C3*	C1-C2***; C1-C3*; C2-C3*
Vegetables	6.695	5.256	6.000	***	***	37.95 ***	62.312 ***	***	***
Fruit	6.032	4.378	5.821	***	*	36.42 ***	53.606 ***	C1-C2***; C2-C3***	C1-C2***; C2-C3***
Dairy	3.905	5.244	6.075	***	***	41.54 ***	56.584 ***	***	***
Fish	1.589	2.278	3.038	***	***	44.28 ***	70.229 ***	***	***
Meat	1.863	4.089	3.858	***	***	61.14 ***	90.329 ***	C1-C2***; C1-C3***	C1-C2***; C1-C3***

*p-value significance codes: *** for < 0.001, ** for < 0.01, * for < 0.05, + for < 0.1*
a) Normality of items is present according to the central limit theorem ($n>30$). Normality was further tested with the Shapiro-Wilk-Test.
b1) Variance between clusters was tested with the Bartlett's Test.
c1) Differences in means were tested with ANOVA.
c2) Differences in means in case of non-parametric data were tested with the Kruskal-Wallis-Test.
d1) Pairwise differences in means were tested with the t-test.
d2) Pairwise differences in means in case of non-parametric data were tested with the Mann-Whitney-U-Test.

Table 3.2-4: Cluster analysis – SC and SRC values per cluster and comparison between clusters

	Cluster			Significance tests					
	C1 n = 95	C2 n = 90	C3 n = 106	Normality tests [a]	Vari-ance test [b]	ANOVA [c1]	Kruskal-Wallis-Test [c2]	Pairwise post-hoc t-tests [d1]	Pairwise post-hoc Mann-Whitney-U-Tests [d2]
Healthy	6.379	4.778	6.085	***	***	87.87 ***	111.740 ***	C1-C2***; C1-C3**; C2-C3***	C1-C2***; C1-C3**; C2-C3***
Enables mood monitoring	5.084	3.600	4.698	***		17.140 ***	30.462 ***	C1-C2***; C2-C3***	C1-C2***; C2-C3***
Convenient	3.821	4.878	5.311	***	*	29.35 ***	49.326 *	C1-C2***; C1-C3***; C2-C3*	C1-C2***; C1-C3***
Provides pleas-urable sensation	5.768	5.244	5.557	***		3.321 *	8.689 ***	C1-C2*	C1-C2**; C1-C3.
Natural	6.411	4.856	5.972	***	***	68.55 ***	92.547 **	***	***
Affordable	4.168	4.444	4.906	***		6.399 **	13.673 **	C1-C3***; C2-C3*	C1-C3***; C2-C3*
Helps control weight	4.137	3.322	4.189	***		6.114 **	12.369 ***	C1-C2**; C2-C3**	C1-C2**; C2-C3**
Familiar	3.337	3.844	4.491	C1***; C2**; C3***		14.44 ***	26.043 ***	C1-C2*; C1-C3***; C2-C3**	C1-C2*; C1-C3***; C2-C3**
Environmentally friendly	6.084	4.189	5.613	***	***	83.96 ***	106.43 ***	***	***
Animal friendly	6.116	3.822	5.491	***		89.05 ***	112.12 ***	***	***
Fairly traded	6.011	3.889	5.396	***	*	105.1 ***	122.9 ***	***	***

*p-value significance codes: *** for < 0.001, ** for < 0.01, * for < 0.05, + for < 0.1*

a) Normality of items is present according to the central limit theorem (n>30). Normality was further tested with the Shapiro-Wilk-Test.
b1) Variance between clusters was tested with the Bartlett's Test.
c1) Differences in means were tested with ANOVA.
c2) Differences in means in case of non-parametric data were tested with the Kruskal-Wallis-Test.
d1) Pairwise differences in means were tested with the t-test.
d2) Pairwise differences in means in case of non-parametric data were tested with the Mann-Whitney-U-Test.

Table 3.2-5: Cluster analysis – FCQ values per cluster and comparison between

4. Digitalized individuals themselves

4.1. How to conquer one's weaker self: Does autonomy affordance increase goal performance and well-being?

Abstract: Positive self-tracking technologies support users in conducting personal analytics and aim to foster their users' goal attainment and well-being. A driver for these two is the experience of autonomy which can be afforded by self-tracking IS. In this paper, we examine the influence of autonomy affordance provided by self-tracking IS as well as its actualization on goal performance and well-being. For this purpose, empirical data was collected in a field experiment using a self-developed mobile self-tracking application. The results of a path analysis indicate that the mere provision of autonomy affordance is positively linked to well-being and that its actualization positively affects goal performance, in turn improving well-being. Contributing to design knowledge in positive computing and self-tracking IS as well as Affordance Theory, we find that the design of self-tracking IS should provide autonomy affordance to further both their users' goal performance and well-being

Keywords: Digital self-tracking; Goals; Autonomy; Affordances; Performance; Well-being; Path analysis; Empirical study

Authors: Henner Gimpel, Niclas Nüske, Christian Regal

Status: This article is published in the proceedings of the 54th Hawaii International Conference on System Sciences (HICSS) in Maui, Hawaii (2021), pp. 4436-4445.

4.1.1. Introduction

Increasing digitalization is changing our private and job life. This affects, for example, the way we work, how we communicate, but also how we learn and evolve. As a result, personal analytics is one of the major new trends included in Gartner Hype Cycles for Emerging Technologies (Walker, 2017). Personal analytics describes an individual's use of data for purposes such as healthcare and self-actualization. It mostly makes use of digital technologies for real-time measurement of data regarding goals, activities, and behaviors (Lupton, 2014a). Positive technologies, as a subset of such digital self-tracking technologies - aim to support users in achieving their goals (Botella et al., 2012), the realization of which results in improved well-being (Harkin et al., 2016; Klug & Maier, 2015), another core aim of positive technologies.

A crucial process for attaining a goal is the monitoring of the goal-pursuing activities which helps to ensure that initially-set goals are translated into action (Harkin et al., 2016). A meta-analysis on monitoring goal progress revealed that progress monitoring has more substantial effects on goal attainment when the progress is recorded and the frequency of progress monitoring is increased (Harkin et al., 2016). Digital self-tracking technologies can support this by providing capabilities to monitor the user's goal progress. So-called habit trackers, mostly available as mobile applications, enable users to set goals and easily keep track of the goal progress by providing a stimulating but straightforward design. Loop Habit Tracker, for example, is one of the best-rated habit trackers in the Google Play Store and provides users with a simple and easy-to-use interface to keep track of their goals.

However, it requires more than an easy-to-use interface so that a habit tracker is used continuously (Buchwald et al., 2018; Pinder et al., 2018). Imagine coming home late from work, exhausted from the day. Your self-tracking IS tells you that you still have a run scheduled for today according to a plan that you committed to a few weeks ago. If you do not run today, you will not reach your goal and feel bad for it. You might even question your motives for committing to your plan in the first place. Even if you do run today, it may bring you closer to your goal, but it is not clear whether this will increase your well-being. What if your plan and your self-tracking IS allowed you to easily adapt your behavior to the circumstances? After all, you could have moved the run to a rest day scheduled for yesterday or tomorrow. It might help here if habit trackers not only allowed freedom in the planning stages but also during the execution of the plan and progress tracking.

Furthermore, providing the possibility to adapt the technology and, in particular, the pre-determined plans to meet the user's needs would also foster the continuous usage of the habit

tracker (Buchwald et al., 2018; Pinder et al., 2018). This means that affording users with certain kinds of autonomy while they work towards their goals, which could have a tremendous effect on the success in pursuing goals as well as well-being (Patall et al., 2008; Ryan & Deci, 2000). Such a possibility for autonomy is an affordance. An affordance, in general, is defined as "the possibility for goal-oriented actions afforded to specific user groups by technical objects" (Markus & Silver, 2008). We define an *autonomy* affordance in the context of digital self-tracking as the possibility to continuously adapt the self-tracking information system (IS) and its comprised information to the user's needs. However, most habit trackers mainly focus on an appealing design or a wide selection of features (Zhao et al., 2016) and neglect the potential positive effects of providing autonomy affordance by making a self-tracking IS more adaptable to the user's needs (Pinder et al., 2018). From this we derive the following research question:

What is the influence of the provision of enhanced autonomy affordance and its actualization in digital self-tracking IS on goal performance and well-being?

In the following, we describe the essential components of our research question which are concepts that are discussed in various areas of research such as the IS system design, self-tracking, positive computing, and psychology. Based on this, we derive hypotheses from explaining the relationship between our constructs. Subsequently, we describe the development and deployment of the self-developed self-tracking IS for the data collection. After the presentation and discussion of our results, we cover our work's theoretical and practical implications, its limitations, and the resulting need for further research.

4.1.2. Theoretical background

Self-tracking IS can be employed to increase individuals' well-being and support them, for example, in achieving their goals. These IS are designed with the aim of "improving the quality of our personal experience with the goal of increasing wellness and generating strengths and resilience in individuals, organizations, and society" (Botella et al., 2012). For this purpose, various types of data (e.g., biological, physical, behavioral, or environmental information) are collected within the IS, both manually or by using digital technologies such as mobile devices and sensors. This enables an increasingly detailed real-time measurement of data regarding activities and behaviors and their analysis and distribution (Lupton, 2014b).

A **goal** can be defined as "a cognitive representation of a future object that an organism is committed to approach or avoid" (Elliot & Niesta, 2009). In the context of self-tracking, goals

like doing sports, getting up early, or eating in specific ways may refer to behaviors which the individual aims to transform into habits. “Habits are learned dispositions to repeat past responses” (Wood & Neal, 2007), i.e., behaviors or actions which are automatically triggered by cues in the individual’s context. Goals play an essential role in habit formation as they provide the trigger to perform the first repetitions of the desired behavior which then becomes automatic (Wood & Neal, 2007). Goals can furthermore be distinguished regarding their time horizon. Long-term goals take more than five years, medium-term goals take one to five years (Steca et al., 2016), and short-term goals take up to one year to achieve (Boersma et al., 2006).

Once a goal is set, there are multiple terms for describing the path to its fulfillment as well as its fulfillment itself. In a broad literature review related to goal progress, Klug and Maier (2015) include studies assessing goal progress, goal pursuit, goal attainment, and goal achievement, and subsume the terms under goal success. In a literature review related to monitoring goal progress, Harkin et al. (2016) distinguish between behavioral goal performance and goal attainment. As self-tracking centers on gathering and analyzing data about regular habits, behaviors, and feelings (Lupton, 2014a), and as the behavior of individuals is the basis for any determination of goal success, we will use the term **goal performance** to describe the process of pursuing and possibly accomplishing a goal.

A major driver of goal performance is motivation. According to Ryan and Deci’s Organismic Integration Theory, **motivation** can be subdivided concerning the degree of internalization, which is the extent to which an individual incorporates a value or a behavior’s regulation into the self (Ryan & Deci, 2000). In three studies and a meta-analysis, Koestner et al. (2008) found higher internalization to be substantially related to goal progress, whereas lower internalization was not.

Goal performance has furthermore been linked to enhanced **well-being** in various studies (Ryan & Deci, 2001). The psychological literature regarding well-being can be divided into two main fields: subjective well-being and psychological well-being (Hall, 2015). To determine the overall flourishing of an individual, both need to be considered (Huppert & So, 2009). Subjective well-being takes a hedonic perspective, i.e., it focuses on happiness and positive or negative, temporary feelings. Psychological well-being takes an eudemonic view, i.e., it concentrates on self-attainment and meaning (Ryan & Deci, 2001).

Moreover, according to Ryan and Deci's Self-determination Theory, the three basic needs autonomy, competence, and relatedness are crucial for promoting well-being (Ryan & Deci, 2000). The drivers of **autonomy** are “a sense of choice, volition, and freedom from excessive

external pressure" (Ryan & Deci, 2000). Transferred to the context of monitoring goal performance in self-tracking IS, users experience autonomy if provided with options to adapt their plans and exercise control regarding their goal-directed behavior.

We take an **affordance** perspective on the interplay of the provision of these options in self-tracking IS and their perception and actualization by the users. A functional affordance, in general, is defined as "the possibility for goal-oriented actions afforded to specific user groups by technical objects". In the context of our work, users of self-tracking IS (user group and technical object) aim to achieve and track progress regarding goal performance (goal). An affordance arises from the relationship between the properties of an object and the abilities of the agent who interacts with it. It is not a property or feature of the object per se (Norman, 2013). Following Norman (Norman, 2013), an affordance is communicated by signifiers, which refer to "any mark or sound, any perceivable indicator that communicates appropriate behavior to a person". We define and use the term **autonomy affordance** as the possibility to adapt users' plans for goal-directed behavior, which is enabled by features and communicated by signifiers in a self-tracking IS.

4.1.3. Hypotheses development

According to Self-determination Theory, higher levels of autonomy should result in higher levels of well-being (Ryan & Deci, 2000). In this study, we focus on the subjective well-being facet as it is more variable over time ((Krueger & Schkade); (Diener et al.)). In contrast to the more stable psychological well-being, we can observe the effects of a manipulation of autonomy affordance on subjective well-being in the course of a field experiment. We hypothesize that an enhancement of autonomy affordance positively affects subjective well-being (**H1**). This enhancement of autonomy affordance is manifested as the extension of features (and their signifiers) that enable plan adaptations for the goal-directed behavior of self-tracking IS users. An affordance can exist without being actualized (Strong et al., 2014). H1 covers the mere offer of enhanced autonomy affordance and its relationship to subjective well-being. We suggest that it is enough for users of a self-tracking IS to perceive enhanced autonomy affordance by its signifiers to feel more autonomous.

In case that autonomy affordance is actualized, its actualization (a behavior) should self-evidently be contingent on its provision. We thus hypothesize a positive effect of the enhancement of autonomy affordance on its actualization (**H2**).

As pointed out in H1, self-tracking IS users should feel more autonomous by simply perceiving enhanced autonomy affordance. Besides, we suppose that the positive effect of the experience of autonomy on subjective well-being in part works via the mediator affordance actualization. We hypothesize that the actualization of autonomy affordance positively influences subjective well-being (**H3**).

In a meta-analysis of studies examining choice and its various outcomes, Patall et al. (2008) found significant, mainly positive effects of choice on, among others, effort, task performance, and subsequent learning. Other studies as well showed that the satisfaction of the basic need autonomy, among others, was positively related to learning outcomes (Akbari et al., 2015). Transferred to our context, we hypothesize that the actualization of autonomy affordance positively affects goal performance (**H4**).

Goal performance has been linked to well-being in several studies. Brunstein (1993) found progress in the achievement of personal goals to predict subjective well-being. Two meta-analyses confirmed the high correlation between successful striving towards long-term goals and subjective well-being (Klug & Maier, 2015; Koestner et al., 2002). Steca et al. (2016) found a slightly weaker positive influence of short-term goal progress on subjective well-being. We hypothesize goal performance to positively affect subjective well-being (**H5**).

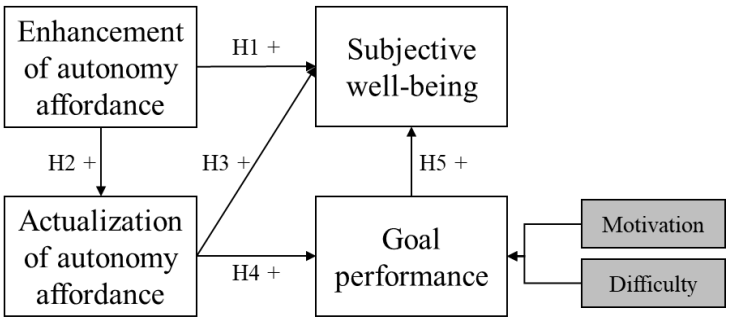


Figure 4.1-1: Hypothesized relationships between enhanced autonomy affordance, its actualization, subjective well-being, goal performance, and the control variables

When examining the effect of enhanced autonomy affordance and its actualization on goal performance and well-being in self-tracking IS, two influences external to self-tracking should be controlled: motivation and difficulty. Vansteenkiste et al. (2004) showed intrinsic goal-motivation as well as autonomy-supportive environments to have an impact on the performance of students. We cover the latter influence, autonomy-supportive contexts, with our main independent variable, enhanced autonomy affordance. However, we do not yet consider the former influence, motivation. Thus, we include a goal's original motivation as a control variable.

Lastly, performing well concerning goals that are easy to achieve seems to be more likely than concerning harder or more complicated goals. As a second control variable of goal performance, we, therefore, include goal **difficulty** in our model. Figure 4.1-1 outlines the proposed relationships between our four focal constructs and the two control variables.

4.1.4. Methodology

The empirical test of the hypothesized relationships bases on a field experiment manipulating autonomy affordance to measure the effects. As no self-tracking IS allowing to manipulate autonomy affordance was readily available, we designed, developed, and deployed a mobile application for tracking the goal performance of individuals regarding self-set goals. Participants were randomly assigned to either of two treatments differing in the level of autonomy affordance. Data was gathered automatically by the app.

4.1.4.1. The measurement instrument

The mobile application developed to allow for testing our hypotheses was available for the operating systems Android and iOS. The app enabled users to enter goals that they wanted to achieve or habits that they wanted to integrate into their life. On one tab ("GOALS"), users could create and manage goals. To create a goal, users entered a title or selected one from a list of 90 recommendations from different categories such as sports and learning. Users were then asked to indicate the weekdays on which they would like to conduct activities pursuing the new goal. Users were asked to state the subjective difficulty of reaching the new goal and to select the most suitable motivation for the new goal from a list. Users were also able to add further goals, edit, or delete existing goals.

In a second tab ("JOURNAL"), users could view their goal journal. The view provided a list divided into separate days which were displayed in the headline of each section, starting one week before the current day and ending three weeks after. Under each headline, all goal-pursuing activities of all goals which were planned for that day were listed and identified via the goal title. For each of these activities, users could log their progress by clicking on a check (done) or on a cross (not done). In each case, they were asked to indicate their current feeling on a scale of five emoji. Logging and unlogging activities were enabled for the current day and all days before.

For illustrations of the measurement instrument, please see Figure 4.1-2 and Appendix 4.1-1.

4.1.4.2. Manipulating autonomy affordance

We created two versions of the app which differed regarding the level of autonomy affordance. We manipulated autonomy affordance by including or excluding a total of three features and three autonomy affordance signifiers (see Figure 4.1-2 and Appendix 4.1-1 for illustrations) which were derived from an analysis of commercial habit-tracking apps and user interviews in the app design stage:

(1) The first feature enabled users to change the weekdays on which goal-pursuing activities were planned. Users could deliberately edit goals and alter their plans by adding, changing, or deselecting weekdays. Autonomy affordance was signified by a calendar symbol, a heading reading "Days of the week", and switches for each weekday.

(2) Users were able to add an activity to pursue one of their already created goals on every given day. This second feature means that users could spontaneously add a goal-pursuing activity to a day on which no such activity had been planned or to expand their plan for the day by an additional activity for the same goal. Autonomy affordance was signified by a plus button which was positioned next to the date of each day in the goal journal tab of the app.

(3) Lastly, users could also move an activity to another day. Thus, they were able to carry out activities earlier or later than initially planned. Moving an activity was enabled for all activities that had not yet been logged. Autonomy affordance was signified by a calendar button displayed next to each activity.

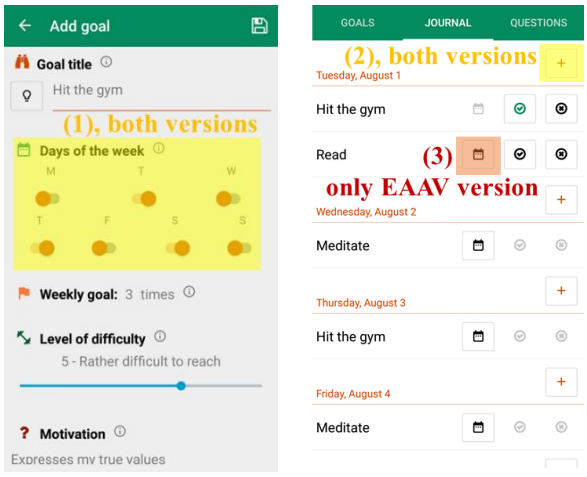


Figure 4.1-2: Screenshots of the app showing the three autonomy affordance signifiers

In the low autonomy affordance version (LAAV), we included the first two features and autonomy affordance signifiers. It is important to note that users had the autonomy to decide on their plans regarding their goal-pursuing activities anyways. The question here merely was in

how far and how easily the app allowed for changing the plan to fit the behavior. We included these first two features and signifiers for each user to provide enough autonomy within the app as not to frustrate users and not to impair the usage of the app. However, changing the weekdays (first feature) required users to edit goals and modify their overall weekly plan for the goals in a rather cumbersome fashion. Also, spontaneously adding activities for existing goals (feature (2)) required users to mark the activities that were substituted by the spontaneously added ones as not done and admit failure.

Autonomy affordance was only genuinely enhanced to a level above minimum usability requirements by the third presented feature and signifier. Smoothly moving activities within the journal alleviated the struggles mentioned above and enabled the users to modify their plans freely. The enhanced autonomy affordance version (EAAV) consequently comprised all three presented features and signifiers. By providing the features and signifiers (1) and (2) in both versions and all three in the enhanced autonomy version as shown in Figure 4.1-2, we aimed to achieve the difficult task of balancing user-friendliness (providing a minimum level of autonomy affordance so that users stay with the app) and differentiation between versions (providing considerably enhanced autonomy affordance as compared to the low autonomy affordance version).

4.1.4.3. Experiment design and procedures

We placed the app in the Google Play Store and the Apple App Store and advertised it via email and various social media channels as well as a local newspaper and a local TV channel. The experiment ran from April to September 2017.

The app uploaded all data to a cloud service - users were accurately informed about the intent and extent of data capture, upload, storage, and use and provided informed consent a priori. The data did not include any personally-identifying information. Starting with the first opening of the app, the upload was conducted every five days if a wireless network was available. If not, uploading via cellular data was delayed for three more attempts to spare data.

Either of the two app versions were randomly assigned after a user had installed the app. To sum up, we had two experimental treatments differing in the level of autonomy affordance (low autonomy affordance vs. enhanced autonomy affordance), random assignment of participants to treatments, and a between-subject comparison for the treatment variable enhanced autonomy affordance.

4.1.4.4. Measurement of constructs

For the measurement of the constructs, we relied on log data that we acquired by tracking the goal-setting and goal-pursuing behavior of our field experiment's participants in the app.

Construct	Operationalization based on log data
Subjective well-being	An indication of the current emotional state after marking an activity as done or not done on a scale of 5 emoji (ranging from 1 representing frustration to 5 representing elation)
Goal performance	Number of goal-pursuing activities logged as done (rather than not done) divided by the sum of logged goal-pursuing activities; values from zero (for users who logged all activities as not done) to one (for users who logged all activities as done)
Enhancement of autonomy affordance	Binary indicator on whether the user was randomly assigned to the version of the app with low (0) or enhanced (1) autonomy affordance
Actualization of autonomy affordance	Sum of changes of weekdays on which goal-pursuing activities were planned for (first feature), spontaneously added activities (second feature), and moved goal-pursuing activities (third feature, available in the enhanced autonomy affordance app version) divided by the number of all activities in the observation period; values from zero (for users who did not actualize any autonomy affordance) to infinity (for users who often actualized autonomy affordance)
Motivation	Selection of the most suitable motivation for each goal from (English expressions adapted from Reis et al. (2000)): "Interesting or enjoyable" (intrinsic), "Expresses my true values" (identified), "Avoid anxiety or guilt" (introjected), or "Forced by external situation" (external)
Difficulty	Selection of the subjective difficulty of reaching each goal on a 7-point Likert scale with the anchors "1 - Very easy to reach" and "7 - Very difficult to reach"

Table 4.1-1: Constructs measured via log data and their operationalization and calculations

Creating, editing, and deleting goals, or logging, adding, and moving activities were logged. Based on this log data, the measures for the constructs could be calculated. Table 4.1-1 lists the nature of the collected log data and the definition of these measures.

Although an emoji scale to measure subjective well-being has not been validated yet, multiple similar scales (e.g., smiley scales) have been used to capture subjective well-being directly after experiences (Ross et al., 2015). Thus, we employ the feeling after logging indicated on a scale of five emoji as an unobtrusively and frequently surveyed measure of subjective well-being. Please see Figure 4.1-7 of Appendix 4.1-1 for an illustration. Its log data provides a rather continuous and unobtrusive basis for analyses as compared to, e.g., a longer multi-item survey scale once a week.

4.1.5. Results

4.1.5.1. Descriptive results

For our analyses, we consider the users who logged activities as done or not done for at least two weeks. We choose this minimum observation period to avoid biases caused by short-term, uncommitted users. This gives us a sample of n = 54. Considering the 49 users who answered

the optional question about their age, the mean age is 29 years with a minimum of 17 years and a maximum of 60 years. Considering the 48 users who answered the optional question about their gender, the share of female users is 58 percent.

The separation of the examined participants into users of the LAAV (34 users, also see "Provision" in Table 4.1-2) and the EAAV (20 users) distinguishes users according to the autonomy affordance *provided* to them. However, whether the mere availability of affordance entailed its *actualization* remains to be tested. A comparison of the autonomy affordance actualization measure (see Table 4.1-2) of users who were assigned the EAAV with users who were assigned the LAAV yields an observable difference. Users of the EAAV exhibited a mean actualization of 0.083. In 74.9 percent of all times users of the EAAV actualized affordance, they used the third provided feature that was only available to them but not to the other group. Users of the LAAV showed a mean actualization of only 0.032. A Mann-Whitney-U test resulted in the rejection of the null-hypothesis that the two distributions of the actualization measure (20 EAAV users vs. 34 LAAV users) belong to the same population with a p-value of 0.012. This is a first indicator of the positive association of the provision of enhanced autonomy affordance and its actualization and provides support for H2. As both the provision of enhanced autonomy affordance (H1 and H2) and its actualization (H3 and H4) were hypothesized to influence the presented constructs, the following presentations of descriptive results will distinguish the users both regarding autonomy affordance provision and autonomy affordance actualization (see "Actualization" in Table 4.1-2).

		Provision		**Actualization**	
	Total	E	L	E	L
n	54	20	34	26	28
Mean affordance actualization	0.05	0.08	0.03	0.10	0.01
Median number of goals	5	5	5	5	5
Median number of weekly activities	18	18	18.5	16.5	20
Median goal difficulty	4	4	4	4	4
Median goal motivation	2	2	2	2	2.5
Median logging period (d)	34	31	38	32	38
Median share of logged activities	0.95	0.98	0.93	0.98	0.87
Median goal performance	0.63	0.64	0.62	0.62	0.63
Mean feeling after logging	3.51	3.62	3.44	3.55	3.47

Table 4.1-2: Descriptive results

The users entered between 1 and 19 goals with a median of 5 goals and 18 goal-pursuing activities per week. Typical goals include doing sports, eating more fruits or less sugar, studying a language, or getting up early. The median goal difficulty is 4 and the goals' median motivation is 2 (introjected). Users logged activities for periods up to 160 days, with a median

of 34 days. A comparison using a Mantel-Haenszel test (Mantel & Haenszel, 1959) which adapts the concept of survival curves for users of the two app versions suggests no significant group difference in the logging period (p-value of 0.249). Users logged between 4 and 100 percent of all activities, with a median of 95 percent. The observed goal performance is between 13 and 100 percent, with a median of 63 percent. I.e., across all users, 63 percent of planned activities logged by the users were done by them (according to self-report) while they failed to do 37 percent. The mean of the overall feeling after logging across all users is 3.51. Regarding activities logged as done, the feeling is 4.10. For activities logged as not done, the feeling after logging is 2.57.

Table 4.1-2 displays the results of the descriptive analyses separated into an enhanced (E) and a low (L) subgroup based on autonomy affordance provision (Provision; based on random assignment) or autonomy affordance actualization (Actualization; based on a median split according to observed behavior).

4.1.5.2. Hypotheses testing with path analysis

We hypothesized the enhanced provision of autonomy affordance to affect subjective well-being directly and positively (H1) as well as indirectly and positively via the mediator autonomy affordance actualization (H2 and H3). We expected autonomy affordance actualization to positively affect goal performance (H4), and goal performance to positively affect subjective well-being (H5). Additionally, we included the motivation and difficulty of goals as two important control variables.

We tested the hypothesized relationships by employing path analysis and utilizing the lavaan R package (Rosseel, 2012). Path analysis allows for explaining relationships among directly measured, uni-dimensional constructs, both of which requirements are fulfilled given the operationalization of the examined constructs detailed in Table 4.1-1. Figure 4.1-3 depicts the results of the path analysis, including the estimated path coefficients and their significance level. H1, H2, H4, and H5 were supported while we found no support for H3.

Following Little and Kline (2016), we conducted a Chi-square test and calculated the fit indices root mean square error of approximation (RMSEA), comparative fit index (CFI), and square root mean residual (SRMR) to assess our model. The Chi-square test statistic over the degrees of freedom results in an acceptable value of 0.804 (Gefen et al., 2000), whereas the p-value of 0.045 hints at suboptimal model fit (Barrett, 2007). The RMSEA of our model is 0.130, with values smaller than 0.07 indicating good model fit (Steiger, 2007). The CFI indicates a satisfactory model fit if higher than 0.90 (Hu & Bentler, 1999) and amounts to 0.877

for our model. The SRMR should show values smaller than 0.08 (Hu & Bentler, 1999) and is 0.077 for our model. Overall, we conclude that our model exhibits a moderate fit and include a discussion of this topic in the limitation section. The R^2 values for subjective well-being, goal performance, and autonomy affordance actualization are 0.560, 0.277, and 0.108, respectively.

4.1.6. Discussion

We hypothesized the provision of enhanced autonomy affordance to directly and positively influence subjective well-being (H1), a relation that was found significant. This implies that the mere provision of enhanced autonomy affordance improved the users' feelings, even when controlling for the effects of actualized autonomy affordance and goal performance (users generally felt better after logging done than after logging not done). Hence, the provision of enhanced autonomy affordance lead to improved subjective well-being without it being actualized. It is important to note that this applies to the measurement of subjective well-being with a smiley scale as laid out in the methodology section and needs to be verified with other measures of subjective well-being in the future.

The provision of enhanced autonomy affordance was positively related to its actualization (H2). Users who were provided with an additional feature that allowed them to adapt the plans for their goal-directed behavior and who were presented with more autonomy affordance signifiers did indeed exercise the additionally provided options more often and actualized autonomy affordance to a greater extent.

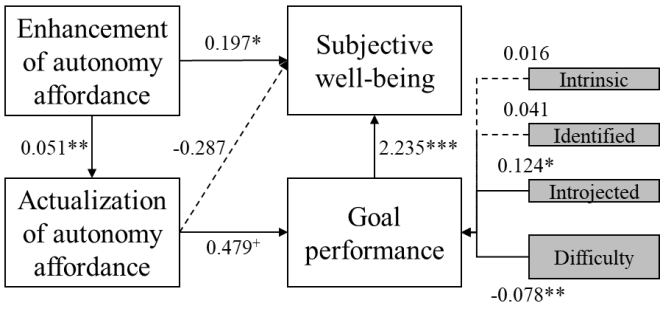


Figure 4.1-3: Results of path analysis including path coefficients

The exercise of autonomy affordance, however, did not translate directly into higher degrees of subjective well-being as postulated in H3. This might indicate that the provision of enhanced autonomy affordance was sufficient to increase the users' subjective well-being. Its

actualization might not be necessary to reap the benefits of a more autonomous feeling of the users on subjective well-being.

The actualization of autonomy affordance did, however, improve goal performance (H4). The actualization might have enabled users to react to unforeseen restrictions and bypass them, resulting in a higher goal performance due to the adaptability of their goal-pursuing behavior to their circumstances.

Lastly, subjective well-being was significantly and positively affected by goal performance (H5). The better the users of the app performed, the better they felt after logging activities as done or failed. This confirmation of H3 is intuitive and in line with a larger body of literature (Klug & Maier, 2015; Koestner et al., 2002).

Therefore, we answer our research question as follows: The provision of enhanced autonomy affordance directly increases the user's subjective well-being. Also, goal performance is positively affected as enhanced autonomy affordance increases its actualization, which in turn increases goal performance. The positive effect of goal performance on subjective well-being, in turn, leads to an indirect effect of the provision of enhanced autonomy affordance on the users' subjective well-being. Interestingly, the mere provision of enhanced autonomy affordance seems to be sufficient to increase the user's subjective well-being, while the increase of goal performance requires affordance actualization.

The current work has three main implications that relate to our contribution to the underlying literature, the research instrument, and the design of self-tracking IS. First of all, our hypotheses aggregate findings from various areas of IS research and psychology, such as well-being, motivation, and personality. Although only four of the five hypotheses are supported empirically, our results support the positive effects of the provision of enhanced autonomy affordance on its actualization, goal performance, and subjective well-being. Thus, our results strengthen the findings of Self-determination Theory regarding the relationship between autonomy and well-being presented in the theoretical background and hypotheses development sections. More importantly, we demonstrate the underlying theory's applicability in the context of the design of IS for self-tracking goal-directed behavior. To the best of our knowledge, this study is the first to argue and empirically demonstrate these effects in this context. Hence, our study contributes to the body of design knowledge in positive computing and self-tracking IS. Besides, we have shown that the effect of autonomy might not originate from its actualization, but that its offering might already be sufficient. We add to Affordance Theory as we

empirically observed that the mere provision of affordance can affect the users' subjective well-being while self-tracking goals.

Second, we created a measurement instrument by developing a mobile application that represents an easy way to capture the entirety of our model's constructs. Its design may facilitate similar research endeavors in the future. Once the app had been developed and distributed, it reliably and continuously captured empirical data and delivered it to our research team. The maintenance effort was limited to minor updates and the data analysis could be automated. Nevertheless, we recommend several refinements of the app's design before further applying it as a measurement instrument. Users should be able to enter goals that do not necessarily have at least one goal-pursuing activity a week. The app should allow goals with differing activity-rhythms as well. Next, users should be able to pass on goal-pursuing activities and not be restricted to either marking them as done or failed. This way, the app could implement pauses in the goal-directed behavior due to illness or vacation, track the users' activities more accurately, and afford the users with additional autonomy. The proposed refinements should improve the usability of the app, the amount of time for which users stay with the app, and the quality of the captured data.

Third, based on the results, we conclude that any self-tracking IS which is intended to further the success and well-being of its users while they work towards their goals should implement autonomy-supportive functions such as providing choices regarding goal-directed behavior. Furthermore, we argue that the presented considerations on the influence of the provision of enhanced autonomy affordance on subjective well-being can be transferred to organizational contexts like universities, schools, and companies as well. In these settings, usually, both the goals and the IS that is used to track the goal progress are predetermined by the organization. In contrast to self-tracking goals in the private, individual context where users freely choose the IS and the goals themselves, the behavior of some organizational users might thus be significantly less autonomously regulated. This highlights the need for autonomy-supportive functions and stresses their potential to increase the well-being of the members of an organization. These effects are, in turn, likely to translate into benefits of monetary or reputational nature for the organization.

4.1.7. Conclusion

4.1.7.1. Limitations

The current work's research process and results have limitations which highlight the need for further research about the interconnections of the provision of enhanced autonomy affordance, goal performance, and well-being in self-tracking IS. First of all, although 54 individuals took part in the study for at least 14 days, the sample size is still quite small and the achieved empirical model fit is not optimal, which considerably impairs generalizability. However, we do not focus on the interpretation of the exact values of the coefficients. Still, we take significant results as the first confirmation of both the relationships between the dependent and the independent variables and its direction. Therefore, to verify our results, the study should be rerun after the refinements to the app that were proposed in the discussion section to achieve a larger sample size.

Second, the data that was collected by the app originates from self-reports by the users. Furthermore, according to interviews with several users who used the option to provide feedback, which was given during the experiment, their interpretations of not logging an activity differed. For some users, it had the equivalent meaning of logging an activity as not done. For others, it meant that they had simply forgotten to log and that the share of done and not done activities, if they had logged them, would have been similar to that of the days or weeks before.

Third, the installation and subsequent usage of a self-tracking app represent a form of self-selection. Not every individual knows about habit trackers, has access to them, or is sufficiently convinced of their usefulness to install and use them. Further research needs to develop an understanding of who the users of self-tracking IS are and why they track their behavior. It should be analyzed whether there are differences in personality, behavioral patterns, or other characteristics in comparison to non-users. Future studies should as well build on works like that of Gimpel et al. (2013) to determine which motivations lead users to engage in self-tracking. Similarly, it is yet unclear whether there are users who benefit more or less from the provision of autonomy affordance.

4.1.7.2. Summary

The current work examined the effects of the provision of enhanced autonomy affordance on its actualization, goal performance, and well-being in the context of self-tracking IS for goal-directed behavior. Our theoretical development leverages Self-determination Theory and Af-

fordance Theory and relates explicitly to the literature on self-tracking and positive computing. The theoretical hypotheses were mostly empirically supported in a field experiment. The empirical data was gathered via a mobile application that was developed for this purpose. The app collected self-tracking data about the goal-directed behavior of 54 participants who used it for a median observation period of 34 days. The results represent a first indication that self-tracking IS should afford autonomy to further both their users' goal performance and well-being.

Overall, our research and its further development contributes to positive computing and self-tracking IS and informs designers of self-tracking systems on the benefits of affording users with autonomy rather than telling them to defeat their weaker self and stick to their pre-determined plans regardless of the circumstances. Furthermore, it shows that in this context, merely affording more autonomy can have positive effects above and beyond the positive effects of the actualization of affordance.

With this, we hopefully supported users, despite exhausting working days, in reaching their goals and at the same time increase their well-being.

4.1.8. References

Akbari, E., Pilot, A., & Robert-Jan Simons, P. (2015). Autonomy, competence, and relatedness in foreign language learning through Facebook. *Computers in Human Behavior*, *48*, 126–134. https://doi.org/10.1016/j.chb.2015.01.036

Barrett, P. (2007). Structural equation modelling: Adjudging model fit. *Personality and Individual Differences*, *42*(5), 815–824.

Boersma, S. N., Maes, S., Joekes, K., & Dusseldorp, E. (2006). Goal processes in relation to goal attainment: Predicting health-related quality of life in myocardial infarction patients. *Journal of Health Psychology*, *11*(6), 927–941. https://doi.org/10.1177/1359105306069095

Botella, C., Riva, G., Gaggioli, A., Wiederhold, B. K., Alcaniz, M., & Banos, R. M. (2012). The present and future of positive technologies. *Cyberpsychology, Behavior and Social Networking*, *15*(2), 78–84. https://doi.org/10.1089/cyber.2011.0140

Brunstein, J. C. (1993). Personal goals and subjective well-being: A longitudinal study. *Journal of Personality and Social Psychology*, *65*(5), 1061–1070.

Buchwald, A., Letner, A., Urbach, N., & Entreß-Fürsteneck, M. v. (2018). Insights into personal ICT use: Understanding continuance and discontinuance of wearable self-tracking devices. In *Proceedings of the 26th European Conference on Information Systems (ECIS)*, Portsmouth, United Kingdom.

Diener, E., Lucas, R. E., & Scollon, C. N. (2006). Beyond the hedonic treadmill: Revising the adaptation theory of well-being. *The American Psychologist*, *61*(4), 305–314. https://doi.org/10.1037/0003-066X.61.4.305

Elliot, A. J., & Niesta, D. (2009). Goals in the context of the hierarchical model of approach–avoidance motivation. In G. B. Moskowitz & H. Grant (Eds.), *The Psychology of Goals* (pp. 56–76). Guilford Press.

Gefen, D., Straub, D., & Boudreau, M.-C. (2000). Structural equation modeling and regression: Guidelines for research practice. *Communications of the Association for Information Systems*, *4*. https://doi.org/10.17705/1CAIS.00407

Gimpel, H., Nißen, M., & Görlitz, R. A. (2013). Quantifying the quantified self: A study on the motivations of patients to track their own health. In *Proceedings of the 34th International Conference on Information Systems (ICIS)*, Milano, Italy.

Hall, M. (2015). *Detecting well-being in digital communities: An interdisciplinary engineering approach for its indicators* [Doctoral Thesis]. Karlsruher Institut für Technologie (KIT), Karlsruhe.

Harkin, B., Webb, T. L., Chang, B. P. I., Prestwich, A., Conner, M., Kellar, I., Benn, Y., & Sheeran, P. (2016). Does monitoring goal progress promote goal attainment? A meta-analysis of the experimental evidence. *Psychological Bulletin*, *142*(2), 198–229. https://doi.org/10.1037/bul0000025

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Huppert, F. A., & So, T. T. C. (2009). *What percentage of people in Europe are flourishing and what characterises them? Prepared for the OECD/ISQOLS meeting "Measuring subjective well-being: an opportunity for NSOs?" in Florence - July 23/24, 2009.* University of Cambridge, The Well-being Institute.

Klug, H. J. P., & Maier, G. W. (2015). Linking goal progress and subjective well-being: A Meta-analysis. *Journal of Happiness Studies*, *16*(1), 37–65. https://doi.org/10.1007/s10902-013-9493-0

Koestner, R., Lekes, N., Powers, T. A., & Chicoine, E. (2002). Attaining personal goals: Self-concordance plus implementation intentions equals success. *Journal of Personality and Social Psychology*, *83*(1), 231–244. https://doi.org/10.1037//0022-3514.83.1.231

Koestner, R., Otis, N., Powers, T. A., Pelletier, L [Luc], & Gagnon, H. (2008). Autonomous motivation, controlled motivation, and goal progress. *Journal of Personality*, *76*(5), 1201–1230. https://doi.org/10.1111/j.1467-6494.2008.00519.x

Krueger, A. B., & Schkade, D. A. (2008). The reliability of subjective well-being measures. *Journal of Public Economics*, *92*(8-9), 1833–1845. https://doi.org/10.1016/j.jpubeco.2007.12.015

Little, T. D., & Kline, R. B. (Eds.). (2016). *Methodology in the social sciences*. *Principles and practice of structural equation modeling* (Fourth edition). The Guilford Press.

Lupton, D. (2014a). Self-tracking cultures: Towards a sociology of personal informatics. In *Proceedings of the 26th Australian Computer-Human Interaction Conference on Designing Futures: the Future of Design.* Symposium conducted at the meeting of Association for Computing Machinery (ACM), Sydney, New South Wales, Australia.

Lupton, D. (2014b, August 27). *Self-tracking modes: Reflexive self-monitoring and data practices: Paper for the 'Imminent Citizenships: Personhood and Identity Politics in*

the Informatic Age' workshop, 27 August 2014, ANU, Canberra. Canberra, Australia. University of Canberra, Faculty of Arts & Design, News & Media Research Centre.

Mantel, N., & Haenszel, W. (1959). Statistical aspects of the analysis of data from retrospective studies of disease. *JNCI: Journal of the National Cancer Institute*, *22*(4), 719–748. https://doi.org/10.1093/jnci/22.4.719

Markus, M. L., & Silver, M. (2008). A foundation for the study of IT effects: A new look at DeSanctis and Poole's concepts of structural features and spirit. *Journal of the Association for Information Systems*, *9*(10), 609–632. https://doi.org/10.17705/1jais.00176

Norman, D. A. (2013). *The design of everyday things* (Revised and expanded edition). Basic Books.

Patall, E. A., Cooper, H., & Robinson, J. C. (2008). The effects of choice on intrinsic motivation and related outcomes: A meta-analysis of research findings. *Psychological Bulletin*, *134*(2), 270–300. https://doi.org/10.1037/0033-2909.134.2.270

Pinder, C., Vermeulen, J., Cowan, B. R., & Beale, R. (2018). Digital behaviour change interventions to break and form habits. *ACM Transactions on Computer-Human Interaction*, *25*(3), 1–66. https://doi.org/10.1145/3196830

Reis, H. T., Sheldon, K. M., Gable, S. L., Roscoe, J., & Ryan, R. M. (2000). Daily well-being: The role of autonomy, competence, and relatedness. *Personality and Social Psychology Bulletin*, *26*(4), 419–435.

Ross, T., Burris, A., Oliveira, L., Arnott, B., & Araujo-Soares, V. (2015). A feasibility study of the effect of phone-based feedback of other commuters' subjective experiences on driver intentions to change. In A. Marcus (Ed.), *Lecture Notes in Computer Science. Design, User Experience, and Usability: Design Discourse* (Vol. 9186, pp. 548–558). Springer International Publishing. https://doi.org/10.1007/978-3-319-20886-2_51

Rosseel, Y. (2012). Lavaan: An R package for structural equation modeling and more. Version 0.5–12 (BETA). *Journal of Statistical Software*, *48*(2), 1–36.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, *55*(1), 68–78. https://doi.org/10.1037//0003-066X.55.1.68

Ryan, R. M., & Deci, E. L. (2001). On happiness and human potentials: A review of research on hedonic and eudaimonic well-being. *Annual Review of Psychology*, *52*, 144–166.

Steca, P., Monzani, D., Greco, A., D'Addario, M., Cappelletti, E., & Pancani, L. (2016). The effects of short-term personal goals on subjective well-being. *Journal of Happiness Studies*, *17*(4), 1435–1450. https://doi.org/10.1007/s10902-015-9651-7

Steiger, J. H. (2007). Understanding the limitations of global fit assessment in structural equation modeling. *Personality and Individual Differences*, *42*(5), 893–898.

Strong, D., Volkoff, O., Johnson, S., Pelletier, L [Lori], Tulu, B., Bar-On, I., Trudel, J., & Garber, L. (2014). A theory of organization-EHR affordance actualization. *Journal of the Association for Information Systems*, *15*(2), 53–85. https://doi.org/10.17705/1jais.00353

Vansteenkiste, M., Simons, J., Lens, W., Sheldon, K. M., & Deci, E. L. (2004). Motivating learning, performance, and persistence: The synergistic effects of intrinsic goal contents and autonomy-supportive contexts. *Journal of Personality and Social Psychology*, *87*(2), 246–260. https://doi.org/10.1037/0022-3514.87.2.246

Walker, M. J. (2017). *Hype Cycle for Emerging Technologies, 2017*. Stamford, Connecticut, The United States of America. Gartner, Inc.

Wood, W., & Neal, D. T. (2007). A new look at habits and the habit-goal interface. *Psychological Review*, *114*(4), 843–863. https://doi.org/10.1037/0033-295X.114.4.843

Zhao, J., Freeman, B., & Li, M. (2016). Can mobile phone apps influence people's health behavior change? An evidence review. *Journal of Medical Internet Research*, *18*(11), e287. https://doi.org/10.2196/jmir.5692

4.1.9. Appendix

Appendix 4.1-1

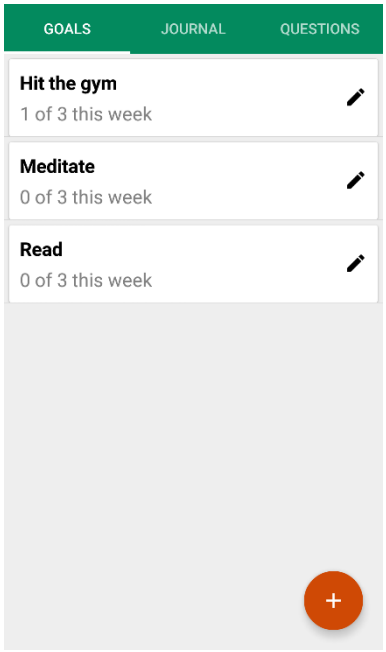


Figure 4.1-4: GOALS tab

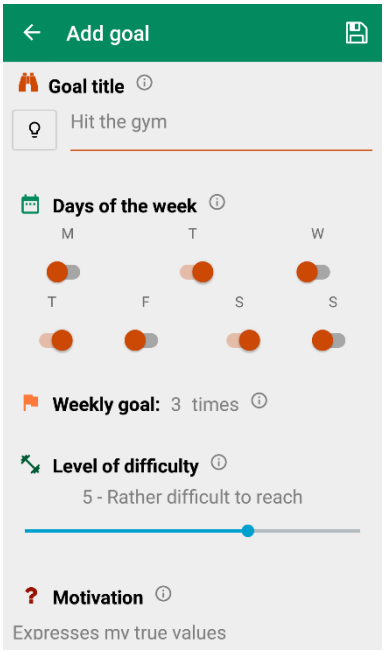


Figure 4.1-5: Screen for adding a goal

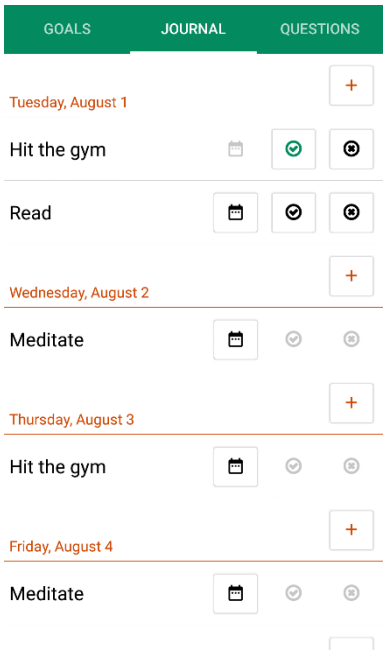


Figure 4.1-6: JOURNAL tab

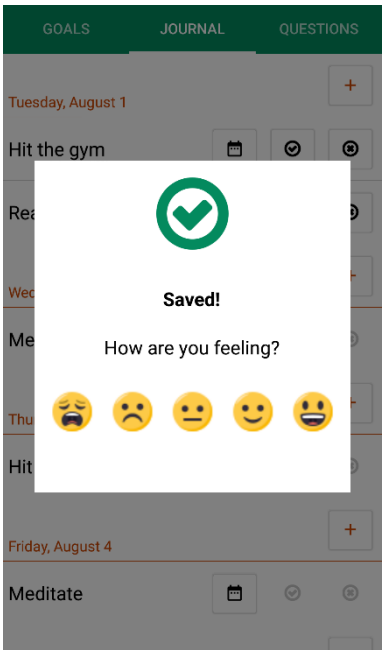


Figure 4.1-7: Screen for indicating the feeling after logging on a scale of five emoji

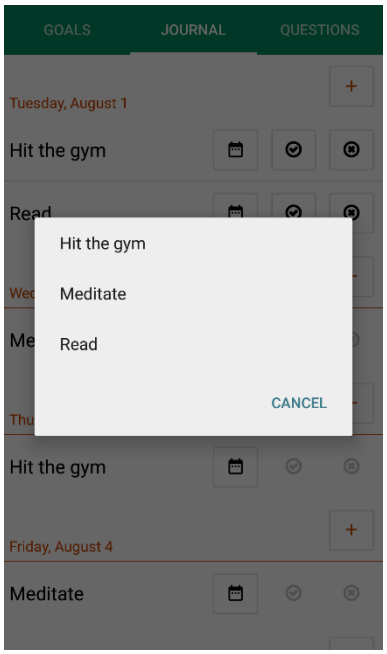


Figure 4.1-8: Screen for spontaneously adding an activity of an already created goal after clicking on autonomy affordance signifier (2)

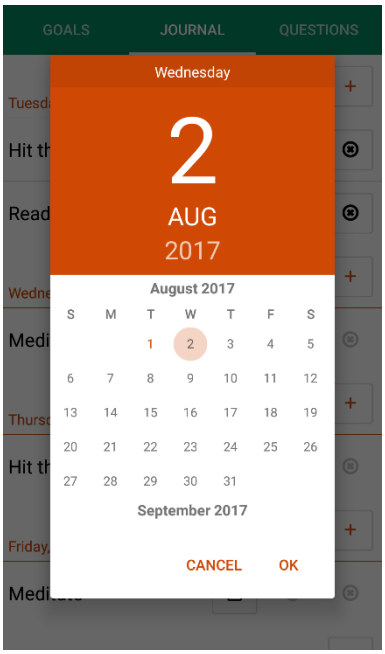


Figure 4.1-9: Screen for moving an activity to another day after clicking on autonomy affordance signifier (3)

5. General discussion and conclusion

The aim of this dissertation is to advance the knowledge and understanding of the digitalization of individuals as employees, customers, and themselves. This comprises the analysis of selected aspects of the design of digital technologies, the behavior of individuals when interacting with or via digital technologies, and the consequences of this interaction. This chapter first summarizes the results and implications of the research articles that are included in this dissertation in section 5.1 and discusses their limitations and opportunities for future research endeavors in section 5.2. It closes with a conclusion in section 5.3.

5.1. Summary of results and implications

The description of the results and implications of the five research articles is structured along the framework presented in the introductory chapter: The focused roles of individuals as employees, customers, and themselves are covered from the three research angles of design, behavior, and consequences. Additionally, overarching meta-inferences are drawn at the end of this section for an integrated view.

5.1.1. Results and implications for digitalized individuals as employees

Papers 1 and 2, which are included in chapter 2 of this dissertation, deal with individuals as *employees*. Paper 1 does so from a *design* and a *behavioral* perspective, establishing which digital workplace technologies (DWTs) constitute today's workplaces and how they are used and perceived by individual employees. Paper 2 builds upon this *behavioral* perspective and additionally considers the negative *consequence* technostress as well as mitigating organizational mechanisms.

The results of paper 1 are threefold; all of them have their own implications. First, it derives a comprehensive, structured overview of 41 DWTs based on sources from literature and practice. This derivation includes validations of both the completeness of the included DWTs and their assignment to eleven categories using card sorting with several IS researchers. As such, it represents an indication for researchers and practitioners as to which DWTs there are in the first place. Puzzlingly, this has not been found in the IS literature so far from an employee-centric and holistic perspective. Second, paper 1 applies the overview of DWTs in a large-scale survey among 2,496 German employees, ascertaining which DWTs are used by individual employees, how frequently they are used, and how intensely they are perceived. This informs both research and practice about the status quo of digitalization in German workplaces

and can be the basis for further comparative analyses between, for example, companies, industries, or federal states. Summarizing these two key results, paper 1 makes a valuable empirical contribution, or in other words, provides a theory for analyzing in the sense that it firstly answers the question of what the technological landscape at German workplaces looks like in a structured way. Following long-standing calls from the IS literature, it thereby prominently considers the IT artifact as a central research subject. As a third key result, paper 1 elaborates on possible applications of the overview of DWTs to gain insights about how – combined with further data such as indicators of employee performance or well-being – it can be the basis for individualized digital work (re)design: optimizing work practices, identifying and fostering positive interrelationships of DWTs and other factors in the workplace environment, and restricting or preventing negative outcomes while considering individual differences among employees. The results thus represent a way for researchers and practitioners to create a profound understanding of the context of individual employees' workplaces as a crucial prerequisite for implementing well-grounded and efficient interventions.

Paper 2 takes the overview of DWTs presented in paper 1 as a starting point and applies it to operationalize its focal independent variable, the degree of workplace digitalization, as the total number of DWTs at an individual employee's workplace. Based on observations from the same large-scale survey among German employees as paper 1 and using structural equation modeling, it finds that higher degrees of workplace digitalization increase overall technostress. However, taking a closer look at the six different technostress creators that constitute technostress in general, it reveals that a higher degree of workplace digitalization is associated with less pronounced techno-complexity and techno-unreliability. A similar picture unfolds regarding the effect of the three technostress inhibitors on technostress as well as their moderating effect on the relationship between the degree of workplace digitalization and technostress. These observations imply that the effects of the three technostress inhibitors are not consistently technostress-diminishing, as might have been expected. In addition to demonstrating an additional valuable application scenario of paper 1, paper 2 sheds light on the specific, varying, and partly counter-intuitive relationships between the degree of workplace digitalization, technostress, and technostress creators, and the three technostress inhibitors. It enriches IS literature by theorizing and analyzing with a joint perspective on all three constructs in combination. Thereby, it focuses on the overarching degree of workplace digitalization instead of single technologies, as predominant in prior literature, and takes a more holistic perspective. The findings are valuable for both researchers and practitioners in understanding the intricate relationships between the degree of workplace digitalization, technostress creators,

and technostress inhibitors in detail, and to design and implement effective technostress interventions. They emphasize the need to individually consider technostress creators and technostress inhibitors and demonstrate that their relationships must be addressed separately to avoid unintended negative consequences.

5.1.2. Results and implications for digitalized individuals as customers

In papers 3 and 4, the focus switches from individuals in their roles as employees to individuals in their roles as *customers* who interact with companies. Paper 3 derives *design* recommendations for data privacy measures to address individual customers' concerns in these interactions and examines how their implementation, as a *consequence*, would be evaluated. Paper 4 deals with the *design* of digital nudging elements (DNEs) to foster ecologically sustainable grocery shopping by individual customers and evaluates their effectiveness by observing customers' *behavior*.

Paper 3 is set against the background of increasingly digitalized and customer data-intensive products and services and correspondingly growing data privacy concerns on the customers' side. As a first key result, it derives a set of 32 data privacy measures structured along seven dimensions of data privacy concerns that can be implemented by companies. These measures are based on legislative requirements to a large extent. However, several measures are also rooted in academic literature, practitioner texts, and expert interviews, and thus, partly go beyond merely fulfilling legal obligations. Paper 3, thus, provides research and practice with a structured overview of measures that can be taken by companies to protect the data privacy of customers in their interactions or while using their products and services. This represents a starting point for the deliberate design and investigation of data privacy concepts and strategies. Furthermore, paper 3 applies the Kano method in two online surveys with a total of 489 participants, one based on a scenario in the aviation sector and one based on a scenario in the online retail sector. Customers are asked to evaluate the impact of the implementation or non-implementation of the 32 measures on their satisfaction. As a second key result, paper 3 finds that the implementation of most measures is seen as a basic prerequisite and that their lack would be penalized by customers with reduced satisfaction. Nevertheless, some measures have the potential to delight customers and increase their satisfaction. Based on the two surveys, paper 3 observes that measures that delight customers are often those that go beyond legal requirements and that several differences in the perception of measures exist depending on the industry considered. Thus, it informs researchers and practitioners that well-handled data privacy has the potential to create a mutually beneficial situation for individual customers

and companies: the mitigation of individual customer data privacy concerns on the one hand and increased customer satisfaction, which in turn is associated with customer loyalty and the market value of companies on the other hand. It informs theory and practice that there is an upside to data privacy that goes beyond its predominant perception by companies as a necessary evil.

Changing the context from data privacy to e-commerce, paper 4 presents findings regarding the challenges of e-commerce in the area of food. First, it analyzes the extant literature on nudging to determine the nudging elements that have the potential to foster ecologically sustainable grocery shopping behavior by individual customers. Second, paper 4 transfers three promising nudging elements – default rules, simplification, and social norms – to a digital choice environment and implements these DNEs in a fictional online grocery store. Third, by asking 291 participants to complete a shopping task in this online grocery store in a field experiment, the impact of the DNEs is analyzed by observing their shopping behavior. A regression analysis shows that controlling for individual food-choice motives and food consumption preferences, default rules are moderately effective in fostering ecologically sustainable choices for the overall sample of customers. Cluster analysis further reveals that simplification is effective among environmentally conscious customers. Paper 4 enriches previous literature that predominantly focuses on physical choice environments by transferring DNEs to an online context and implementing and evaluating them. It adds to previous literature by taking a joint perspective on three DNEs at the same time and comparing their effectiveness. Paper 4 thus contributes valuable insights into how the shopping behavior of customers can be nudged into more environmentally sustainable directions and how the effectiveness of DNEs differs among different DNEs per se and individual characteristics. Apart from mitigating individual challenges such as information overload and decision insecurity as well as possibly supporting healthier food consumption, it demonstrates how digital interventions taken by companies can support a more sustainable future of the planet at the macro level.

5.1.3. Results and implications for digitalized individuals themselves

Paper 5 complements the presented results by concentrating on digitalized individuals *themselves*. Rooted in the field of positive technologies, which aims to improve the flourishing of their users, it covers the *design* of a habit tracking app, the observation of its users' *behavior*, and the analysis of the *consequences* of its use on well-being and performance.

As a first key result, combining several literature strands from IS and psychology, paper 5 builds on Self-determination Theory to design and develop a habit tracking app that provides

its users with opportunities to exercise autonomy (termed "autonomy affordance") while working toward their goals. It demonstrates to researchers and practitioners how features could be designed and implemented into digital technologies that aim to foster the fulfillment of the basic psychological need for autonomy and, ultimately, well-being. Second, the habit tracking app is applied in a field experiment with 54 participants to observe their user behavior for about one month on average. Thereby, the participants are divided into low-autonomy and high-autonomy groups, and the observation of the actualization of autonomy affordance was emphasized. The self-developed app, thus, provides researchers with a useful tool to observe the goal-directed behavior of individuals with the possibility of manipulating autonomy affordance as an independent variable. Third, based on the accumulated data and using path analysis, paper 5 examines the effects of providing autonomy on well-being and performance (i.e., success regarding goal attainment). It finds that the mere provision of autonomy affordance is positively linked to well-being. The actual exercise of autonomy affordance by its users has a positive effect on goal performance, which in turn improves well-being. Paper 5, by enriching previous literature on self-tracking IS, positive technologies, and Affordance Theory – provides research and practice with indications of how autonomy affordance offered by digital self-tracking technologies has the potential to support human flourishing. It shows the applicability of Self-determination Theory in the context of self-tracking IS and adds to the body of design knowledge regarding positive technologies.

5.1.4. Integrated perspective on results and implications

The results presented in the previous sections are summarized in Table 5.1-1 at the end of this section. It compiles the separate results emerging from the five research articles regarding the analysis of the digitalization of individuals as employees, customers, and themselves from the research angles design, behavior, and consequences. Table 5.1-1 further aggregates the findings over the different research angles for a holistic overview of the three focal roles, which are presented in detail in the following paragraphs. Thereby, it becomes apparent that, as intended by the applied framework and described in the introductory chapter, the different research angles inform and build on each other to form a comprehensive view on the digitalization of individuals.

Taking an aggregated view of the results and implications of papers 1 and 2, three contributions to the successful navigation of the digitalization of individuals as employees emerge. First, the overview of DWTs and its application to collect empirical observations provide a basic understanding of how the digitalization of individual employees manifests itself in the

use of DWTs, and a broad spectrum exists regarding how pronounced this degree of workplace digitalization appears depending on the individual employee. Second, the digitalization of workplaces is identified as a driver of the adverse consequence technostress among individual employees. Thereby, the pitfall of looking at technostress on a general level should be avoided, and one should differentiate among the separate technostress creators. As the interrelationships of the different technostress creators with the degree of workplace digitalization and technostress inhibitors vary and are partly counter-intuitive, each dynamic needs to be considered separately. Third, based on the given comprehensive sample, the effectiveness of technostress inhibitors as organizational measures to protect employees is analyzed in detail. The differentiated analyses and findings support the derivation of approaches that exploit the benefits of the digitalization of individuals as employees while simultaneously targeting the restriction of technostress in a deliberate fashion.

Consolidating the implications of papers 3 and 4, a deepened understanding of the double-edged sword of the digitalization of individuals as customers and how it can be successfully navigated emerges. On the one hand, the digitalization of customers seems to cause conflicts of interest. To provide personalized experiences and maximize profits, companies might strive to collect as much customer data as possible. By contrast, customers are increasingly fearful of their data privacy. To improve profits, online grocery stores might be interested in maximizing e-commerce sales and offering a broad range of products. As a consequence, customers might be overwhelmed by the provided options and their aspirations to make appropriate choices. Furthermore, imprudent consumption challenges our basis of existence. On the other hand, papers 3 and 4 imply that the digitalization of customers need not necessarily have antagonistic objectives. They demonstrate how companies can assume their legal (in case of most data privacy measures) or moral (in case of some data privacy measures that go beyond legal requirements as well as nudging ecologically sustainable food choices) responsibilities in mutually beneficial ways. Well-designed data privacy may increase customer satisfaction. As this has been found to drive loyalty and ultimately increase the value of companies, well-executed data privacy can be expected to not only be beneficial for customers but also for companies. DNEs implemented in grocery stores might alleviate individual customers' difficulties in making ecologically sustainable choices. This leads to a possible triple-win situation for customers who shop more efficiently and possibly enjoy health benefits, companies who profit from generally higher prices of ecologically sustainable products and greener images, and the environment that in turn sustains digitalized individuals in all their roles.

Paper 5 contrasts the negative consequences of digitalization of individuals with a promising beneficial application of digital self-tracking technologies. Employees might be in peril of technostress; customers might experience data privacy concerns and challenges in decision making; and individuals themselves might have to consider the possible negative effects of excessive self-quantification. Nevertheless, digital technologies have the potential to foster the flourishing of individuals with regard to both performance and well-being. Beyond the context of individuals themselves, complementing digital technologies at work with features that provide autonomy affordance could, for example, be utilized to battle negative consequences such as technostress.

Combining the three research angles, design, behavior, and consequences, as well as the three roles of individuals as employees, customers, and themselves, three overarching implications emerge regarding the digitalization of individuals. (A) The included research articles show that to truly understand and foster successful digitalization of individuals, research should be executed at a rather individual and detailed level. This applies to considering both individuals based on various characteristics (e.g., individual workplace configurations or food consumption preferences) as well as zooming in on focal constructs (e.g., separate technostress creators instead of overall technostress, individual consideration of measures instead of data privacy policies as a whole). There is no standard solution that fits all individuals, and differentiation is key. (B) As the different research angles inform and build on each other, research should be conducted on the three different roles. As mentioned earlier, findings regarding the design of positive technologies (e.g., provision of autonomy affordance to foster well-being) for individuals themselves could be applied to mitigate technostress or other detrimental influences on employees at the workplace. In addition, technostress might also occur among individuals themselves, and findings that were originally derived from workplace environments might contribute to ameliorating the situation. The same bidirectional relationship applies to individuals as customers (e.g., data privacy is also relevant at the workplace, and companies might build on research about improving the well-being of individuals themselves when developing their products and services). (C) On a rather practical note, the most promising solutions for successful navigation of the digitalization of individuals are likely the ones that equitably benefit the involved parties. Individuals themselves might be the most devoted users of digital technologies when they improve their flourishing. Customers might reward companies' outstanding data privacy policies with loyalty and growing sales. And besides being more content at their workplaces, individual employees who experience less technostress due to employers' implementation of mitigating mechanisms are also likely to be more productive.

		Research angles			
		Design	Behavior	Consequences	Overall findings
Roles of digitalized individuals	Employees (*papers 1 and 2*)	▪ Comprehensive, structured overview of 41 DWTs in 11 categories that constitute individual employees' workplaces (paper 1)	▪ Observation of the user behavior and perception of the 41 DWTs in a large-scale survey among German employees (paper 1 and paper 2) ▪ Operationalization of the degree of workplace digitalization based on this observation (paper 2)	▪ Establishment of four positive and two negative relationships between the degree of workplace digitalization and the six technostress creators (paper 2) ▪ Finding that the three technostress inhibitors have varying, not consistently technostress-diminishing effects on these relationships (paper 2)	▪ Understanding of how the digitalization of individual employees' workplaces is manifested in DWTs ▪ Identification of the effects of DWT user behavior on the negative consequence technostress ▪ Insights on how technostress inhibitors might mitigate this occurrence of the adverse consequence technostress
	Customers (*papers 3 and 4*)	▪ Comprehensive catalog of 32 possible data privacy measures that can be implemented by companies, structured along seven dimensions of data privacy concerns by customers (paper 3) ▪ Exemplary implementation of the three DNEs default rules, simplification, and social norms in an online grocery store (paper 4)	▪ Observation of a moderate positive effect of default rules on ecologically sustainable shopping behavior for the overall sample of participants (paper 4) ▪ Observation of a positive effect of simplification among environmentally-conscious customers (paper 4)	▪ Evaluation of the impact of the implementation of the 32 data privacy measures on customer satisfaction in two exemplary scenarios (paper 3) ▪ Realization that an upside of data privacy exists for companies and that a win-win solution for individual customers and companies is conceivable (paper 3)	▪ Understanding of how the apparently conflicting objectives of customers and companies regarding data privacy and ecologically sustainable shopping might be reconciled in a mutually beneficial way ▪ Indications of how companies can assume their legal and moral responsibilities and concretely implement these mutually beneficial situations
	Themselves (*paper 5*)	▪ Design and development of a habit tracking application that includes autonomy affordance features intending to foster the well-being of its users while working towards their goals (paper 5)	▪ Application of the habit tracking app to observe the goal-directed behavior and actualization of autonomy affordance in a field study (paper 5)	▪ Finding that the mere provision of autonomy affordance has a positive effect on well-being (paper 5) ▪ Observation that the actualization of autonomy affordance leads to improved performance which in turn has a positive effect on well-being (paper 5)	▪ Indication how autonomy-supportive features in digital technologies might be designed ▪ Provision of a measurement tool to observe goal-directed user behavior ▪ Implication that self-tracking IS can foster the well-being of its users

Table 5.1-1: Summary of the findings of the included research articles

5.2. Future research

Based on the presented findings and implications of the articles included in this dissertation, several novel questions emerge that are promising avenues for further research. Furthermore, the advancement of the presented results should consider the limitations of the present work. This chapter will elaborate on opportunities for further research and address limitations regarding the digitalization of individuals as employees (section 5.2.1), customers (section 5.2.2), and themselves (section 5.2.3).

5.2.1. Future research on digitalized individuals as employees

Similar to any research article, papers 1 and 2 have some limitations that should be considered and addressed in further research. First, although the overview of DWTs represents a valuable, structured, and comprehensive compilation of DWTs that is informative regarding the status quo of workplace digitalization, it may be just a reflection of current times and must be understood as adjustable, not static. Consequently, researchers should critically reexamine the timeliness of the overview of DWTs and adapt it accordingly before applying it or before further examining the interrelationships between the degree of workplace digitalization, technostress, and technostress inhibitors. Second, the same applies to the data that represent the basis of paper 1 and paper 2 in general. It constitutes a one-time observation of a large sample of German employees. Further research might consider the analysis of longitudinal data to study the examined relationships over time, preferably among other or additional populations, to improve generalizability. Third, numerous promising applications are conceivable when combining the overview of DWTs with further data. One was demonstrated in paper 1. Another one constitutes the use of the overview presented in paper 2. Others might be the combination of DWT use data with data regarding employee performance and well-being and the derivation, implementation, and analysis of measures to foster performance and well-being. This would enable employees to successfully navigate the digitalization of their workplaces and avoid pitfalls such as technostress. Finally, paper 2 demonstrated that the effects of the degree of workplace digitalization on technostress creators and the effects of technostress inhibitors vary. Further research should strive to ascertain why these variations occur and what their implications are for mitigating technostress among individual employees.

5.2.2. Future research on digitalized individuals as customers

Based on the results of paper 3, which deals with the identification of data privacy measures and how they might be evaluated by individual customers, several further questions might

inspire research and at the same time address the limitations of the paper. First, the derivation of data privacy measures focused on European legislation, and the survey participants were recruited in the German-speaking area. Studies in other legislative and geographical contexts might reveal similarities and differences, as well as implications for the generalizability of the results. Second, the evaluation of data privacy measures was based on fictional scenarios, as were the customers' statements. Against the background of the privacy paradox, wherein customers often state intentions that are subsequently not reflected in their actions, additional observation and analysis of real-world behavior would be promising. Lastly, the analysis of the customers' evaluation of the data privacy measures showed that individual differences exist in their potential impact on customer satisfaction. Further research should examine why these discrepancies occur, and to which individual characteristics they are attributable. Through advanced customer segmentation, data privacy concepts can be developed that consider individual customer needs, thus reinforcing possible mutually beneficial settings between companies and their customers.

The specified limitations and proposed ways of addressing them can also be applied to paper 4. Research would benefit from rerunning the field experiment and analyses with a broader and more diverse set of participants. Apart from fictional shopping tasks, DNEs can be implemented in real-world online settings, and customer behavior can be observed in more natural contexts. Further research might determine how individual differences in the effectiveness of DNEs can be explained and leveraged. Implementing and analyzing more DNEs as well as different manifestations of the DNEs could further advance the knowledge of which tools exist to promote ecologically sustainable shopping behavior and how they are best applied.

5.2.3. Future research on digitalized individuals themselves

Paper 5 parallels the other included research articles regarding the limitations and their remedies. Repeating the field experiment with a larger and more diverse sample with an improved measurement instrument would improve the assessment and generalizability of the paper's findings and implications. Additionally, although the field experiment allowed the collection of objective observational data to a large extent, several measures, such as the query of well-being, were based on self-reports. Relying further on objective measures, such as biometric data, would strengthen the research approach. Apart from addressing these limitations, two promising avenues for further research can be identified. On the one hand, further examining the design of autonomy-supportive features or features that fulfill the basic psychological needs of relatedness and competence would provide research and practice with additional

tools to foster human flourishing. On the other hand, applying these findings in other contexts regarding individuals themselves or individuals as customers and employees would support the dissemination of positive technologies to a broad spectrum of application scenarios and help leverage the benefits of the digitalization of individuals.

5.3. Conclusion

The aim of this dissertation is the advancement of knowledge and understanding regarding the successful navigation of the digitalization of individuals as employees, customers, and themselves. The five included research articles contribute insights regarding the status quo of digitalized workplaces, digitalization of employees as a driver of technostress, and mitigating mechanisms. They provide indications on how to ensure the data privacy of customers, how to improve their shopping behavior, and how mutually beneficial solutions could be designed for both customers and companies. They demonstrate how digital technologies could be applied to foster human flourishing. Overall, this dissertation informs research and practice about the pitfalls of the digitalization of individuals, how they might be avoided or alleviated, and how its benefits can be exploited.