Cognitive Processes While Using Technology

On Shaping the Next Level of Technology-mediated Work

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List of Abbreviations and Acronyms

Adaptive Control of Thought Theory	ACT
American Conference on Information Systems	AMCIS
Analysis of Covariance	ANCOVA
Analysis of Variance	ANOVA
Association for Information Systems	AIS
Artificial Intelligence	AI
Attention Deficit Hyperactivity Disorder	ADHD
Attention Restoration Theory	ART
Attention-Related Cognitive Errors Scale	ARCES
Average Variance Extacted	AVE
Bad Berleburg, Germany	BLB
Behavioral Control	BC
Bring-your-own-device	BYOD
Bundesministerium des Inneren, für Bau und Heimat	BMI
Cognitive Network Model	CNM
Comparative Fit Index	CFI
Complex Working Memory Task	CWM
Concept-knowledge Theory	C-K Theory
Confirmatory Factor Analysis	CFA
Control	CO
Control-reactance Compliance Model	CRCM
Creative Support Systems	CSS
Cronbach's Alpha	α
Curiosity	CU
Data Resource Management	DRM
Daydreaming Frequency Scale	DDFS
Decisional Control	DC
Decision-Support	DS

Decision-support System(s)	DSS
Decomposed Theory of Planned Behavior	DTPB
Default Mode Network	DMN
Dependent Variable	DV
Design Science Research	DSR
Design-Thinking	DT
Diffusion of Innovation Theory	DOI
Digital Innovation	DI
Electrocardiogram	ECG
Electroencephalography	EEG
Enjoyment	ENJ
Enjoyment of Technology	EOT/EOD
European Conference on Information Systems	ECIS
European Journal of Information Systems	EJIS
European Union	EU
Event-related Potential	ERP
Exploratory Factor Analysis	EFA
Extended Unified Theory of Acceptance and Use of Technology	UTAUT2
Eye Tracking	ET
Focused Immersion	FI
Framework for Immersive Virtual Environments	FIVE
functional Magnetic Resonance Imaging	fMRI
German Federal Ministry of Education and Research	BMBF
Governance Laboratory	GovLab
Government Information Quarterly	GIQ
Hasso-Plattner-Institut	HPI
Hawaii International Conference on System Sciences	HICSS
Head-mounted Displays	HMDs
Hedonic-Motivation System Adoption Model	HMSAM
Human-computer Interaction	HCI

Hypothesis	H
Information Systems	IS
Information Systems Journal	ISJ
Information Systems Research	ISR
Informations- und Kommunikationstechnologien	IKT
Instructed Mind Wandering	IMW
International Conference on Information Systems	ICIS
International Conference on e-Business	ICE-B
International Conference on Informatics and Computing	ICIC
International Conference on Information and Communication Technology, Society and Human Beings	ICT
International Conferences Theory and Practice in Modern Computing and Internet Applications and Research	IADIS
International Institute for Communication and Development	IICD
International Journal of Electronic Commerce	IJEC
International Journal of E-Planning Research	IJEPR
International Journal of Scientific and Research Publications	IJSRP
Job Characteristics Model	JCM
Journal of Information Technology	JIT
Journal of Information Technology Theory and Application	JITTA
Journal of Management Information Systems	JMIS
Journal of Strategic Information Systems	JSIS
Journal of the Association for Information Systems	JAIS
Kaiser–Meyer–Olkin Test	KMO
Knowing-in-Action	KiA
Kompetenzoffensive Bad Berleburg Digital	KOBoLD
Long Term Memory	LTM
Magnetoencephalography	MEG
Maximum Likelihood	ML
Mean	M

Measurement Scales for Mind Wandering	WAND
Memory Failure Scale	MFS
Mind Wandering Trait: Deliberate	MWT-D
Mind Wandering Trait: Spontaneous	MWT-S
Mind-excessively-wandering Scale	MEWS
Mindful Attention Awareness Scale	MAAS
Mind-Wandering Questionnaire	MWQ
Management Information Systems Quarterly	MISQ
Motivational Model	MM
Multimotive Information Systems Continuance Model	MISC
Multivariate Analysis of Covariance	MANCOVA
Multivariate Analysis of Variance	MANOVA
National E-Government Competence Center	NEGZ
Neuro-information-systems	NeuroIS
Open Government Data	OGD
Open Online Courses	OOC
Pacific Asia Conference on Information Systems	PACIS
Perceived Ease of Use	PEOU
Perceived Usefulness	PU
Personal Computer	PC
Positive and Negative Affect Schedule	PANAS
Positron Emission Tomography	PET
Projekt: Experimentierräume in der agilen Verwaltung	AgilKom
Reflection-in-Action	RiA
Reflection-on-Action	RoA
Research Question	RQ
Root Mean Square Error of Approximation	RMSEA
Satisfaction with Technology	SWT
Satorra–Bentler Scaled Test Statistic	MLM
Search of Associative Memory Theory	SAM

Self-determination Theory	SDT
Skin Conductance Response	SCR
Social Cognitive Theory	SCT
Spontaneous Activity Questionnaire	SAQ
Standard Deviation	SD
Standardized Root Mean Square Residual	SRMR
Status Quo Bias	SQB
Status Quo Bias Perspective	SQBP
Stress Reduction Theory	SRT
Sustained Attention Response Task	SART
Task Performance	PERF
Technology Acceptance Model	TAM
Temporal Disassociation	TD
Theory of Inventive Problem Solving	TRIZ
Theory of Planned Behavior	TPB
Theory of Reasoned Action	TRA
Tucker–Lewis Index	TLI
Tukey's Honestly Significant Difference	HSD
Unified Theory of Acceptance and Use of Technology	UTAUT
Unusual Uses Task	UUT
Users' Task Performance	PERF
Variance Inflation Factor	VIF
Virtual Reality	VR
Working Memory	WM
Working Memory Capacity	WMC

Foreword

In a world where many of us work from home watching a screen, often for long hours in an environment rife with distractions, it is easy to imagine how cognitive processes impact our information technology behaviour. For example, one can imagine the negative impact of mind wandering while sitting through a meeting which lasts for hours, while paradoxically relating to the benefits of mind wandering while listening to an enjoyable podcast. Yet, information systems researchers know relatively little about the impact of cognitive processes. These processes have not been a primary interest of the discipline.

Frederike Oschinsky makes a persuasive case for why cognitive processes matter. In this dissertation, she draws from twenty-six research publications related to the topics of human-computer interaction, decision support systems, and digital innovation to advance three key findings. First, she shows that an individual's cognitive state can impact the effectiveness of an information system, especially if the goal of the information system are creative work outcomes. Second, she finds that cognitive biases can inhibit digital transformation, but can also be managed with effectively designed decision support systems. Third, she shows how technological artifacts can be designed to facilitate creative processes, and consequently more productive collaborations. These findings are supported with evidence uncovered using an impressive assortment of methods including literature reviews, case studies, qualitative interviews, questionnaire surveys, and behavioural experiments. The studies also concern a considerable breadth of phenomena including mind wandering, biases in decision making, and effective team collaborations.

What is most impressive about this work is that Frederike Oschinsky lays a clear foundation for something more. She outlines "a vivid future of technology use embracing human factors in all industries that are more fast paced and complex and even more challenging." As a colleague that has played a part in her journey, and as someone living in a time of profound sociotechnical change, I have no doubt that this work is just the beginning of a much larger endeavour to look beyond the screen and to the dimensions of the human mind. This work is essential reading for any information systems or cyberpsychology researcher who wants to know how a better understanding of cognitive processes can improve the information systems that are essential to the contemporary workplace.

Colin Conrad, PhD, Assistant Professor, Dalhousie University, Canada

Part A

OVERVIEW

1. Introduction

The doctoral thesis "Cognitive Processes While Using Technology" deals with the interlinking of information systems (IS) research, social science, and psychology to gain a deeper understanding of technology-related behavior in the digital age. It explores the relationship between the users' cognitive processes and their technology usage behavior. Technological artifacts can influence human attention and decision-making (Hevner et al., 2004). They consequently affect productivity, innovation, well-being, and business growth. This work shows how cognition through thought, experience, and the senses impact core variables in the IS discipline.

The study of designing systems to best serve their users is critical, because it is a necessary step to make technology enjoyable, helpful, safe, and functional. To create tools that are intuitive and accessible by people with a wide variety background, became even more crucial during a global pandemic when working from home. This implies not only software (e.g., videoconferencing or project management on Microsoft Teams, SharePoint, or Slack), but also backbone technology (e.g., virtual private network use, data recovery, or malware protection). As such investigating the use of technological artifacts for the acquisition, organization, and use of knowledge is relevant for industry and business as well as for our everyday life.

One of the most enduring questions at the intersection of human behavior and system use and design is how to measure the cognitive processes while using technology. Literature on this puzzle falls into two streams. One stream employs neuroscientific measures on the individual level to inform IS design, IS use, emotion research, and neuro-adaptive systems (vom Brocke et al., 2020). The alternative stream focusses on the organizational level and applies more perceptual measures. My research integrates both perspectives, as I collect self-reports along with behavioral and neurophysiological data to contribute to both behavioral and design-oriented approaches relevant to IS research.

My research is divided into three areas: The first focuses on human-computer interaction (HCI). People interact with technology in manifold ways. I use the examples of daydreams and interruptions to illuminate cognitive challenges while using technology. This reveals the value of studying outcomes beyond task performance. The second area deals with users' cognitive biases and the bounded rationality paradigm. It links these perspectives to established approaches on technology acceptance. My papers synthesize interdisciplinary literature and derive recommendations for action. They detect a huge potential of distributed cognition and technology-mediated knowledge transfer in multilevel organizations. The third area presents how technology can support creativity. My investigations offer design implications for collective innovation and digital service co-design. They discuss numerous options for future research in multistakeholder settings. The papers were accepted by peer-reviewed journals and major IS conferences.

In summary, this work leads through the past and future potentials of conducting cognitive research in the study and profession of IS. It illustrates the general importance of studying cognitive processes in the development, design, and use of technology. On the one hand, its theoretical extensiveness results in a considerable understanding of socio-technical phenomena where systems produce, procure, distribute, and process information. On the other hand, its empirical investigations help derive design implication for technological artifacts that take human factors into account. Its methodological approaches are carefully tailored to the underlying research questions. Within the scope of this doctoral thesis, theoretical approaches are presented and integrated, empirically examined, and then supplemented with own theoretical and empirical contributions. This is significant as the acknowledgement of cognitive processes while using technology offers sound evidence for the rigor and relevance of IS as an applied discipline – and for its continuing evolution.

2. Research Background

The following section presents three major research areas in which cognitive processes are of central importance for IS research: (1) HCI, (2) decision support, and (3) digital innovation. Conducting studies in all these areas was heavily influenced by changes in technology, research method, and context. Nevertheless, by systematically integrating quantitative and qualitative data and by looking at various cognitive processes in concert, this work elucidates the interplay between cognition and technology use. It provides a deep understanding of human behavior in the digital age. My interest was the advancement of the IS discipline by clearly explaining technology-related phenomena. For this, I opened the black box of human perception and thought.

First, I present pioneering models as well as a framework for exploring cognitive processes while using technology. Second, I illustrate the three research areas which structure my articles. Third, I show the research design and methods. Finally, I synthesize the major findings, summarize open research questions, and reflect on the enduring contribution of studying cognitive processes for IS research.

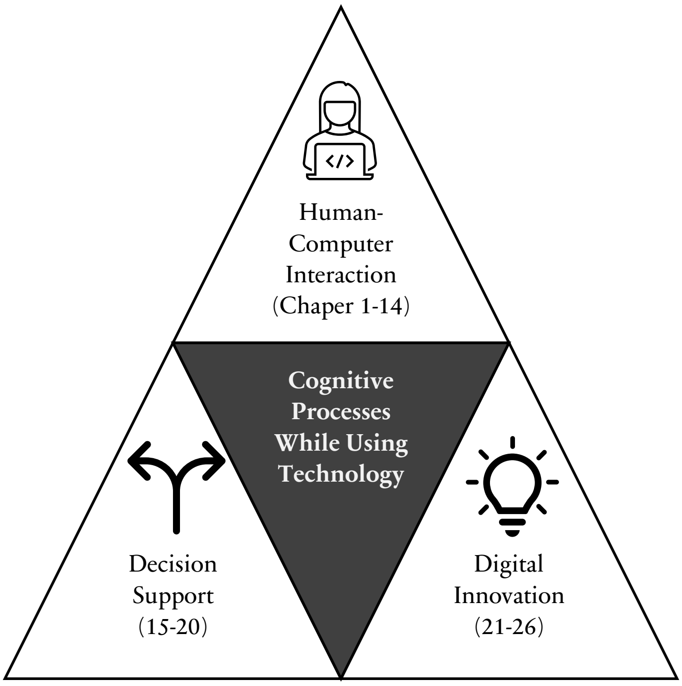

Figure 1.1: Main Areas of Interest in the Doctoral Thesis

2.1 On Cognitive Processes While Using Technology

Cognitive psychology describes cognition as "the activity of knowing: the acquisition, organization and use of knowledge" (Neisser, 1976, p. 1). The term was coined in the 1970s. Notably, IS research being the prominent field of studying technology for the acquisition, organization, and application of knowledge (Davern et al., 2012). From the beginning, cognitive processes have, thus, been of great relevance to the IS discipline (ibid.). Today, it is widely accepted that technological artifacts can influence human perception and thought (Hevner et al., 2004).

I developed my analysis by drawing on Davern et al.'s (2012) pertinent work on cognitive IS research and Card et al.'s (1983) expedient model of human information processing. The authors consider technological artifacts as "representations" of reality (see Wand & Weber, 1990; Weber, 2003). In cognitive science, this is the paramount way of explaining and describing the nature of ideas and concepts on the micro-level. They may be twofold: External representations present information to a technology user, whereas internal representations are mental actions of the user. When forming representations while using technology, the user's cognitive system connects sensory input from the environment (e.g., hearing a ringtone), to an automatic internal state (e.g., anticipation of conversation), and to an appropriate output of the motor system (e.g., answer a call)

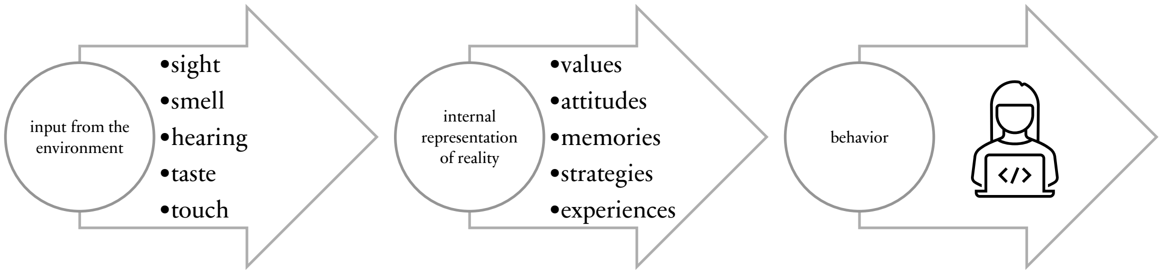

Figure 1.2: Internal and External Representations According to Representation Theory

In addition to the perspective on the representations of each individual user, I later followed Hutchins (1990, 1991, 1995) and Hollan et al. (2000) as presented in Davern et al. (2012). They have developed the concept of distributed cognition, which means to collectively share cognitive resources to extend individual abilities. This process can involve other people or objects in the environment (Gureckis & Goldstone, 2006).

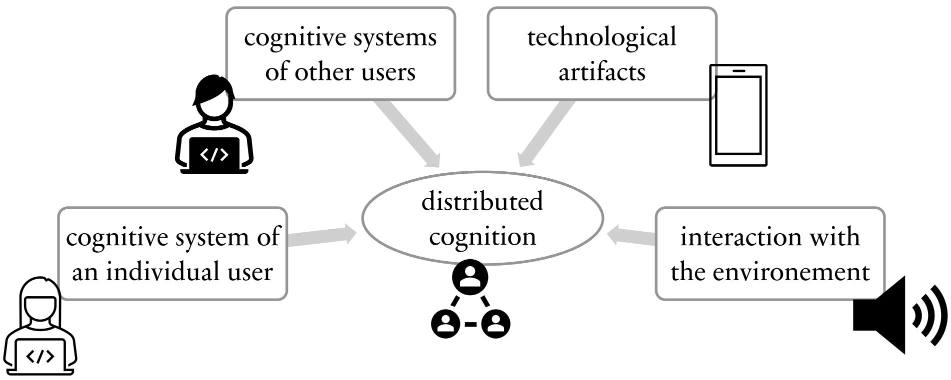

Figure 1.3: Distributed Cognition While Using Technology

Cognition can be distributed between an individual and a system or multiple individuals and diverse systems. Many tasks inherit a collaborative nature in today's world of volatility, uncertainty, complexity, and ambiguity (VUCA world). Distributed cognition may involve communication, knowledge transfer, or even shared representations across individuals and systems. While these activities are relevant for many research fields, this work focusses on IS phenomena.

Guided by the concepts of representations and distributed cognition as well as inspired by the work of Davern at al. (2012), I framed my doctoral thesis into three main research areas: dealing with representations on an individual level (i.e., HCI), reasoning with representations in an interplay with technology (i.e., decision support), and developing representations in multistakeholder settings (e.g., digital innovation).

2.2 Human-Computer Interaction

Scope

HCI focuses on the design of technology and the interaction between users and computers (Davern et al. 2012). While initially concerned with only computers, the field now covers diverse forms of information technology (IT) such as smartphone application usage, software development, or online streaming. By doing that, it touches multiple disciplines such as IS, computer science, human factors engineering, and psychology. One of the field's main interests lies in processes and outcomes of users interacting with technology to accomplish tasks. Therefore, it speaks for itself that cognitive science has played a paramount role in understanding, modeling, and designing the interactions. The human factors of interest are physical, cognitive, and affective. In my work, I focused on cognitive aspects. Moreover, I concentrated on tasks that provide a flow of information (e.g., games and messages) from the user to the technology and back, as mental representations are involved.

The Role of Cognition and Performance

In the 1970s, early HCI research has studied displays, in print and on screen, to understand their impact on performance. As systems became more interactive, it has switched to online tasks and screen design, and an investigation of user interaction (Todd & Benbasat, 1987). It informed designers to identify difficulties in performing tasks and to minimize them. The early work inspired me to study how cognitive resources are used while using technology and how IT interfaces impact cognition and performance (Chapter 7 and 8). My assumption was that a particular system design (e.g., hedonic or utilitarian) led to better or worse task performance. In the initial papers, performance has been set as accomplishing specified task requirements and operationalized by accuracy and efficiency. However, I soon realized that for most knowledge workers, performance implies more than fast and correct processing. The abilities to learn, to solve complex problems, and to be creative are among the most important future skills. Although my work did not go far enough to consider the customization of system designs to specific tasks or task performance (implied by the cognitive fit theory developed by Vessey & Galletta, 1991), it well accounted for the increasing personalization and individualization of technology and the users' autonomy to choose what technology to use (Chapter 17 and 18).

As previous work has shown in a comprehensive way, users increasingly expect individual IS in business (Klesel, 2019), leisure (Kordyaka, 2020), education (Freude, 2019; Lemmer, 2021), and health (Müller, 2021) to fulfill their tasks. Personalizing technological artifacts significantly impacts cognition and, thus, task performance. The question arises whether a user can decide for herself or himself, which technology she or he wants to use for a task (e.g., Chapter 17 and 18). Next, technology-related tasks at work often expanded, became more complex, and rely on teamwork. Thus, I present studies considering more dynamic tasks (e.g., digital innovation and creativity, see Chapter 14, 30 and 31), and tasks in vivid networks (e.g., co-designing smart city environments, see Chapter 28 and 29).

Designing Information Systems Beyond the Individual

As communication and co-working became more relevant in times of the global pandemic, HCI scholars increased the effort to understand cognition when working on collaborative computer-mediated tasks in remote locations (adding to media richness theory and social presence theory; Chapter 19 and 20). Corona clearly is a remote work catalyst: In Germany, the proportion of employees working exclusively from home has significantly increased in 2020 (33 percent) compared to before the outbreak of the pandemic (4 percent) (Hans Böckler Stiftung 2021). Many are still being encouraged to avoid face-to-face work.

On the one hand, environmental input may differ between working from home or in the office. The employees experience changed sensory inputs (e.g., interfaces, views, noise) and room settings (see Chapter 31 and 16). Moreover, there may be different social interactions,

with either colleagues, pets, or family. For instance, my work observed that in times of frequent video conferences and collaborative IS, scholars need to be increasingly aware of not only what is happening on screens but in the surrounding. For instance, our studies revealed that creativity is influenced by teammates and the workplace design.
On the other hand, technological advances require new cognitive skills. Particularly noteworthy is the huge and still increasing amount of information we need to deal with at work, which makes it challenging to decide where we direct our attention to (see Chapter 9). In addition, the number of interruptions increases almost exponentially, which results in a real battle for our attention, and devours our cognitive resources (see Chapter 14, 15 and 16). The average employee gets interrupted every eight minutes or roughly 50-60 times a day. My interest in what the employees experience during these interruptions (e.g., whether their attention becomes externally-focused or internally-focused) led to my studies on daydreaming. On top of this, interactivity in cross-functional and diverse organizations, international teams, and knowledge-intensive networks increases the need to go beyond considering only individual users, but to understand multistakeholder settings.

The Role of Attention and Mind Wandering

In the work on mind wandering while using technology (Chapter 7-15), my co-authors and I have drawan on knowledge from psychology, neuroscience, and the social sciences. To derive the conceptual definition of the IT mind as a new form of on- and off-task thought in technology-related environments, we have also built on established concepts in IS research, namely IT mindfulness (e.g., Sun et al., 2016; Jensen et al., 2017; Thatcher et al., 2018), IT mindlessness (e.g., Kim & Sundar, 2012; Dernbecher & Beck, 2017) and IT mind wandering (e.g., Wati et al., 2014; Sullivan et al., 2015; Oschinsky et al., 2018). We have examined how these concepts have been investigated and which research questions arise.

Mindfulness

The notion of mindfulness has received extensive research attention, resulting in a variation of its conceptual meaning (e.g., Dernbecher & Beck, 2017; Thatcher et al., 2018). Mindfulness, originating in psychology, focuses on how we are sensitive to the context, actively engaged in the present, and notice new things (Langer, 2000). It is defined as a flexible state of mind and represents an individual being alert, dynamic, and fully aware

(Langer, 1989a, 1989b). Mindfulness "leads to greater sensitivity to context and perspective, and ultimately to greater control (…)" and positive results (Langer, 2000, p. 220). Studies have revealed that the benefits of mindfulness are vast and profound since it can increase competence, memory, creativity, health and longevity, as well as decrease accidents, errors, and stress (Langer & Moldoveanu, 2000; Brown & Ryan, 2003; Garland et al., 2011; Hülsheger et al., 2013; Michel et al., 2014; Zivnuska et al., 2016). Mindfulness consists of five psychological states: (1) focus on the present; (2) alertness to difference; (3) sensitivity to context; (4) awareness of multiple perspectives; and (5) openness to novelty (Langer, 1998). Consequently, a mindful person attentively responds to environmental stimuli, challenges existing knowledge, and constantly creates new categories and interpretations. This is seen as the prerequisite for making better and more sustainable decisions.

Mindlessness

Much less studied, though clearly important, is the less flexible state of mindlessness, which has been introduced into psychological research as an antonym of mindfulness. According Dernbecher and Beck (2017; see Langer, 1989a), it is defined as a state of reduced attention in which we are trapped in old categories and distinctions drawn in the past. Mindlessness implies adhering to a single perspective and being oblivious to alternative ways of thinking (ibid.). It is characterized by reduced attention, blind faith in existing routines and old categories, and an overreliance on distinctions drawn in the past. Mindless individuals appear to be rigid, rule-governed, and context-insensitive (ibid.).

I followed the interpretation of Dernbecker and Beck (2017), who have built on Kaganer and Vaast (2010), to classify mindlessness on a spectrum from more to less mindful behavior. Being mindless (i.e., the negative end of this spectrum) is regarded as the opposite of being very mindful (Fiol & O'Connor, 2003). Against this background, there are two ways in which mindlessness manifests itself: repetition and single exposure (Langer, 2000). The first way is well-known and implies that if we repeat something enough times, we acquire skills needed to achieve our goal. As soon as we believe to know something well, we tend to act mindlessly. The second way in which mindlessness manifests itself happens when presented with new information. If we process it without considering the alternatives, we are governed by routines and behave mindlessly. The way we act is dictated by how our behavior made sense in the past rather than in the present.

Thus, we blindly rely on rules, routines, and habits. This eventually results in a weaker performance.

Mind Wandering

By looking closely at the current state of research, I have contemplated that mindlessness is not the only construct that is said to be the opposite of mindfulness. It has previously been suggested that mindfulness and mind wandering form opposing constructs (e.g., Mrazek et al., 2012). Mind wandering is considered “a shift of executive control, away from a primary task to the processing of personal goals” (Smallwood & Schooler, 2006, p. 946). Strikingly, research suggests that we let our mind wander up to half of our waking time (Mooneyham & Schooler, 2013; Smallwood et al., 2007). As a dynamic state of task-unrelated, spontaneous, and unguided thought, mind wandering is related to the inner state of an individual no longer focusing on the current task (Choi et al., 2017; Andrews-Hanna et al., 2014; Fox & Christoff, 2018; Seli et al., 2018; Christoff et al., 2011). Rather than on current task-related content, thoughts focus on self-generated and present-unrelated topics (Smallwood & Schooler, 2015). They loosely wander from topic to topic and are off the task.

Mind wandering is often discussed to be a possible cause for attention failures (Engert et al., 2014; Seli et al., 2018; Zhang & Kumada, 2017). Empirical studies show that mind wandering has a negative influence on many daily activities. For example, while driving a car, it increases the response time and velocity (Yanko & Spalek, 2014; Zhang & Kumada, 2017). When working on the computer, mind wandering can lead to incorrectly reading business correspondence (Feng et al., 2013; Mooneyham & Schooler, 2013; Unsworth & McMillan, 2013) or to a high volatility to errors when calculating.

However, due to the omnipresence of mind wandering in our daily life, I took a closer look and quickly discovered the positive side of it. Remarkably, less cognitive control is also considered to be a reason why mind wandering can improve problem-solving, innovativeness, and future-oriented thinking (Mooneyham & Schooler, 2013; Smallwood & Schooler, 2015; Christoff et al., 2011, 2016). Thought is orientated toward the future (Stawarczyk et al., 2011) and improves working memory (Mooneyham & Schooler, 2013). With few exceptions, creative ideas (Baird et al., 2012) are an undisputed necessity for knowledge workers, resulting in system designs to enhance fun and immersion (Agarwal & Karahanna, 2000), but not yet mind-wandering episodes.

Mind wandering can be measured either as a state or as a trait with two subtypes (deliberate and spontaneous). Whereas the state captures a momentary mental action or a sequence of mental actions that arise relatively free while using technology in a given moment, the trait captures, either intentional or unintentional, the tendency for having internally focused thoughts in everyday life (see Chapter 9). Table 1 provides an overview of the definitions of the key concepts.

Concept	**Definition**	**Example**
Mindfulness	Mindfulness is a flexible state of mind in which we are actively engaged in the present, notice new things and are sensitive to the context (Langer, 2000).	Mindfulness can help users overcome inappropriate or addictive IT use, by helping individuals "unplug" from their use of social networking sites. (adapted from Thatcher et al., 2018)
Mindlessness	Mindlessness means to be trapped in old categories and distinctions drawn in the past (Langer, 1989a). It is a state of reduced attention (ibid.).	Relying on existing routines and operating "on automatic pilot" can result in diminished performance and a reduced ability to navigate technology. (adapted from Langer, 1998)
Mind Wandering	Mind wandering is "a shift of executive control away from a primary task to the processing of personal goals" (Smallwood and Schooler, 2006, p. 946).	Attention may be directed off-task not only by external stimuli, but also by internally-generated thought such as mind-wandering. This can affect task performance, depending on the task complexity. (adapted from Wati et al., 2014)

Table 1.Definition of Relevant Mind-related Concepts

It has been shown that it is not possible to always focus on environmental stimuli (i.e., being constantly mindful), because cognitive resources are limited and quickly exhausted (e.g., Kahneman, 1973, 2011). Looking only at focused technology use thus insufficiently explains a large part of our everyday life thinking habit (Smallwood et al., 2008; Smallwood & Schooler, 2015). My work considered that people often do not attentively or sensitively use technology, and deduced two other states of mind, which are more automatically occurring (i.e., mindlessness and mind wandering).

After differentiating the concepts, I explored what they have in common. Mindfulness and mindlessness both focus on the present task and build a continuum showing the extent to which we are sensitive and dynamic to context. At the same time, mindfulness and mind wandering can both facilitate problem solving and creativity. However, in the case of mind wandering, this only seems to apply to difficult tasks (Baird et al., 2012; Wati et al., 2014). Finally, there are aspects all concepts share. First, we acknowledge that all concepts are on the micro-level and not the organizational level. Second, they all refer to the state-of-mind as being cognitive, internal processes, which differ from observable behavior. Third, the concepts have been referred to as states, which are different from traits (for a different approach see e.g., Thatcher et al., 2018). They neither address the stable personal nature (e.g., personal innovation or playfulness), nor unique individual characteristics (e.g., IT habit).

Mind-related Concepts in Information Systems Research

In recent years, the relationship between technology use and cognitive processes has gained increasing momentum in IS research (e.g., Riedl et al., 2017). However, existing approaches often consider IT and brain activity as distinct entities. The concept of an IT mind, which incorporates the intertwinement of technology and the way we think when using it, can enrich our understanding. Section I in Part B presents the papers that deal with the investigation and operationalization of these processes in more detail.

IT Mindfulness

We define IT mindfulness as a flexible state of mind in which we are actively engaged in the present, notice new things and are sensitive to the context in relation to the features of information systems. Current IS literature has recognized IT mindfulness as an important cognitive state of mind that affects IT-related outcomes (Dernbecher & Beck, 2017; Sun, 2011; Sun et al., 2016; Thatcher et al., 2018). To develop the study on cognitive processes while using technology, it is a crucial step to investigate contemporary IT phenomena.

In line with existing literature (Wati et al., 2014; Sullivan et al., 2015; Thatcher et al., 2018), we adapted psychological principles to technology-related settings (Sun, 2011; Swanson & Ramiller, 2004; Butler & Gray, 2006; Vacca, 2018). For instance, Sun et al. have provided evidence that IT mindfulness is a pivotal concept in the domain of post-adoption (Sun, 2011; Sun et al., 2016). Furthermore, a mindful state-of-mind can influence the way people use technology and how efficiently they manage their cognitive resources. In addition, Thatcher et al. (2018) have shown that IT mindfulness can predict more active system use (e.g., deep structure usage), more automatic system use (e.g., continuance intention), as well as possible discontinuance of use (e.g., breaking habits) (Thatcher et al., 2018). IT mindfulness therefore helps to identify one's needs and capacities and to choose fitting technology (Cram & Newell, 2016; Sun et al., 2016; Swanson & Ramiller, 2004; Wolf et al., 2012). Mindful usage can reduce uncertainty and increase perceived usefulness and intention of use (Sun & Fang, 2010).

IT Mindlessness

Since unawareness of context might severely limit task performance and lead to an increase in errors during IT use, also mindlessness has implications for IS research. I defined IT mindlessness as a state of reduced attention in which we are trapped in old categories and distinctions drawn in the past in relation to the features of information systems. For instance, when technology users are limited by mindless automatisms, IT cannot live up to its potential (Nass & Moon, 2000; McAvoy & Butler, 2009; Lee, 2010; Kim & Sundar, 2012; Sammon et al., 2012; Liang et al., 2013). Moreover, employees might not be as prepared for changes in IT and, therefore, might be unable to adopt innovations. This can then lead to what is known in research as the "bandwagon effect", which means to rely on an existing technology which is not serving one's needs (Cram & Newell, 2016; Swanson & Ramiller, 2004). This suboptimal use of technological artifacts can lead to unsatisfactory or even unreliable outcomes.

IT Mind Wandering

As a state that can either reduce task performance or increase creativity and knowledge retrieval, mind wandering while using technology (IT mind wandering) has implications for IS research. It occurs in technology-related settings when users spontaneously switch from task-related to task-unrelated thoughts (Sullivan et al., 2015). Because many users tend to use multiple applications and features simultaneously, they are easily distracted or interrupted (e.g., Addas & Pinsonneault, 2018; Galluch et al., 2015). Expecting numerous notifications, they additionally generate task-unrelated thoughts (Wati et al., 2014; Sullivan et al., 2015; Oschinsky et al., 2018). Technology is ubiquitous. Understanding attention and information overload seem to be especially relevant, as mind wandering is affected by task complexity. It can have a negative effect on performance efficiency and a bipartite effect on performance accuracy. If the task at hand is moderately complex, IT mind wandering has no significant effect. If the task is highly complex, however, it has a positive effect (Wati et al., 2014). In addition, mind wandering can act as a moderator between technology-related thought and creativity and strengthen the relation between technology-related on-task thought and knowledge retention (Sullivan et al., 2015). Consequently, mind wandering in education (e.g. online learning) has experienced growing research interest (Hollis & Was, 2016; Mills et al., 2015; Szpunar et al., 2013).

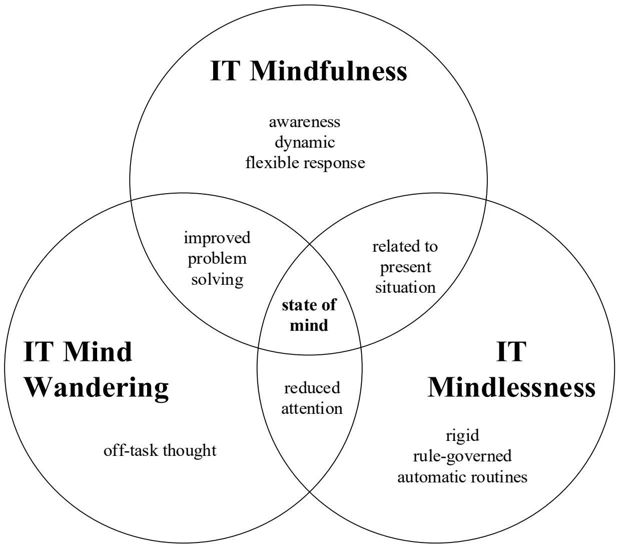

Figure 1.4. The Concepts of IT Mindfulness, IT Mindlessness and IT Mind Wandering.

An overview of the concepts is presented in Figure 1.4, which illustrates the uniqueness of each mind-related concept as well as overlapping themes. All concepts have their merits. To understand, explain, and even predict the cognitive processes while using technology can enable the development of neuroadaptive systems – and to move beyond studying performance in the future. It follows that technology should be designed to mitigate the demands on cognitive resources and the involved state of mind. For instance, user interfaces need to be carefully designed (Chapter 7). This insight is then followed by the question how environmental factors, varying social contexts, or multistakeholder settings are able to influence cognition (Chapter 16, 31 and 32) – be it in the real world or in augmented or virtual reality.

Designing Information Systems Beyond Performance

The consideration of mind-related concepts in IS research inspired me to consider what impacts technology use beyond the individual and beyond performance. This is paramount, because task performance was and still is one of the central variables in the IS discipline. Instead of enriching cognition with attitude and emotion, as many scholars do, my focus became settled on studying additional novel cognitive dependent variables that stem from concepts such as digital innovation and entrepreneurship (e.g., creativity).

A user's ability to originate, produce, or adjust representations is a central concern in this endeavor (c.f. Figure 1.2). Consequently, my co-authors and I have investigated how to design technology to enhance human ideation during mind-wandering episodes (e.g., Chapter 9), decision-making (e.g., Chapter 23), and problem-solving (e.g., Chapter 27). We expect that future technology designs will be more adaptive to foster new insights by the users, and be more interactive to benefit from distributed cognition. Moreover, we assume that technological artifacts will be able to provide the ability to change perspective to meet the demand of tomorrow's dynamic, agile, and multi-national organizations. This also applies to hedonic systems in the workplace and to the growing industry of serious games.

Summary

The previous section provided a brief introduction to research into human-technology interactions. My curiosity about HCI has been nurtured by the digital transformation in our offices and our homes, marked by advances both in hardware and software. Next, my social science background as well as the work by Davern et al. (2012) sensitized me for the ongoing changes in the norms and expectations of designing and using technology. The brief overview revealed that, in the early days, HCI scholars mainly studied performance in structured tasks, measuring the users' speed and error rates. Nowadays, more advanced models are needed to study less structured, but rather complex socio-technical tasks such as in entrepreneurship. This led me to acknowledge broader views of HCI that see cognition in a more diverse manner. Above all, my work revealed the potential of considering both the limitation of task performance and the strength of mind-wandering episodes when designing technological artifacts to foster digital innovation. It is not only a fast way to turn ideas into products and services while machines are not yet able to innovate on their own. It is also a necessity to value human abilities and to address the great demand for new work.

2.3 Decision-Support Systems

Scope

The consideration of human abilities led me to further study how people make decisions. I considered IS literature of the 1970s and 1980s that has been concerned with the relation between a user's need to decide and the design of respective assistive technological artifacts. Decision-support systems (DSS) entail the acquisition, organization, and use of knowledge to support human decision-making (Keen et al., 1978). They are intuitive, comprehensible, and – of utmost importance for the following endeavor – recognize the bounded rationality of users (Simon, 1955). Notably, DSS are designed to compensate for cognitive limitations and biases (Tversky & Kahneman, 1974; Kahneman & Tversky, 1979). They stand out from the rational choice paradigm in economics but have rather been designed for satisficing strategies (Simon 1955), heuristics, and a presentation of available alternatives until an acceptability criterium or threshold is met.

Few existing approaches in the IS discipline have addressed the determinants of reliable decision support in an evidence-based manner (see Chapter 21 for literature review). I fill this gap by again considering the human factors of technology use. To reach this objective, the status-quo-bias perspective is particularly promising. Based on an integrated theoretical model of resistance to technology, my work derives theoretical insights as well as recommendations for measures for the public sector (Chapter 22 and 23) and health care (Chapter 24, 25 and 26). Furthermore, I discuss directions for future research.

The Role of Decisional Guidance

There is a rising awareness about the interplay between cognition and behavior, resulting in work on how DSS designs impact cognitive processes and task performance. As organizations deal with increasingly unpredictable environments in the VUCA world, DSS has expanded their scope from simple planning contexts to complex organizational settings. The current idea is that humans and DSS can work in a complementary fashion: A user with internal representations faces a challenge for which she or he needs assistance. With the help of technology, she or he is presented a machine-made external representation to arrive at an appropriate solution (e.g., Benbasat & Taylor, 1978).

The concept of decisional guidance has appeared in the 1990s, presenting how a DSS "guides its users in constructing and executing decision-making processes" (Silver, 1990, p. 57). In opposition, system restrictiveness describes how a DSS restricts decision-making to a particular subset (ibid., p. 52). Still, the concepts are not comprehensive. Decision-making is not only about the result, but about the process itself and about avoiding manipulation. The resulting discord in the literature has been picking up speed again in the context of artificial intelligence (AI). Applications include advanced search, recommendation, speech recognition, and even automated decision-making. IS scholars have concentrated on knowledge-based expert, recommender, and explanation systems for a long time, only these days we find an increasing number of studies on data platforms, eLearning, management systems (Chapter 24), and business intelligence (Chapter 31).

The Role of Acceptance and Resistance to Technology

To explain the decision-making behavior when using IT, my co-authors and I consider the field's fundamental work on the acceptance of technology. Davis's (1989) pivotal article on the acceptance of technology has derived two significant antecedents to the use of technology: Perceived usefulness and perceived ease of use. Perceived usefulness is "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320). In contrast, perceived ease of use is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320; see also Chapter 22 and 23). The theory acceptance model aims to provide a general explanation of the determinants of the acceptance of technology and to identify a small number of basic variables that address the determinants of acceptance (Davis et al., 1989). It is applied across a wide range of end-user technologies and user populations while being economical, and parsimonious (see Chapter 22 and 23).

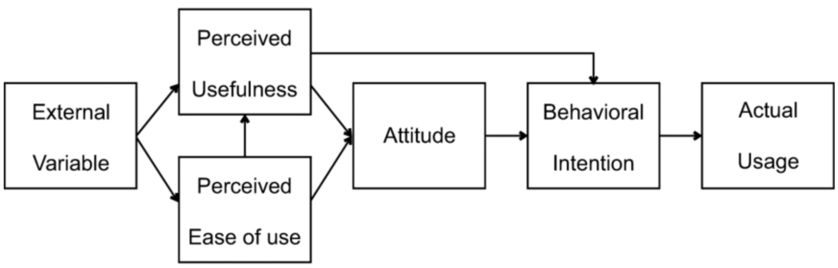

Figure 1.5: The Technology Acceptance Model (Davis et al., 1989)

Although the model is widely-known and reliable, it does not yet sufficiently explain user resistance as there is a difference between non-acceptance and resistance to technology.

Non-acceptance of technology means that a person simply does not use a system to complete a task (Burton-Jones & Gallivan, 2007; Burton-Jones & Straub, 2006; Lapointe & Rivard, 2007). Resistance to technology, in turn, refers to a behavioral reaction in which a user expresses a reluctance to use the system (Lapointe & Rivard, 2005; Meissonier & Houzé, 2010; Waddell & Sohal, 1998). It is a cognitive or emotional response to the perceived threatening pressure to change the status quo (Koo et al., 2017). According to Kim and Kankanhalli, resistance in technology-related situations is "[the] opposition of a user to change associated with a new IS implementation" (2009, p. 568; see Chapter 22 and 23). As humans often resist change, but technology offers rational and objective advantages, biases are clearly present. In our opinion, the adaptation of the original approach from the realm of psychology to the IS domain offers clear benefits.

Based on a comprehensive mixed-method study (Chapter 23), we can derive an evidence-based model of resistance to technology. User resistance is explained by three major factors: Rational decision-making, psychological commitment, and organizational and social influences. The first group encompasses switching benefits, transitions costs, and perceived value and goes hand in hand with approaches from traditional economics. The second group entails the wish to feel in control and to account for sunk costs, what the *homo oeconomicus* might call "irrational" and, thus, a clear indication of valuing human factors when implementing technology in organizations. Finally, the third group consists of organizational support practices, the management as role model, colleague opinion, and the perceived value for others (i.e., citizens). This finding is discussed below.

Designing Decision Support Beyond the Individual

A central finding of our work was that social aspects play a major role every time it comes to human decision-making. In the public sector, our results indicate that resistance to technology is explained, among other things, by the value for citizens, which results from the acceptance of a certain technology (i.e., document management systems). In the health care domain, the cooperation between doctors and nurses as well as the perceived competence and empowerment of patients are central. Today, important decisions are rarely made alone but collectively. Again, this calls for designs that allow and promote distributed cognition in technology-related settings.

The need for further research is accompanied by numerous puzzles that have not yet been comprehensively solved within the IS discipline. Neighboring fields such as political science, economics, and philosophy and are involved with collective decision-making, but do not cope with the design of technological artifacts that are able to guide its activity, procedure, and outcome. One example is whether collective decision-making should be binding or voluntarily, and whether the support offered by the DSS stays the same in each scenario. Next, joint decision-making is also about supporting fairness, privacy, effort affordance, and social inclusion. How a system guarantees this and who is ultimately responsible remains to be discussed. In a positive case, different decisionmakers are brought together, and participation is rewarded. In a negative case, regret, stress, or even punishment result. Ultimately, collective decision-making is a multi-stage process, and each phase can be thought of in terms of the interaction with technology: Preparation, information, debate, ideation, finding solutions, coordination and monitoring are separate steps. Depending on the weight of the different phases, the results can vary considerably. Finally, future studies will have an impact on the design of technology that assists not only collective decision-making, but also joint ideation, problem-solving and innovation. This will be further discussed in the following section.

Summary

This section presented an overview on technology-mediated decision-making. Technology use and machine-made decision support in organizations have significantly increased in recent decades. As a result, the acceptance of or resistance to these systems play a crucial role. Bounded rationality is paramount in decision support studies in the IS literature. However, there is relatively little cognitive research examining cognitive biases. We have taken this fact into account and show empirical evidence for the tendency to remain in the here and now (status quo bias perspective). Similarly, we identify missed opportunities regarding distributed cognition and knowledge transfer. We derive recommendations for action that consider cognitive processes and social factors when implementing technology. Research needs to go beyond micro-level analysis because studying technology-enabled collective decision-making clearly requires organizational-level analysis. This also applies to appreciating the huge potential of AI for decision-making practices in different sectors.

2.4 Digital Innovation

Scope

After the other two research areas deal with how people interact with technology, how they use it to fulfill tasks and make decisions, I turn to the question of how they use it to have new and useful ideas – i.e., how technology use leads to creativity and innovation. Creating – be it a dissertation thesis, a house, or a system – is a fundamental cognitive activity (Albert & Runco, 1999; Kaufman, 2016). It means to form new and useful items, either tangible (e.g., inventions or a paintings) or intangible (e.g., ideas or music). In IS research, creating can point at software development, software engineering, or digital innovation. Creativity involves the production of ideas by an individual or small group, and is different from innovation, which is defined as the successful implementation of creative ideas within an organization (Amabile and Pratt, 2016). In this context, digital innovation is a practical realization of ideas that results in the introduction of technological inventions, digital business models or digital services; or their improvement (ISO TC 279 standard 56000:2020). Once it occurs, an innovation can spread from the innovator to other individuals (diffusion of innovation by Tarde (1903; see Kinnunen, 1996).

Going back to creation itself, it is worth looking at the five different stages of the creative process (Sadler-Smith, 2015). First, there is preparation, where we gather materials, conduct research, and let our minds wander. By drawing on existing knowledge and past experiences (i.e., internal representations), we start to ideate. When generating ideas, we can build on divergent as well as convergent thinking. The first explores multiple emerging options in a non-linear manner (Guilford 1956). The second organizes this output, as it structures the ideas to arrive at a logical solution (ibid.). When we stop to actively ideate, we take a step back. The incubation stage begins, involving our unconsciousness. This stage often results in the illumination or insight stage, which is marked by an “aha” moment. After the incubation stage, an idea has emerged. It is then tested in the evaluation stage. Finally, the verification stage brings the idea to life. Only then, an idea can be implemented (innovation) and spread (diffusion of innovation).

Generating new knowledge and new products, processes, or services naturally involves representations: The internal representations of a creator, the external representations from the environment, and the complex interplay between them. Against this background, IS research has become interested in how to translate internal representations into external ones (e.g., program code, see Srinivasan and Te’eni, 1995). IS research on creativity-support systems has been particularly inspiring. We identified several heuristics as well as visual cues and contextual information that can be incorporated into technological artifacts to facilitate the creation process (Chapter 28 and 30-32). Afterwards, we looked at the individual creators, creative teams, and inspiring surroundings (Chapter 27 and 29), which is covered in the next paragraph.

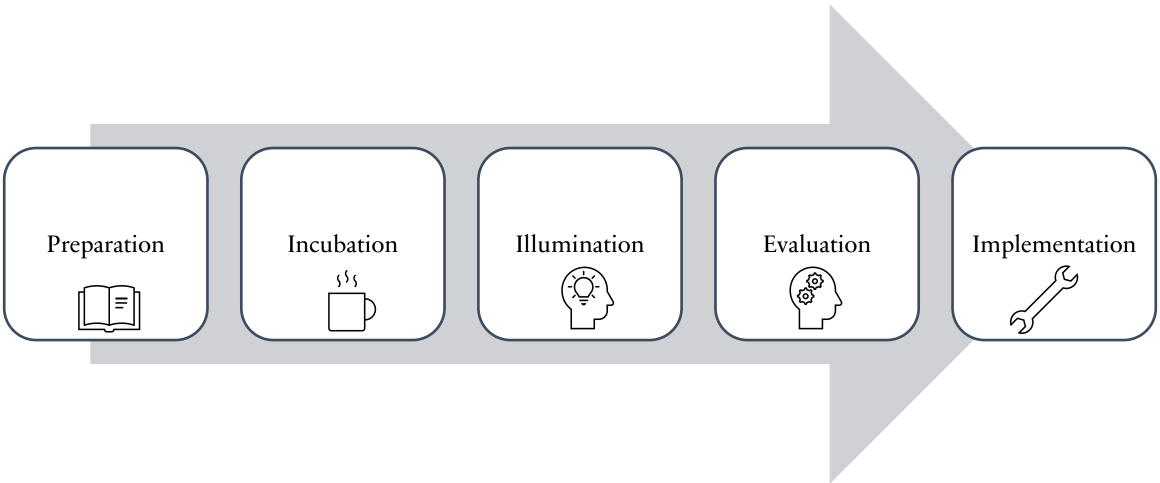

Figure 1.6: The Stages of the Creative Process

The Role of Specialized Knowledge and Knowledge Transfer Beyond the Individual
Creativity relies on existing knowledge (c.f. Figure 1.6). When being confronted with digital innovation processes that involve a broad and diverse group of stakeholders, I identified the need to study the difference between specialized (expert) knowledge and unspecialized (novice) knowledge. I asked myselves how specialized knowledge enables the creators to generate representations that lead to more applicable solutions (e.g., digital services). I studied individual capabilities, environmental factors, team dynamics, and even forms of interior design as well as organizational policies. The investigation led to three critical components for successful innovation processes: (1) team, (2) process, and (3) workspace (Chapter 27). For instance, I learned that a mix of expertise, combining specialized and unspecialized knowledge, can be beneficial to successful innovation. In addition, different group compositions are needed depending upon the phase of the creative process. Moreover, experts tend to chunk information into large familiar patterns (Newell & Simon, 1972; Adelson, 1981). In contrast, novices verbalize fewer, more superficial goals than experts, as their statements lack specificity and detail (ibid.).
Bridging the gap between specialized knowledge and unspecialized knowledge involves knowledge sharing (i.e., sharing representations) and knowledge transfer (i.e., distribution

of expertise). It deals with pooling experience, intellectual capital, cultural habits, and organizational values. Information, tools, and skills need to be exchanged to improve the absorptive and creative capacity of individuals and organizations. Social media is said to be a solution because it is convenient, efficient, and widely used. However, IS literature has identified serious challenges in this regard (e.g., selection bias). We identified the benefits of using platforms that reliably allow for knowledge transfer – both online and onsite (e.g., MURAL collaboration boards). This has been particularly evident in times of the global pandemic, in which, the remote work processes became a necessity and more flexible work models such as job sharing are on the rise. Because the platforms organize, create, capture, and distribute knowledge and ensure its availability for all users, there is potential value to design the technological artifact involved.

As pointed out in the introduction, distributed cognition can address the increased need for knowledge transfer (Hutchins, 1990, 1991, 1995) and allows for cognition beyond the individual (c.f. Figure 1.3). Most creative processes happen in teams, although most stories are told on sole inventors such as Newton or Einstein. Still, most inventors interact with others. Consequently, we see an opportunity to study collaborative innovation processes and technology-enabled distributed cognition (e.g., entrepreneurship). According to Wegrich, we define collaborative innovation as an arrangement where stakeholders engage in a "collective, consensus-oriented, and deliberate (…) process with the goal to design and implement new, creative solutions to current (…) challenges." (2019, p. 12). There are vast opportunities to coin how to design the technological artifacts and processes that facilitate such distributed cognition and collective innovation.

Summary

The previous section introduced research on collective innovation, and the potential to involve technology at different stages of the creative process. Many innovation processes and outcomes were digitized, resulting in novel theorizing. Research on digital innovation needs to account for multistakeholder settings (team), new working methods in the digital age (process) as well as for sensory inputs from the environment (workspace). The design thinking paradigm provides implications for theory and practice, enriching the toolset, skillset, and mindset of today's knowledge workers and entrepreneurs.

The three research areas also allow drawing broad, overall conclusions. Most IS literature focuses on individual technology users, decision-makers, or creators. In multilevel and multistakeholder settings, however, we need additional comprehensible studies to further explore knowledge transfer, collective innovation, and distributed cognition. To enable such distributed cognition, systems need to address numerous users that use various technological artifacts, embedded in complex organizational environments. IS researchers must, therefore, acknowledge diverse interdependencies in broad socio-technical contexts. Thus, designing technological artifacts that sustainably enhance digital innovation and entrepreneurship invites them to see HCI, decision support, and digital innovation in concert. The need to improve and accelerate interaction (HCI), knowledge transfer (DSS), and collective problem-solving (digital innovation (DI)). Going beyond the individual calls for appropriate designs of technological artifacts that can foster distributed cognition.

3. Research Agenda

After the theoretical background of the research areas was presented in Chapter 2, I move on to deal with the structure of my research and its main research questions.

3.1 Thesis Structure

The thesis is separated into two parts: part A and part B. In line with Lemmer (2021), Part A presents an overview of all research articles. Part B includes all respective research articles and covers twenty-three publications as well as three manuscripts under revision.

Journal articles are published or accepted by journals such as the Government Information Quarterly, Internet Research, Electronic Markets – International Journal on Networked Business, Association for Information Systems (AIS) Transactions on Human-Computer Interaction, Data Base for Advances in Information Systems, or HMD Praxis der Wirtschaftsinformatik.

Conference publications appear in the conference proceedings by the International Conference on Information Systems (ICIS), European Conference on Information Systems (ECIS), American Conference on Information Systems (AMCIS), Hawaii International Conference on System Sciences (HICSS), Pacific Asia Conference on Information Systems (PACIS), the Neuro-Information-Systems (NeuroIS) Retreat, the International Conference on e-Business (ICE-B), and the International Conference on Information and Communication Technology, Society and Human Beings (ICT).

There are also book chapter contributions such as in “New Perspectives on Digitalization” or “Information Systems and Neuroscience” published by Springer.

The papers have not been modified in their content. Nevertheless, they were revised linguistically and grammatically and converted into a uniform format. Consequently, there may be deviations from the original. Furthermore, the work had been developed, written, and published at different points in time, and may deviate in their terminology and wording (e.g., abbreviating core concepts in some papers, but not in others).

Section	#	Citation	VHB[a]	IF[b]
Human-Computer Interaction (HCI)	1	Oschinsky, F. M., Klesel, M., Ressel, N., Niehaves, B. (2019). Where Are Your Thoughts? On the Relationship between Technology Use and Mind Wandering. In: Proceedings of the 52nd Hawaii International Conference on System Sciences (HICSS-52), Maui, Hawaii. (published)	C	-
	2	Mind Wandering While Using Technology: Evidence from An Explorative Study (under review)	-	-
	3	Klesel, M., Oschinsky, F. M., Conrad, C., Niehaves, B. (2021): Does the Type of Mind-Wandering Matter? Extending the Inquiry About the Role of Mind-Wandering in the IT Use Experience. Internet Research 31 (3), (published)	-	6.773
	4	Mind Wandering in Information Technology Use. Scale Development and Cross-validation (under review; IF expected)	B	1.828
	5	Oschinsky, F. M., Niehaves, B., Riedl, R., Klesel, M., Wriessnegger, S. C., Mueller-Putz, G. R. (2021). On How Mind Wandering Facilitates Creative Incubation While Using Information Technology: A Research Agenda for Robust Triangulation. In: Proceedings of the Virtual NeuroIS Retreat 2021, Vienna, Austria. (published)	-	-
	6	Klesel, M., Schlechtinger, M., Oschinsky, F. M., Conrad, C., Niehaves, B. (2020). Detecting Mind Wandering Episodes in Virtual Realities Using Eye Tracking. In: Davis, F., Riedl, R., vom Brocke, J., Léger, P.-M., Randolph, A., Fischer, Th. (Hgg.) Information Systems and Neuroscience. NeuroIS Retreat 2020. Springer, Berlin. (published)	-	-
	7	Klesel, M., Oschinsky, F. M., Niehaves, B. (2019). Investigating the Role of Mind Wandering in Computer-Supported Collaborative Work: A Proposal for an EEG Study. In: Davis, F., Riedl, R., vom Brocke, J., Léger,	-	-

		P.-M., Randolph, A., Fischer, T. (Hgg.) Information Systems and Neuroscience. Springer, Berlin. (published)		
	8	Baumgart, T. L., Klesel, M., Oschinsky, F. M., Niehaves, B. (2020). Creativity Loading – Please Wait! Investigating the Relationship between Interruption, Mind Wandering and Creativity. In: Proceedings of the 53rd Hawaii International Conference on System Sciences (HICSS-53), Maui, Hawaii. (published)	C	-
	9	Baumgart, T. L., Oschinsky, F. M., Niehaves, B. (2021). Investigating the Impact on Creativity in a Supportive Technology-Driven Environment: An Experimental Approach. In: Proceedings of the 27th Americas Conference on Information Systems (Virtual AMCIS 2021), Montreal, Canada. (published)	D	-
	10	Reßing, C.; Nguyen, T. P. T., Oschinsky, F M. (2021), Restorative Effects of Virtual Reality Nature Simulations at the Workplace. An Experimental Approach. In: Proceedings of the International Conference on Information Systems (ICIS 2021), Austin, Texas. (accepted)	A	-
	11	Klesel, M., Haag, S., Oschinsky, F. M., Ortbach, K. (2019). Freedom of Technology Choice: An Experimental Evaluation. In: Proceedings of the 40th International Conference on Information Systems (ICIS 2019), Munich, Germany. (published)	A	-
	12	Weber, S., Klesel, M., Oschinsky, F. M., Niehaves, B. (2020). How Autonomy is Used in Information Systems Research: Status Quo and Prospective Opportunities. In: Proceedings of the 53rd Hawaii International Conference on System Sciences (HICSS-53), Maui, Hawaii. (published)	C	-
	13	Oschinsky, F. M., Niehaves, B. (2021). Do Employees Stay Satisfied in Times of Digital Change? On How Motivation Aware Systems Might Mitigate Motivational Deficits. In: Proceedings of the 18th International Conference on e-Business (ICE-B 2021), Lisboa, Portugal. (published)	-	-
	14	Oschinsky, F. M., Klein, H. C., Niehaves, B. (2019). Working in the Digital Age: Merging a Status Quo Bias Perspective and Reflective Practice. In: Proceedings of the 12th International Conference on ICT, Society and Human Beings 2019 (ICT 2019), Porto, Portugal. (published)	-	-
Decision-Support	15	Godefroid, M.-E., Zeuge, A., Oschinsky, F. M., Plattfaut, R., Niehaves, B. (2021). Cognitive Biases in IS Research: A Framework Based on a Systematic Literature Review. In: Proceedings of the 25th Pacific Asia	C	

		Conference on Information Systems (Virtual PACIS 2021), Dubai, United Arab Emirates. (published)		
	16	Oschinsky, F. M., Stelter, A., Kaping, C., Niehaves, B. (2020). To Resist, or not to Resist, that is the Question: On the Status Quo Bias of Public Sector Employees When Dealing with Technology. In: Radtke, J., Klesel, M., Niehaves, B. (Eds.), New Perspectives on Digitalization: Local Issues and Global Impact. Proceedings on Digitalization at the Institute for Advanced Study of the University of Siegen, Siegen, Germany. (published)	-	-
	17	Oschinsky, F. M., Stelter, A., Niehaves, B. (2021). Cognitive Biases in the Digital Age. How Resolving the Status Quo Bias Enables Public-sector Employees to Overcome Restraint. In: Government Information Quarterly (GIQ). (published)	-	7.279
	18	Müller, M., Oschinsky, F. M., Freude, H., Reßing, C., Knop, M. (2019). Beyond Rationality: Exploring the Role of Cognitive Bias in Technology Acceptance by Physicians. In: Proceedings of the 40th International Conference on Information Systems (ICIS 2019), Munich, Germany. (published)	A	-
	19	Oschinsky, F. M., Müller, M., Niehaves, B. (2020). Demigods of Technology Use – How Beating the Overconfidence Bias Can Prevent Medical Errors. In: Proceedings of the 53rd Hawaii International Conference on System Sciences (HICSS-53), Maui, Hawaii. (published)	C	-
	20	Müller, M., Knop, M., Reßing, C., Freude, H., Oschinsky, F. M., Klein, H. C., Niehaves, B. (2020). Constituting Factors of a Digitally Influenced Relationship between Patients and Primary Care Physicians in Rural Areas. In: Proceedings of the 53rd Hawaii International Conference on System Sciences (HICSS-53), Maui, Hawaii. (published)	C	-
Digital Innovation (DI)	21	Invite Everyone to the Table, but not to Every Course – How Design-thinking Collaboration can be Implemented in Smart Cities to Design Digital Urban Services (under review; IF expected)	B	4.765
	22	Klein, H. C., Oschinsky, F. M., Rubens, S. (2021). Cultivating Creativity: Insights from German Local Governments about the Drivers and Barriers of Change. In: Proceedings of the Hawaii International Conference on System Sciences (Virtual HICSS-54), Koloa, Hawaii, United States. (published)	C	-
	23	Klein, H. C., Oschinsky, F. M., Stelter, A., Niehaves, B. (2021). Design Thinking als Werkzeug für Co-kreation und Co-design – Ein Erfahrungsbericht in 5 Thesen. In: HMD Praxis der Wirtschaftsinformatik. (published)	D	-

	24	Klein, H. C., Weber, S., Schlechtinger, M., Oschinsky, F. M. (2020). Does one Creative Tool Fit All? Initial Evidence on Creativity Support Systems and Wikipedia-based Stimuli. In: Proceedings of the 41st International Conference on Information Systems (Virtual ICIS 2020), Hyderabad, India.	A	-
	25	Klein, H. C., Oschinsky, F. M., Weber, S., Niehaves, B. (2020). MUSE – Towards a Concept of Inspiring Ambient Technology Driven by Artificial Intelligence. In: Proceedings of the 24th Pacific Asia Conference on Information Systems (Virtual PACIS 2020), Dubai, United Arab Emirates.	C	-
	26	Klein, H. C., Oschinsky, F. M., Weber, S., Kordyaka, B., Niehaves, B. (2020). Beyond the Obvious – Towards a Creativity Support System using AI-driven Inspiration. In: Proceedings of the 26th Americas Conference on Information Systems (Virtual AMCIS 2020), Salt Lake City, United States.	D	-
[a] VHB-JOURQUAL3 (https://vhbonline.org/fileadmin/user_upload/JQ3_WI.pdf) [b] IF (Impact Factor) according to the Journal Citation Reports released in 2020/2021				

Table 2: Overview of Peer-Reviewed Research Articles

3.2 Main Research Questions

As Chapter 2 illustrated, the following sections are divided into three research areas: The first area focuses on the HCI. Humans interact with technology in manifold ways. In my studies, I used the example of daydreams to illuminate the cognitive challenges involved in working on a task while using technology. The second area deals with the perspectives of bounded rationality and cognitive biases. I linked these approaches with established literature on technology acceptance. The third area finally considers the questions of how technology can support human creativity. I gained initial insights on technology-mediated distributed cognition, and collective innovation.

Since this work contains 26 different papers, all of which present own research questions, I dedicate this section to overarching research questions for each of the three main research areas (c.f. Figure 1.7).

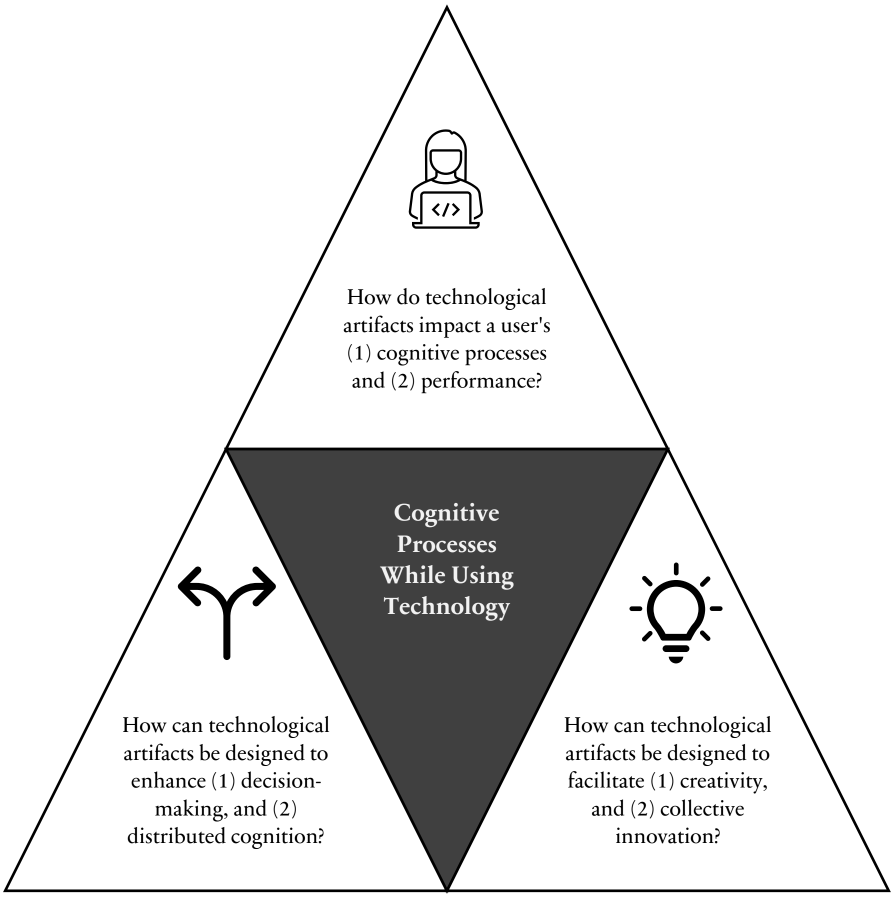

Figure 1.7: Main Research Questions in the Doctoral Thesis

4. Research Design

Numerous research methods are used in this doctoral thesis. My work includes five major methodological approaches: Literature Reviews, Conceptual Articles, Quantitative Research, Qualitative Research, and Mixed-method Research.

On the one hand, data collection uses various strategies, processes, or techniques. On the other hand, they generate evidence for analysis to uncover information or to create understanding. According to the paradigm to use appropriate research methods to answer the underlying research questions, I used different types and tools for both data collection and analysis. The appropriate tools and techniques helped to follow a stringent research cycle from identifying research topics (literature reviews), discovering appropriate theories and methods (conceptual articles), data collection and analysis (qualitative, quantitative, or mixed), toward interpretation and conclusion. The circle is not straight-forward but iterative, as it includes numerous loops with additional literature reviews and feedback from anonymous reviewers.

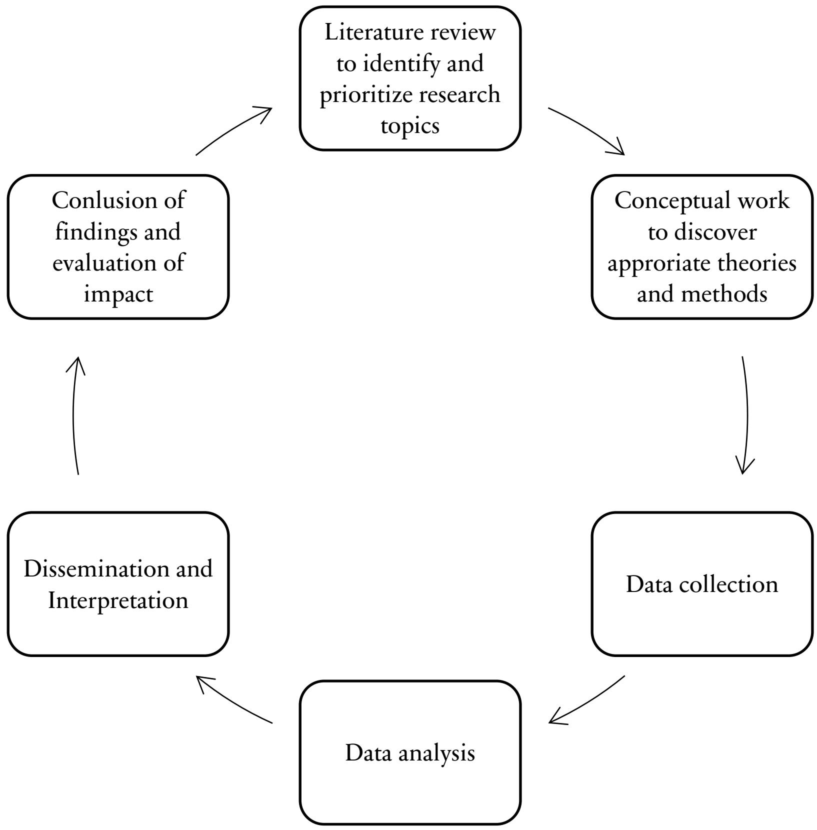

Figure 1.8: Overview of the Research Cycle of each Research Area in this Thesis

In addition to the diverse research methods in place, the papers in this doctoral thesis study different levels of analysis. Whereas the work in the field of NeuroIS operated at the micro-level (e.g., brain imaging), other investigations on distributed cognition or collective innovation went beyond the individual to investigate technology use in broader, more contextualized organizational environments on the macro-level. This approach backs the effort to do field work (qualitative), neuroscientific experiments (quantitative), and triangulation (mixed) by always accounting for rigor and relevance. It also highlights the benefits of mixed-method approaches that welcome diverse scientific methods. They reveal a unique ability to increase external and internal validity and to potentially uncover causality. Finally, conceptual work and literature reviews help to understand cognition in diverse contexts and develop theory. A well-crafted research is the cornerstone of science.

Literature Reviews

A review helps come up with the theories and arguments of an empirical approach. It defines, specifies, and restrains the main concepts as used in future research. When exploiting a new research field, we analyze prior knowledge (vom Brocke et al., 2015; Webster & Watson, 2002). Most researchers do reviews as full articles (systematic reviews, meta-analyses, and critical analyses). The knowledge of doing valuable reviews contributed to all other papers – each of them containing a chapter on the theoretical background. The main steps for performing a review are: (1) search for relevant literature; (2) evaluate sources; (3) identify themes, debates, and gaps; (4) outline structure; and (5) write a review.

#	Objective and Method	Method	Contribution
12	Investigate how the concept of autonomy is applied in IS research	Literature Review	As autonomy has been widely used in IS research, we show avenues for future research.
15	Investigate how the concept of cognitive biases is studied in IS research	Literature Review	The review clusters cognitive biases in IS research.

Table 3: Overview of Literature Reviews in this Thesis

Conceptual Articles

Conceptual articles are a powerful tool for theory building. To ensure intersubjective understanding of this non-empirical work, however, they are grounded in a clear research design, to justify the choice of theories, hypotheses, and analyses. The conceptual techniques and tools applied in this thesis encompass but are not limited to: (1) theory synthesis and typologies; (2) theory adaptation; and (3) models.

#	Objective	Method	Contribution
6	Investigate how eye tracking devices can measure mind wandering in VR settings	Model	We find empirical evidence on the usefulness of eye tracking to approximate mind wandering.
7	Propose an EEG study on mind wandering for computer-supported collaborative work	Model	The paper sheds light on the potential of combining self-reports with neurophysiological markers in future studies.

8	Investigate the relation of interruptions, mind wandering, and creativity	Theory Synthesis	We propose an experiment where interruptions stimulate mind-wandering episodes.
9	Further investigate the impact of mind-wandering episodes on creativity	Theory Synthesis	We propose an experiment to examine the mediating effect of mind wandering between interruptions and creativity.
10	Investigate how to simulate nature using VR during breaks at the workplace	Theory Adaptation	We propose an experiment to measure the restorative effects of nature simulations in VR.
13	Investigate how motivation-aware systems might mitigate motivational deficits of employees in times of digital change	Theory Synthesis	We propose a mixed-method approach to develop a design for motivation-aware systems.
14	Investigate how work can be designed in the digital age using design-oriented approaches	Theory Synthesis	It is valuable to merge the status-quo-bias perspective with the approach on reflective practice.
19	Investigate how beating the overconfidence bias can prevent medical errors	Model	We propose a questionnaire and a scenario-based experiment to study the overconfidence bias in healthcare.
25	Integrate the cognitive network model and the dual-pathway approach to creativity	Theory Synthesis	The paper comes up with a theory-driven concept for inspiring ambient machine-learning systems.
26	Integrate the cognitive network model and fixation literature by following a design science research design	Model	The model serves as a roadmap to study AI-driven CSS by using a design-oriented approach.

Table 4: Overview of Conceptual Articles in this Thesis

Qualitative Research

To gather interpretable data about experience, meaning, attitude, emotion, or behavior, I chose qualitative research methods. These approaches explore how or why things occur. They assist the researcher to interpret events and to describe actions. They aim at transparency, intersubjective understanding, and reach. The knowledge of various qualitative methods served the later mixed-method approaches. The qualitative research techniques and tools applied in this thesis encompass but are not limited to: (1) interviews (i.e., structured, semi-structured, unstructured); (2) focus group interviews; (3) on-site observations; (4) document analysis; and (5) case studies.

#	Objective	Method	Main insight
20	Investigate the relation between patients and physicians on the way to telemedicine and treatment digitalization	Semi-structured Interviews	The patients' activation, the design of a treatment process and a vivid patient-physician-interaction are relevant for the physicians' willingness to use health technologies.
21	Investigate how design-thinking tools can be implemented in smart cities to design digital urban services	Case study with unstructured interviews, focus group interviews, and observations	There are initial guidelines on how to involve diverse actors, integrate design-thinking coaches, and design innovative collaboration techniques in a digital way.
22	Investigating the drivers and barriers of creative work in public organizations	Focus group interviews	The paper highlights four main topics that determine the drivers and barriers to enable creativity in the public sector.
23	Investigating the drivers and barriers of implementing design-thinking tools in public organizations	Case study with observation	Based on our exemplary case, we propose five ways to use design-thinking tools for co-creation.

Table 5: Overview of Qualitative Research in this Thesis

Quantitative Research

To gather numerical data which can be ranked, measured, or categorized, I chose quantitative research methods. They help to do statistical analysis and to conduct empirical research. This paves the way for uncovering observable patterns or correlations as well as for careful derivation of generalizable conclusions. Quantitative methods aim at validity, reliability, and objectivity. The research techniques and tools applied in this thesis encompass but are not limited to: (1) surveys; (2) coding of observational or interpretable data; (3) experiments. Experiments include neurophysiological data collection in the laboratory. In one study, we also got to know the potential of dealing with big data and data science.

#	Objective	Method	Main Insight
1	Investigate the relation between technology use and mind wandering	Survey (N = 90)	There is a statistically significant difference between hedonic use and utilitarian use in relation to mind wandering.
2	Investigate the relation between technology use and mind wandering as well as between mind wandering and creativity	Survey (N = 208)	There is a statistically significant difference in the amount of mind wandering while using different technology designs. Using hedonic systems results in more mind-wandering episodes compared to utilitarian systems.
3	Highlight resemblances and distinctions between mind-wandering episodes and cognitive absorption for technology users	Survey (N = 619)	Two types of mind-wandering episodes (deliberate and spontaneous) are differently related to cognitive absorption.
4	Scale development and cross-validation of mind wandering in technology-related settings	Pilot survey (N = 35), main survey (N = 364), cross-validation survey (N = 336)	Based on our data, we derive an instrument that measures mind wandering either as a state or as a trait with two subtypes (deliberate and spontaneous).
11	Investigate the concept of technology choice	Experiment (N = 54)	We highlight the role of choice in early stages of technology use.
24	Investigate the relatedness of stimuli to offer evidence on data-driven creativity support	Coding	Future research needs to control for individual differences based on demographic variables.

Table 6: Overview of Quantitative Research in this Thesis

Mixed-methods Research

To integrate both qualitative and quantitative research I chose to do multi-method studies and triangulation. They help gain a holistic view about technology-related phenomena by combining and analyzing the data with deeper contextualized insights. Moreover, they enable me to verify the data from two or more sources.

#	Objective and Method	Method	Main Insight
5	Offer an agenda for the robust triangulation of data on mind-wandering episodes that can facilitate creative incubation	Qualitative and quantitative (model)	Triangulating behavioral data, experience sampling, and neurophysiological markers is promising to measure mind-wandering episodes during a problem-solving task.
16	Investigate the status quo bias when dealing with resistance to technology	Qualitative and quantitative (model)	Mixed-method approaches are a promising way to measure the cognitive biases of public sector employees.
17	Further investigate the status quo bias when dealing with resistance to technology	Qualitative and quantitative (study)	Triangulation is appropriate to measure the cognitive biases of public sector employees. We contribute to the understanding of the resistance to technology.
18	Investigate the status quo bias when dealing with resistance to technology	Qualitative and quantitative (model)	Merging qualitative and quantitative data is a promising approach to measure the cognitive biases of physicians.

Table 7: Overview of Mixed-method Research in this Thesis

Limitations

The breadth of my approach – be it in theory or methodology – does not come without shortcomings. First, the papers within this doctoral thesis have been published between 2018 and 2021, which implies that the literature on HCI, DSS, and digital innovation has evolved during these years. Aligning with Klesel (2019), the findings can vary in their interpretation and scope. Second, there are limitation of the research methods, which are discussed in each empirical paper. For instance, the sample size might be insufficient, the access to data limited, the respondents biased, or underlying trends difficult to pinpoint. By addressing the limitations as best as possible, I paved the way to challenge my findings. For example, this could concern the operationalization of creativity and digital innovation. I saw exciting new opportunities for data science methods for further studying cognitive processes (e.g., deep learning, machine learning or AI including data modelling, software engineering, and data visualization). Research methods themselves will further develop along with technical innovations and I look forward to being able to answer the research questions of the future using tomorrow's methods. Third, the investigation of underlying theoretical constructs and effects in this thesis is not complete and makes no claim to be fully comprehensive. Future research can focus on these limitations and nevertheless draw from the multiple insights to explore cognitive phenomena. I invite fellow scholars to address my thesis' shortcomings and to offer additional conclusions both for research and practice.

5. Major Findings and Outlook

I explored three distinct research areas that investigate cognitive processes while using technology and provided an overview. In Part B, I identify multiple avenues for studying cognitive phenomena in future IS research – which are briefly summarized in Part A. Based on my theoretical as well as practical insights, I envisage an exciting path that lies ahead of IS scholars. They are invited to study cognition beyond task performance and beyond individuals. The door is open to conduct research across diverse teams, communities, and systems. I conclude by outlining avenues for IS research in rich socio-technical contexts.

5.1 Future Directions

Due to the ability of technological artifacts to influence cognitive processes and ultimately performance, cognition is clearly relevant for IS research. By studying cognitive processes while using technology, I closely investigated the relation between the design and use of technology. The following overview supports IS researchers in planning and conducting studies that leverage the potential of the knowledge and tools offered by cognitive science. After the major findings are presented for each research area (see Figure 1.9), there is a synthesis of the results and an outlook.

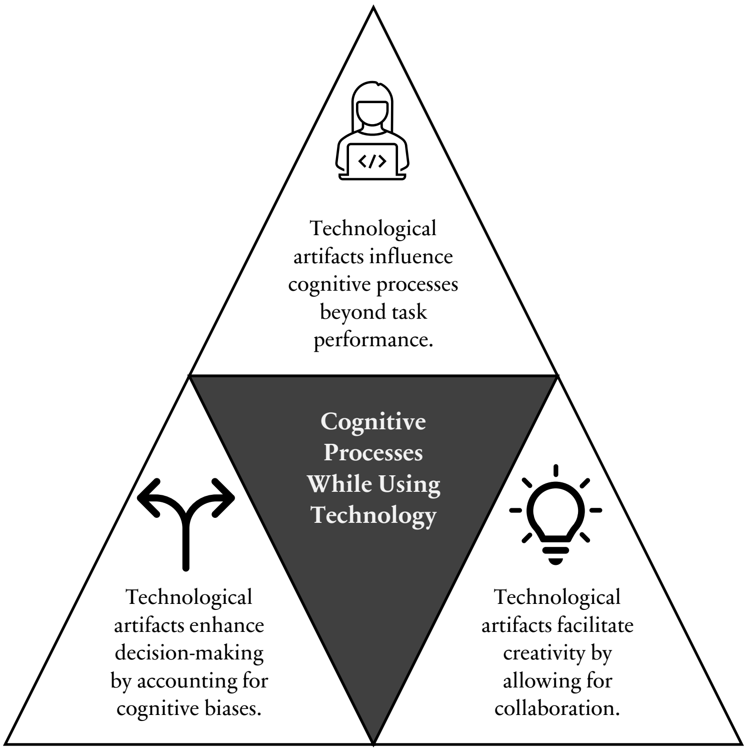

Figure 1.9: Summary of Major Findings

Human-Computer Interaction

In early days, IS researchers interested in the interaction between humans and computers mainly investigated the users' performance in structured tasks. Nowadays, more advanced models are needed to understand usage behavior when working on dynamic, complex, and oftentimes collaborative tasks. As the HCI field started to acknowledge cognition in technology-related settings in a more diverse manner, I started to study not only task performance, but a wider range of variables in technology-related settings. My biggest contribution was the conceptualization and operationalization of mind-wandering episodes while using technology. To the best of my knowledge, my co-authors and I were the first to differentiate the concept of mind-wandering from related concepts such as mindfulness or mindlessness. In addition, we showed that the design of a system (utilitarian / hedonic) has an influence on the occurrence of such episodes. Based on this initial evidence and enriched with the latest findings in neuroscience and psychology, it became possible to then differentiate the state and trait dimension of mind-wandering episodes and to make them measurable with a new scale explicitly for technology-related settings. We also deciphered the difference between spontaneous and intended mind-wandering episodes. Our work presented those spontaneous episodes to be just as

disruptive as technology-induced interruptions. On the contrary, the intended episodes can be considered a promising path to creativity as we identified initial evidence for a positive relationship. Ultimately, however, all studies highlighted the necessity of a valid measurement of mind wandering and creative quality. Our proposition to carefully triangulate mind wandering data takes this into account. It is the pioneering approach in the IS discipline that combines subjective and objective data on mind-wandering episodes while using technology.
The ubiquity of information, the diffusion of fake news and the development of systems that adapt to the mental state of a user, offer various ways for future IS research. Above all, this doctoral thesis highlights the great potential of considering both the limitation of attention (e.g., mind wandering), a broader spectrum of dependent variables beyond performance (e.g., creativity) and the strength of distributed cognition for design (e.g., digital innovation). This work shows new avenues for investigating the environment during technology use (e.g., restorative effects in virtual reality) and invites interdisciplinary work on the future of work (e.g., satisfaction in distributed teams). It paves the way for designing technological artifacts that can account for cognitive resources (e.g., users with special needs). In sum, my first main research question (How do technological artifacts impact a user's (1) cognitive processes and (2) performance?) resulted in the first major finding:

Technological artifacts influence cognitive processes beyond task performance.

The field of HCI has important implications for further developing the IS field. As contribution for theory, this doctoral thesis opens the door for further empirical and design science research studies on mind-wandering episodes while using technology. The ability of these artifacts to influence cognition offers relevant indications for designing them. Moreover, the increasing amount of neuroscientific evidence in the IS field necessitates the inclusion of knowledge and tools from cognitive science, neuroscience, and psychology. Finally, the HCI area is highly suitable to engage with industry because it can provide cognition-based advice on the design of digital products and services.

Decision-Support Systems

Technology use and machine-made decision support are the norm rather than the exception in today's organizations. As a result, the acceptance of or resistance to these DSS implement at work play a crucial role. My doctoral thesis illustrates that cognitive processes are paramount in decision support studies. The greatest contribution is to clearly show why the digital transformation is not proceeding at the forecasted pace. It can be explained by the tendency of employees to stick to the here and now (i.e., status quo bias perspective). Describing and discussing the employees' cognitive biases is of great value for theory and practice. It helps to come up with recommendations for actions and highlights to look at both the individual and the organizational level when big changes are about to occur. Until now, there has been little research examining the cognitive biases of the users. We fill this gap and offer multiple avenues for future IS research.

There are similar research opportunities regarding distributed cognition, collective decision-making, and knowledge management. For instance, studying technology-enabled collective decision-making requires to go beyond the micro-level toward analysis on the organizational level. In addition, research is invited to further appreciate the potential of technology for decision-making practices in different sectors (e.g., using AI in health care). In doing so, it stops equating people and computers (computers work like people; people think like computers), but rather sees the relation as a symbiosis of unique entities with their own abilities, skills, and characteristics. By acknowledging that the interaction between humans and technology is an activity that consists of non-interchangeable actors, the IS discipline will benefit from vast opportunities to inform the creation of tools and techniques. They help to reach decisions in a quick and frequently collective manner, thus, offering fruitful guidance for the desig of a new generation of decision support. All in all, my second main research question (How can technological artifacts be designed to enhance (1) decision-making, and (2) distributed cognition?) resulted in the second major finding:

Technological artifacts enhance decision-making by accounting for cognitive biases.

The field of DSS has important implications for further developing the IS field. For theory, my work identifies great potential of meta-analyses and reviews that consider the cognitive biases of technology users. Moreover, a better conceptual understanding of the distributed cognition is valuable. For practice, it is a necessity for organizations to analyze and synthesizes vast amounts of data. Based on a company's data, DSS can produce meaningful reports and forecasts as well as informed decisions based on data. They prepare input for customers that can be adjusted to user-specific needs. Balancing the human factors of decision-making by carefully designed DSS in different industries with various user groups or even collectively, can increase the performance of companies in the short and long run.

Digital Innovation

Based on well-established work on creativity, innovation, and entrepreneurship, my work shows that IS research needs comprehensible studies to further explore knowledge transfer, collective innovation, and other aspects of distributed cognition. In our investigation on knowledge transfer, we come to initial insights on how to design knowledge transfer between multiple stakeholders. We offer a guide for implanting structured innovation processes (i.e., design thinking) to guide collaboration and knowledge management. Our biggest contribution is that we identified three critical components for successful innovation processes: (1) team, (2) process, and (3) workspace. We learned that a mix of expertise, combining specialized and unspecialized knowledge can be beneficial to ideation and that different group compositions are needed depending upon the phase of the creative process.

Collaborative innovation represents a promising approach to strengthen user- or citizen-centricity, but requires infrastructures for networking, exchange, and coordination. Regarding the participation of multiple actors in collective innovation projects, we stress that everyone can be invited to the table, but not necessarily to every phase of the creative process. The involvement of experienced coaches can be valuable. In the future, establishing guidelines, combining insights from different sectors, designing appropriate assistive technology, and continuously evaluating and adapting existing frameworks will lead to the further development of smart living environments, where collective innovation becomes reality. To conclude, my third main research question (How can technological artifacts be designed to facilitate (1) creativity, and (2) collective innovation?) resulted in the third major finding:

Technological artifacts facilitate creativity by allowing for collaboration.

The field of digital innovation has important implications for further developing the IS field. For theory, the topic emerged as an important research area in the IS discipline and beyond. The creation of new and useful products, processes, services, or business models through digital technologies can be studied on the individual or organizational level, and with whole economies and globalized markets. Future studies are, therefore, invited to look at the development and adoption of single technological artifacts, but also at emerging organizational structures, digital platforms, and ecosystem characteristics. For practice, digital innovation can inform new economic activities such as appropriate entrepreneurial strategy or promising venture. Incorporating collective innovation into these economic activities offers ways for business growth and social impact.

Synthesis

In both the areas of HCI and DSS, I discovered interactivity between a technological artifact and the user to be key in explaining technology use. In addition to task performance or decision quality, it was worth considering other variables (e.g., creativity, autonomy). Also, it became clear that the design of specific aspects of a technological artifact (e.g., utilitarian / hedonic) can affect behavior. The studies on attention and mind-wandering then illustrated that technology design benefits from being tailored to the task and the user. Cognitive effort or cognitive load are promising starting points for future studies in this context (e.g., considering the Yerkes-Dodson Law or flow research).

I discovered a shift from the individual micro-level to the complex organizational macro-level (for distributed cognition see Hollan et al., 2000) in all three research areas. NeuroIS studies (operating on the individual micro-level) and cognitive IS research (operating on the organizational macro-level) complement each other. My work highlights that technological artifacts are instrumental at work (e.g., communication in distributed teams), joint decision-making (e.g., shared representations), and collective innovation (e.g., knowledge transfer). Given the centrality of collaboration for businesses, both in remote and onsite settings, future IS research can benefit from understanding the broader social context of technology use behavior as well as its connection with other environmental factors such as workplace design. Acknowledging the interplay of cognitive processes of various users by design can provide insights on the development and use of technology in rich and meaningful contexts.

Also present in all research areas, I observed technological artifacts that were able to enhance either performance, creativity, decision-making, or collaboration. The design imperative underlying all major research questions in this doctoral thesis (c.f. Figure 1.7) can be expressed as an issue of creating value for the future of work. Comprehensive system designs evidently increased the productivity and creativity of knowledge workers. Considering the cognitive processes of users – be it individually or collectively – bears the potential for economically optimal as well as mentally satisfying work conditions in the digital age. When we rethink our work and the way we work, we also need to think about how to use and design the assistive technological artifacts. The development and implementation of neuroergonomic design features in our systems may establish a new culture of concentration at work (e.g., Fraunhofer's CareCam). In this vein, design science research accounting for (distributed) cognition can gain momentum.

In the digital age, the context of technology use has noticeably changed compared to the early days of IS research (especially when it comes to task complexity, individualization, and design). Also, the way we study cognitive processes while using technology has clearly evolved (particularly regarding measurement objectification and the turn away from only subjective experience reports). This trend seems to continue as the world might start a new normal of using technology in the private and the business domain in a post-pandemic era. Designing knowledge transfer beyond the individual calls for seeing HCI, decision support, and digital innovation in concert. The need to improve and accelerate interaction (HCI), decision-making (DSS) as well as problem-solving and knowledge transfer in the complex organizations of today's VUCA world, invites future research to come up with appropriate design implications for technological artifacts that can foster distributed cognition and collective innovation. Up to today, most systems focus on single technology users, decisionmakers, or creators. To enable distributed cognition, however, appropriate systems need to address a group of people, using various technological artifacts, embedded in complex environments. Developers need to acknowledge diverse interdependencies.

All in all, the thoughts on a future research agenda on cognitive processes while using technology encompass three directions for future IS: (1) mind-wandering episodes; (2) distributed cognition; and (3) collective innovation. All these directions offer implications for technology design, technology use, and the development of neuro-adaptive systems. They are of great importance for theory, practice, and design.

Based on the synthesis of my major findings, there is room for further cognitive studies in IS research (e.g., on interface design and collective customization). This thesis certainly had an underlying intent to provide guidance to design. As technology advances and new contexts of use constantly emerge, I expect cognitive processes in IS research to remain of central interest. Cognition is increasingly distributed (c.f. Figure 1.10). For instance, researchers are invited to further study how to generate knowledge from the interaction (1) between different users, (2) between the user and their environment, (3) including the technological artifacts they interact with, and (4) how these artifacts are responsive to the environment themselves. The arrows in the figure indicate interaction.

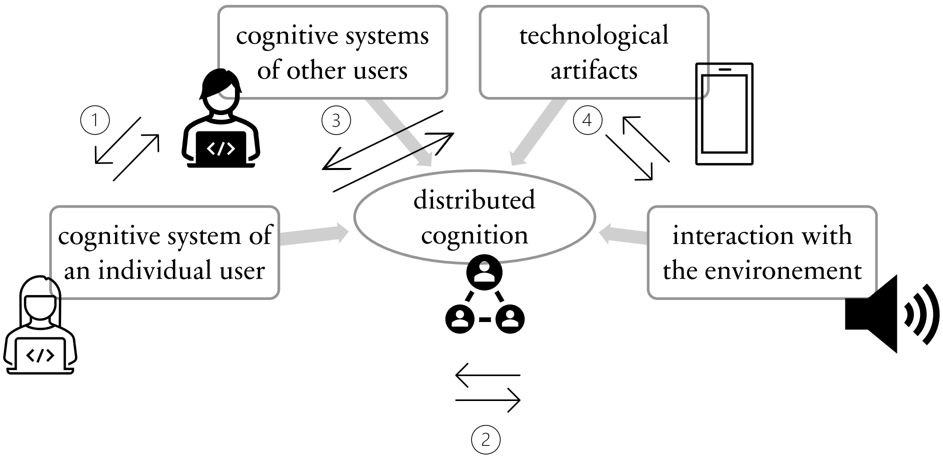

Figure 1.10: The Future of Cognitive Information Systems Research

Future cognitive IS research will depend on successfully sharing internal representations across groups. Furthermore, it is necessary that technology use in organizations is not only about task performance (like in the industrial age), but about human factors, distributed cognition, and neuroergonomy (appropriate for the digital age).

5.2 Conclusion

My work is an effort to understand how to reason with, interact with, and design technology. Throughout this doctoral thesis, I reflected on the ability of technological artifacts to influence the users' cognitive processes and ultimately central outcomes such as task performance, appropriate decision-making, and creativity. I was guided by IS, cognitive and psychological literature as well as by work from multiple neighboring disciplines such as engineering, computer science, social science, or neuroscience. Despite the values of this interdisciplinary approach, my driving and enduring research questions were always about the IS and the technological artifact.

All in all, the history of cognitive research in IS demonstrates that cognition has been a significant focus in the discipline. Following Davern et al. (2012, p. 303) it became "clear that cognitive research has made a substantial contribution to IS" so far. Thus, it comes with no surprise that there is even greater potential for further contributions when acknowledging the future of work and new research methods. Extrapolating from my work, I envisage a vivid future of technology use embracing human factors in all industries that are more fast paced and complex and even more challenging. I invite fellow cognitive researchers in the IS field to join me and to embrace this challenge.

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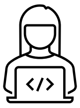
Part B

PEER-REVIEWED RESEARCH ARTICLES

I Human-Computer Interaction



7. Paper 1: Where Are Your Thoughts?

Title	**Where Are Your Thoughts? On the Relationship between Technology Use and Mind Wandering**
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Table 8. Fact Sheet Publication

Where Are Your Thoughts? On the Relationship between Technology Use and Mind Wandering

***Abstract**. Mind wandering is an important brain activity that fosters creativity and productivity. Research suggests that individuals spend up to 50% of their waking time thinking about things that are unrelated to the present situation or task. Previous literature has acknowledged the importance of mind wandering in technology-related contexts by investigating its mediating role between task and individual performance. In this study, we go one step further and investigate the direct relationship between technology use and mind wandering. We investigate if different types of technology use (hedonic use vs. utilitarian use) have an impact on mind wandering. Results from a factorial survey study (n=90) suggest that there is a significant difference between hedonic use and utilitarian use when it comes to mind wandering. Based on these insights, we discuss the role of mind wandering for IS research and potentials for future research.*

7.1 Introduction

Every day, our thoughts trail off up to 50% of our waking time [55]. This mind wandering occurs in various situations such as driving a car, doing work-related tasks, or reading a book. Smallwood and Schooler's [55] compelling review shows, that despite the high price of losing touch with the environment, there are distinct benefits letting your mind wander. For example, research shows that mind wandering enhances creativity [7] or contributes to better productivity and problem-solving skills [55,61]. Therefore, the concept of mind wandering is important for many fields of research and for practice

Similarly, it is most likely that our mind wanders when using technology. Since technology is increasingly becoming a part of our daily lives, this aspect becomes more relevant. Today, technology is used for both hedonic purposes (e.g., gaming or social media) and utilitarian purposes (e.g., E-mails or scheduling). In fact, current studies suggest that our use behavior is intense. In total, an average person uses her mobile phone for various purposes for about 150 minutes per day [cited in 59]. Hence, mind wandering is increasingly relevant when it comes to technology use.

Information Systems (IS) research has recently acknowledged the relevance of mind wandering and has started to investigate technology-related mind wandering (e.g., [61,70]). However, it has been primarily used as a moderating effect. With the increasing use of technology in various domains (e.g., private, or organizational domain) and based on various systems (e.g., hedonic or utilitarian), there is reason to believe that technology use also has a direct effect on mind wandering. Hedonic usage is pleasure-oriented and provides self-fulfilling value to the user [31]. On the contrary, utilitarian usage is productivity-oriented and provides instrumental value (ibid.). Since hedonic usage is closely connected to leisure activities and fun, a user is not tied to instrumental goals. Hence, we expect hedonic usage to lead to a higher level of mind wandering. This is also in line with previous literature demonstrating that different forms of technology use led to different outcomes (e.g., [71]). Consequently, we argue that it is of crucial importance to further investigate a direct relationship between technology use and mind wandering. Through an experimental design with 90 participants, we provide evidence that the use of a specific type of system (hedonic / utilitarian [31]) has an impact on the degree of mind wandering.

Our contributions are likewise theoretical and practical. From a theoretical perspective, we contribute to existing literature on technology use by clarifying the relationship between different types of technology and mind wandering. We approach this topic in an exploratory manner and draw a link between psychological, neuroscientific and IS research. For practitioners, we provide further insights on the role of mind wandering in terms of technology use which in turn can be used to enhance productivity and creativity for knowledge workers. Moreover, our work can be of guidance when it comes to technology design that seeks to enhance creativity and problem-solving. In addition, we encourage future research to minimize disruption [23] and to focus on potential negative consequences regarding technology use.

To address our objective, this paper is organized as follows: First, we investigate the literature on mind wandering in psychology, neuroscience, and IS research. Next, we propose our research model that hypothesizes that there are differences in the relationship between use and mind wandering. Then, we describe our research methodology and present the results. We conclude with a discussion of the results and suggest potential areas for future research.

7.2 Theoretical Background

Studying daydreaming has ignited research on the exploration of the mind's capacity to wander [1-8], yielding in a new research area on mind wandering [9-15]. This increasing interest was accompanied by new measurement techniques. For instance, functional magnetic resonance imaging (fMRI) visualizes how the default mode network (DMN) engages during mind wandering [16-19]. Consequently, various neuroscientific studies have emerged [14,21,30]. Consequently, psychologists nowadays agree that unconstrained mental processes are the norm rather than the exception: Between one third and half of our daily mental activity is unrelated to our external environment and off-task [55]. Mind wandering is commonly defined as "a shift of executive control away from a primary task to the processing of personal goals" [56:946] and as the mind's capacity to move away aimlessly from external happenings and tasks [24].

The current state of research illustrates that mind wandering mostly occurs during the resting state, in non-demanding circumstances and during task-free activity [10,58]. Attention drifts from a current task to mental content [44,49,50] and shifts from an external thought generated by the environment to an internal, task-unrelated idea [26]. Such a state of decoupled attention is characterized by thinking exclusively about internal notions and feelings and by the temporal inability to process external information [53].

Mind wandering is often perceived as cumbersome and prejudicial [53,57]. First, it is enhanced by stress as well as alcohol and substance abuse [20,48,54]. Second, it stands for a lack of awareness and consequently a cause of poor performance, errors, disruption, disengagement, carelessness, and unhappiness [8,19,73]. For example, research shows that it becomes apparent in situations where it is not necessarily desirable, for example, when driving a car [8,73]. Nevertheless, mind wandering also correlates with creativity and a positive mood [7,22,41,70]. It helps give significance to personal experiences and facilitate future planning [41,55]. Furthermore, it can provide mental breaks and helps relieve boredom. In summary, literature shows that mind wandering seems to offer both risks and opportunities.

In IS research, the topic of mind wandering has mainly been neglected notwithstanding its increasing relevance in a time where we are always connected and online without switching to effortless thinking. Always being alert was found to increase psychological distress [9], anxiety and insomnia [32], work overload and reduced organizational commitment [64,65,66,67]. Although IS research offers established knowledge on task performance (e.g., [16,31,12,43]) and attentional shifts (e.g., [60]), it lacks exhaustive findings on the correlation between technology use and task unrelated thought [61]. Thus, various authors publishing in high-ranking journals have called for a more fine-grained view on both technology use behavior and mind activity in IS [17,55,61,62].

Assessing the state of research shows that there has been both an increasing interest and an important gap to fill.

In IS research, Sullivan et al. suggest mind wandering to be both task-related and technology-related, defining technology-related mind wandering as "*task-unrelated thought which occurs spontaneously, and the content is related to the aspects of computer systems*" [61:4]. Wati and her colleagues, who introduced the concept of mind wandering to our domain, devote their pertinent research to this area of research, as they demonstrate that user performance is influenced by an individual's focus ability and mind wandering [70]. Having assessed different levels of task complexity, the authors call for considering the characteristics of technology use in greater detail in the future. At a later stage, the authors focus on the content of thought during mind wandering technology-related and non-technology-related settings [61]. They provide further empirical evidence that mind wandering moderates the relationship between on-task thought with creativity and knowledge retention. Their research repeatedly demonstrates that mind wandering has a significant impact on crucial aspects such as task performance.

Although previous research acknowledged the role of the mind and its impact on outcome variables such as performance, there is little research available that investigates the role of IT mind wandering. Against this background, we seek to shed further light on this research area to understand the relationship between technology use and IT mind wandering.

7.3 **Research Model**

External variables such as technology characteristics or use behavior have a significant impact on outcome variables such as mind-related concepts (e.g., [11]). Therefore, a relationship between technology-related aspects and mind wandering is most likely. Since current literature primarily investigated the indirect effects of mind wandering on its outcomes, we focus on the direct effects of use behavior on the mind wandering experience itself. In doing so, we aim to a better understand mind wandering in the context of IS.

There are two important types of systems (e.g., [38]). Literature on technology acceptance [15,69] widely focuses on utilitarian use to shed light on individual factors that influence technology use and adoption. With the rise of mobile technologies, hedonic factors have become increasingly important. This is most notable regarding social media and mobile games. To that end, previous literature suggests that hedonic use differs from utilitarian use. For instance, Lowry et al. [38] indicate that cognitive absorption is more important when it comes to hedonic use. In the context of the problem at hand, we argue that the use of a hedonic system is expected to be a strong determinant of mind wandering, because it is closely related to activities, we do in our leisure time. Here, people are primarily interested to enjoy using a system instead of following instrumental goals. Moreover, hedonic usage can be considered as an almost non-demanding and effortless activity, and consequently invite the user to let her mind wander. Thus, we assume that the type of system (hedonic / utilitarian) and its corresponding use affects the degree of mind wandering. Against this background, we propose the following hypothesis (H).

H: *The use of hedonic systems leads to a higher degree of mind wandering compared to the use of utilitarian systems.*

7.4 Methodology

Method Selection. To explore variances in terms of mind wandering, we used an experimental design with a strong internal consistency. We applied a factorial survey methodology [47] that has been applied in similar research endeavors (e.g., [68]).

Experimental Procedure. The scenario-based experiment covered four phases: First, participants were informed about the general setting and the goal of the study. Second, the circumstances and initial situation were presented by a short description underlined with an appealing image. Third, the participants were randomly assigned to one of four scenarios and watched a video (about 30 seconds long). Each scenario had been recorded on a mobile phone and followed the same procedure. To ensure a high level of involvement, we invited the participants to refer to the following situation based on what kind of technology they use daily (e.g., smartphone, tablet, or laptop). The participants were asked to fill out a questionnaire at the end.

Context. We introduced the participants to a workplace situation around 10 o'clock in the morning where employees usually enjoy a coffee break. Since a previous task took longer than expected, the participant started her/his break a little later and started paying attention to her/his mobile phone.

Experimental scenarios. After the contextual introduction, each participant watched one of the following videos, which are described briefly in the following (more details for each scenario, including screenshots of the movie, are attached in the appendix):
Scenario 1 (“Gaming”): a common type of hedonic use of technology is playing (mobile-) games (e.g., [37]). To mimic this type of use, we showed the game ”Froggy Jump” by Invictus Games Limited. It is a popular mobile game where the goal to navigate a jumping frog through obstacles to gain points.
Scenario 2 (“Facebook”): another important type of hedonic use relates to social media use. To imitate this type, we selected Facebook and showed a video where the participant navigates quickly through commercials, comments, and postings.
Scenario 3 (“Booking”): to represent utilitarian use of technology, we provided a video that shows a booking process for a railway ticket. Here, the participant saw subsequent steps of booking a ticket, starting with entering the point of departure and destination and ending with paying and skipping the tickets.
Scenario 4 (“E-mail”): finally, to represent a second example of utilitarian use, we showed a video of writing an E-mail to a professor to register for a workshop. In this scenario, the participant saw a complete composition of a short E-mail that was sent to the professor at the end.
Participants. We collected data from 105 participants. We included complete data and excluded observations with less than 3-minutes participation time resulting in 90 observations in total. The participants average age was 29.72 (*SD* = 12.10), 48 were male (53.3%), 42 female (46.7%), and have an average tenure of 8.37 years (*SD* = 10.26).
Measurement. Mind wandering is an internal mental experience and can be measured based on self-reports [55]. In the literature, mind wandering is often measured by means of a single item, which prevents a further analysis of psychometric attributes. Since there are several multi-measures available [42,70,61,51] we selected four items (c.f. Table 9). To ensure content validity, we translated each item from English to the participants’ first language and back. We investigated the internal consistency (based on Cronbach’s alpha), which suggests a good reliability (α = .81). We conclude that the measurement instrument is well suited for the subsequent analysis.
Convergent and discriminant validity. To assess the convergent and discriminant validity, we investigated the correlations matrix between the mind wandering items and the control variables (age, gender, job, tenure). As shown in Table 10, there are significant correlations

between all items that measure mind wandering and non-significant correlation between the control variables and mind wandering. Therefore, we assume a sufficient degree of convergent and discriminant validity. Note, that there are significant correlations between age and tenure as well as job and tenure, which is, however, common for this set of demographic variables. We also investigated the Variance Inflation Factor (VIF). Since all values are below the threshold of 10 ($1.1 < VIF < 5.7$) [29], we conclude that multicollinearity is not a major issue here.

Manipulation Checks. We measured perceived usefulness as suggested by Agarwal and Karahanna [1] to check if our intended manipulation (i.e., hedonic use versus utilitarian use) was successful. Sum scores were computed to carry out an analysis of variance (ANOVA) between all groups. The results indicate that there is a significant variation in terms of perceived usefulness $F(3, 82) = 7.337$, $p < .000$. A post hoc analysis (Tukey's HSD) shows that all manipulations worked as intended.

	In this situation…
WAND1	my mind wandered.
WAND2	I thought about something, which was not related to the situation.
WAND3	I was daydreaming.
WAND4	I did not concentrate on the situation.

Table 9. Measurement Items

	1	**2**	**3**	**4**	**5**	**6**	**7**
1	-						
2	-0.04	-					
3	-0.18	0.14	-				
4	**0.90**	-0.16	-0.26*	-			
5	-0.13	0.05	-0.17	-0.17	-		
6	0.01	0.05	-0.19	-0.02	**0.72**	-	
7	-0.14	0.08	-0.09	-0.16	**0.83**	**0.59**	-
8	0.17	0.10	-0.11	0.12	0.29**	**0.40**	0.32**

1. Age, 2. Gender, 3. Job, 4. Tenure,
5. WAND1, 6. WAND2, 7. WAND3, 8. WAND4

Note. **p < .001**, ** p < .01; * p < .05

Table 10. Correlation Matrix

Scenario 1 (“Gaming”) differs significantly from scenario 3 (“Booking”) and scenario (“E-Mail”). Scenario 2 (“Facebook”) differs significantly from scenario 3 (“Booking”) and scenario 4 (“E-Mail”). Therefore, we conclude that all scenarios reflect utilitarian and hedonic use as intended. An overview is given in Table 11.

				Tukey’s HSD Comparisons		
Scenario	**n**	**M**	**SD**	(1)	(2)	(3)
(1) **Gaming**	22	2.39	1.41			
(2) **Facebook**	25	2.73	1.53	.852		
(3) **Booking**	27	3.78	1.35	.007	.055	
(4) **E-Mail**	16	4.27	1.61	.001	.008	.716

Table 11. Post Hoc Analysis Perceived Usefulness

7.5 Results

We carried out an analysis of covariance (ANCOVA) to identify group differences and possible covariates at the same time. For that purpose, sum scores were used for mind wandering. The results are summarized in Table 9. The results indicate a significant variation among the scenarios, $F(3, 82) = 5.769$, $p = 0.001$. Moreover, this shows that, apart from “job”, there is no significant influencing factor.

Variable	**df**	**F**	**P**
Scenario	3	5.769	.001**
Age	1	0.934	.336
Gender	1	0.615	.434
Job	1	5.012	.028*
Tenure	1	1.112	.295
Note. **p < .01; *p < .05			

Table 12. ANCOVA Results

Since the overall test is significant, we investigated the descriptive statistics and carried out a post hoc analysis using Tukey’s HSD. The post hoc analysis indicates that group 1 (“Gaming”) differs significantly ($p < .05$) from group 4 (“E-mail”). Moreover, we found a significant difference ($p < .05$) between group 2 (“Facebook”) and group 3 (“Booking”) and a significant difference (p < .01) between group 2 (“Facebook”) and group 4 (“E-Mail”). All other groups are somewhere in the middle. An overview of the post hoc analysis is presented in Table 13.

					Tukey’s HSD Comparisons	
Group	**n**	**M**	**SD**	(1)	(2)	(3)
(1) **Gaming**	22	4.06	1.37			
(2) **Facebook**	25	4.45	1.52	.806		
(3) **Booking**	27	3.19	1.69	.194	.017	
(4) **E-Mail**	16	2.73	1.28	.042	.003	.765

Table 13. Post Hoc Analysis Mind Wandering

7.6 Discussion

This study seeks to shed further light on the relationship between technology use and mind wandering. Therefore, it expands on previous efforts that have investigated the intermediate role of mind wandering and put emphasis on wandering in terms of hedonic and utilitarian use of technology.

Discussion of results. In most cases, the results confirm our proposed hypothesis. In fact, three out of four group-wise comparisons are significant. In terms of the considered scenarios, the results indicate that writing an E-Mail shows the lowest level of mind wandering (M = 2.73, SD = 1.28). In contrast to the booking scenario (M = 3.19, SD = 1.69), this difference is significant. It seems that the autonomy that is related to a task may have a pertinent role. This insight is related to previous findings that indicate that the complexity of a task significantly impacts mind wandering. Assuming that writing an E-mail allows a high degree of freedom compared to a structured booking process, it is also more complex to fulfill this task.

Both hedonic scenarios do not differ significantly. Still, we observe a difference in a direct comparison with scenario 3 (“Booking”) because only Facebook use differs significantly. We conclude that other factors such as the degree of cognitive absorption may also play a major role when it comes to mind wandering. Specifically, the results may indicate that playing a game requires the same degree of engagement or cognitive focus as a booking process, which in turn might explain a non-significant relationship between those groups. *Implications for theory*. Even though individuals spend up to 50 percent of their waking time letting their mind wander, IS research has only spent little effort acknowledging related effects. Therefore, future research can benefit from this exploratory study as a point of departure for further research on mind wandering. In specific, it provides initial evidence that the use of hedonic systems has a higher impact on mind wandering which in turns open the door for further research that can investigate what type of aspects are most relevant in this regard. Moreover, with a rising interest in IT mindfulness [17,62,63], IS research can benefit from a more holistic perspective on mental activities. As neuroscience suggests that the state of mind is likely to have an affect technology-related behavior, the field of NeuroIS opens the door for future research in various directions [18,46].

This research suggests that technology-related variables such as technology use or a technological artifact have a significant impact on the state of mind and can thus be understood as an important stimulus of mind activity. Distinguishing between hedonic systems and utilitarian systems, our research also contributes to existing literature on technology use and user acceptance. The increasingly hedonic nature of information systems, where most websites and applications aim at being user-friendly, implies the need to also assess a person's motivation not to use a hedonic system [31] or the danger of using hedonic systems in a dysfunctional manner [59]. With the ubiquity of technology, many potential drawbacks including addiction, work overload, disrupted work-life-balance, technostress can occur (e.g., [64,6,72,59]). Therefore, it remains important to examine different facets of the nature of technology use and the implication for individual well-being and productivity.

For research on 'the dark side' of technology on the other hand, mind wandering might also be an important aspect to consider because it allows individuals to detach and 'dream away' from (possible stressful) situations. Even though this might only happen for a limited amount of time, it might support buffering negative events. Moreover, by following a balanced view on both the benefits of technology use and the implications of mind wandering, this paper can help understand how to maximize positive results while reducing negative consequences of both phenomena at the same time. Those insights offer guidance for academia, managers, organizations, and society.

In summary, we put forward good reasons to further investigate the role of mind wandering in relation to technology. Based on this argument, we also offer new insights into how a primarily psychological state is related to IS. Based on our experimental study, we present implications on how the mind drifts away from current situations and tasks and present a point to connect alternative scenarios or replications near the mark. Considering mind wandering research, we also find links to the dual system theory, which is at the core of Kahneman's canonical work on "thinking fast and slow" [33]. Mind wandering can be related to System 1 (automated, effortless thinking) in contrast to System 2 (controlled and focused thinking).

Implications for design. Although this piece of research primarily seeks to understand the relationship between technology use and mind wandering, it is also beneficial to design-related research. Most importantly, it indicates that, apart from the characteristic of a specific task, the design and the corresponding use experience might also affect mind wandering. Specifically, we assume that specific designs or design elements invite individuals to let their thoughts drift off. Consequently, an IT artifact designed for utilitarian purposes (e.g., an Enterprise Resource Planning system) should consider this aspect to decrease mind wandering because it negatively impacts productivity [70,61]. In contrast, artifacts that are designed to accelerate creativity should in turn stimulate mind wandering because it significantly increases creativity [7]. We thus encourage future research to develop and test design theories considering mind wandering.

Implications for practice. Our research has also implications for practice. It highlights the relationship between use behavior and mind wandering. Therefore, organizations that seek to enhance mind wandering (e.g., creative environments) might investigate where specific types of use behavior might be useful. In contrast, domains in which mind wandering interferes with productivity, hedonic-based use behavior could be reduced. Within the context of managing and using IT, mind wandering has an impact on performance and is consequently important to consider when designing IT artifacts.

7.7 Limitations and Outlook

This study comes with some limitations that open the door for future research. First, since we investigate the relationship between use behavior and mind wandering, we do not distinguish between task-related wandering and technology-related wandering [61].

Hence, future research could include this. Second, structural relationships, i.e., the impact of mind wandering on enjoyment or creativity, are not included here. Third, environmental factors including job characteristics may also play a crucial role when it comes to mind wandering. For example, individuals who are involved in very intense professions may have a more limited opportunity for mind wandering than others. In contrast, individuals who are involved in scheduled work may perceive a higher level of mind wandering. Finally, future research should triangulate the measurement of IT mind wandering using additional techniques such as eye tracking, or brain imaging. Therefore, NeuroIS [18,46] could provide further insights into the role of mind wandering.

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7.9 Appendix A

A1 Gaming (scenario 1)

To simulate the use of a game, we used the mobile game "Froggy Jump". The main objective is to navigate a frog and jump as high as possible. The higher you get the more points you score. Screenshots from the short movie is shown in Figure 7.1.

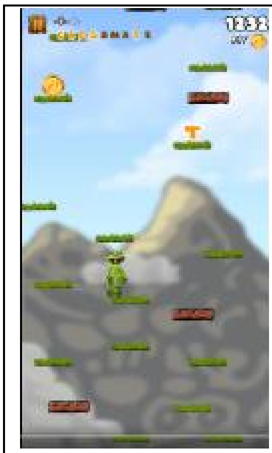	
after 9 sec	after 15 sec

Figure 7.1. Screenshot Gaming Scenario

Facebook (scenario 2)

Facebook was used to simulate social network use because it is widely used and offers a great variety of additional resources that can be queried by the user. The main objective was to simulate a user who goes over several pages (e.g., shopping pages, holiday pages, etc.). Screenshots of three different point that represent the movie are illustrated in the following Figure (c.f. Figure 7.2).

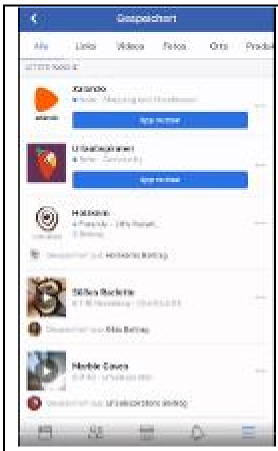	
after 3 sec	after 28 sec

Figure 7.2. Screenshot Facebook Scenario

Booking (**scenario 3**)

To mimic utilitarian use, we provided a booking process in a national railway company. The movie covered all important phases of a booking process: choosing a date, select an appropriate connection, and finally pay the ticket.

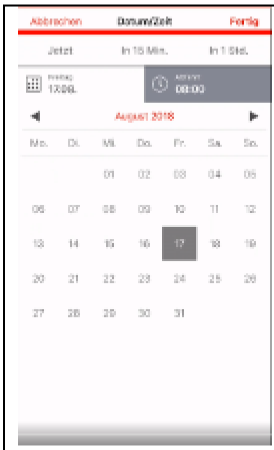	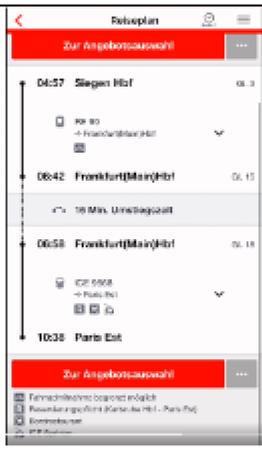
after 7 sec	after 18 sec

Figure 7.3. Screenshot Booking Scenario

E-Mail (**scenario 4**)

A second utilitarian vignette was designed that shows composition and sending of an E-mail. To mimic a utilitarian context, a university professor was chosen as a recipient. An excerpt of the movie is shown in the following figure (c.f. Figure 7.4).

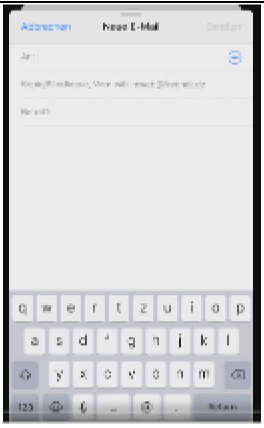	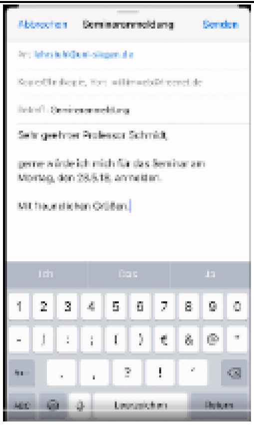
after 3 sec	after 37 sec

Figure 7.4. Screenshot E-Mail Scenario

8. Paper 2: Mind Wandering While Using Technology

Title	**Mind Wandering While Using Technology: Evidence from An Explorative Study**
Authors	Frederike Marie Oschinsky[1] Michael Klesel[2] Björn Niehaves[1] [1] University of Siegen, Siegen, Germany. [2] University of Twente, Enschede, The Netherlands.
Publication Type	Journal Article
Publication Outlet	AIS Transactions on Human-Computer Interaction
Status	Under Review (2nd round)

Table 14. Fact Sheet Publication

Mind Wandering While Using Technology: Evidence from An Explorative Study

Abstract. *Mind wandering is a frequent and profoundly human brain activity that fosters creativity and problem solving. Evidently, individuals spend up to 50 percent of their waking time thinking about things that are unrelated to the present situation or task. While previous Information Systems (IS) literature mainly focused on cognitive processes that deal with the here and now (e.g., mindfulness or flow), only little research investigates the role of mind wandering in technology-related settings. This article seeks to contribute to existing knowledge by investigating the relationship between technology use and mind wandering as well as between mind wandering and creativity in an explorative manner. Under the conditions reported in this study (N = 208), a statistically significant difference in the amount of mind wandering while using different types of technology design emerges. In specific, using hedonic systems results in a higher degree of mind wandering compared to utilitarian systems. Moreover, mind wandering in conjunction with perceived usefulness positively relates to creativity. Because the initial evidence on the importance of mind wandering in technology-related settings is valuable for both academics and managers, this study identifies potential avenues for future research.*

Keywords: *Mind wandering, Hedonic systems, Utilitarian systems, Technology use, Creativity, Exploratory research.*

8.1 Introduction

Our thoughts are oftentimes not tethered to the current situation but jump from one topic to another in a seemingly haphazard manner (Giambra 1989; Golchert et al. 2017). Evidently, our minds trail off for up to 50 percent of our waking time (Killingsworth and Gilbert 2010). Aimlessly 'moving away' occurs in various situations such as driving a car, doing work-related tasks, or reading a book. Smallwood and Schooler's (2015) compelling review shows that despite the high price of losing touch with the environment, there are distinct benefits to letting your mind wander, such as the creative performance of individuals (Agnoli et al. 2018; Baird et al. 2012), pattern recognition (Drescher et al. 2018), problem solving (Mooneyham and Schooler 2013) and future planning (Smallwood and Schooler 2015). Due to its complex nature, the interest in studying the construct of mind wandering has recently increased in various disciplines (Fox and Christoff 2018).

Given its ubiquity, it is most likely that our minds frequently wander when using specific technologies. Since mind-wandering episodes are known to influence performance and creativity, it is beneficial to better understand variations in relation to mind wandering in terms of different systems. While previous literature has put a lot of emphasis on being focused and on how attentional adjustments are made (Ahn et al. 2018), considering off-task thoughts puts the assumption of continuous task-related thoughts while using information technology (IT) in a new light. Considering task-unrelated thought while using IT in turn promises a more holistic perspective on IS-related phenomena. Thus, information systems (IS) research has recently acknowledged its relevance and highlighted the effect of mind wandering under specific IS-related conditions (Oschinsky et al. 2019; Sullivan et al. 2015; Sullivan and Davis 2020; Wati et al. 2014).

With the gaining interest in hedonic systems (Lowry et al. 2013; van der Heijden 2004) and gamification elements in utilitarian settings (Liu et al. 2017; Suh et al. 2017), it is important to investigate cognitive concepts such as mind wandering that are related to non-demanding activities and fun (Lowry et al. 2013). We address the need for further studies in this regard. Through an exploratory study with 208 participants, we provide initial evidence that using a specific type of system (hedonic/utilitarian) has a statistically significant correlation with mind wandering. Moreover, we show that mind wandering also yields a higher degree of creativity when the individual perceives a higher level of usefulness.

Our contributions are likewise theoretical and practical. From a theoretical perspective, we contribute to existing literature by providing the results of an exploratory study that shows significant relationships with regards to mind wandering in specific technology-related conditions. We approach this topic in an interdisciplinary manner and draw a link between psychological, neuroscientific, and IS research. For practitioners, we provide insights on the role of mind wandering while using technology (e.g., workplace technologies), which in turn can be used to enhance productivity and creativity of knowledge workers. Moreover, our work can be of guidance when it comes to human computer interaction that seeks to enhance fundamental 'human' brain activities.

To address our objective, this paper is organized as follows: First, we review existing literature and provide the theoretical background of this study. Second, we propose our research model that hypothesizes that there are differences in the degree of mind wandering when using different information systems. Third, we describe our research methodology and present the results. Fourth, we conclude with a discussion of the results and suggest potential areas for future research.

8.2 Theoretical Background

Mind wandering is a common everyday experience in which attention becomes disengaged from the external environment and turns to internal notions and feelings (Fox and Christoff 2018; Giambra 1995; Smallwood and Schooler 2015). It refers to the mind's easeful and seemingly haphazard way to move away from external happenings and tasks toward mental content (Giambra 1989; Posner and Petersen 1990; Schooler 2002; Schooler et al. 2011). As such, it has been defined as "a mental state, or a sequence of mental states, that arise relatively freely due to an absence of strong constraints on the contents of each state" (Christoff et al. 2016).

The state of decoupled focus predominantly occurs during the resting state, in non-demanding circumstances and during task-free activity (Buckner and Vincent 2007; Smith et al. 2009). Because a temporal inability to process the information of the moment (Smallwood et al. 2007a) is highly undesirable in many situations, initial research has been conducted in the context of reading, driving (Baldwin et al. 2017; Zhang et al. 2017), and clinical applications (Franklin et al. 2017; Seli et al. 2015b) and was aimed at reducing this train of thought (Schooler et al. 2014).

Though mind wandering can have disruptive consequences such as error susceptibility, recent research demonstrates that it also offers unique benefits (Mooneyham and Schooler 2013). On the one hand, mind wandering is perceived as prejudicial (Smallwood et al. 2007a; Smeekens and Kane 2016), because it is enhanced by stress as well as alcohol and substance abuse (Epel et al. 2013; Sayette et al. 2012; Smallwood et al. 2007b). In addition, it stands for a lack of awareness and unhappiness and a cause of poor performance, errors, disruption, disengagement, and carelessness (Baldwin et al. 2017; Drescher et al. 2018; Zhang et al. 2017). On the other hand, research suggests that a shift of attention toward internal thoughts strengthens the cognitive control system (Golchert et al. 2017) and positively relates to creativity, the planning of the future, and positive mood (Agnoli et al. 2018; Baird et al. 2012). The ambiguous nature of mind wandering has attracted growing interest among researchers from various disciplines and invites further exploration of the construct.

With an increasing body of knowledge, several distinct subtypes of mind wandering have been discovered. First, mind wandering can occur both as a state in a specific situation or as a trait in everyday life (Seli et al. 2016a). This characteristic is shared with many psychological constructs (e.g., mindfulness). Second, a distinction is made between deliberate (i.e., intentional) and spontaneous (i.e., unintentional) mind wandering (Seli et al. 2016b). This differentiation goes back to Giambra (1989, 1995), who argues that voluntary shifts of attention involve a higher degree of control compared to involuntary shifts. The intention to begin or to continue a mind wandering episode implies meta-awareness and purposefulness. Various studies show that this distinction has indeed different effects. Most recently, Agnoli et al. (2018) demonstrate that deliberate mind wandering positively predicts creative performance, whereas spontaneous mind wandering is negatively associated with it. Following this line of argument, deliberate mind wandering is important when it comes to outcome variables such as creativity. In contrast, spontaneous mind wandering becomes relevant to explain negative consequences such as reduced performance.

Over the last five years, IS researchers have acknowledged the ubiquity and complex nature of mind wandering (Bockarova 2016; Conrad and Newman 2019; Oschinsky et al. 2019; Wati et al. 2014). Because scholars have recognized that mind wandering can both effect cognition and affect in technology-related settings, they began to study how it shapes a technology user's response to external stimuli or primary task performance (Bockarova 2016). For instance, Sullivan et al. (2015) showed that mind wandering while using technology can have a statistically significant correlation with creativity and knowledge retention. Sullivan et al. (2015) came up with a domain-specific definition understanding technology-related mind wandering as "task-unrelated thought which occurs spontaneously, and the content is related to the aspects of computer systems" (Sullivan et al. 2015). They emphasized the merit of studying mind wandering's relationship to technology use but clarified that an IS research agenda on this concept has yet to emerge.

To anchor the concept of mind wandering in existing IS literature, we discriminate it from related concepts. Like previous literature (Thatcher et al. 2018), we distinguish mind wandering from IT mindfulness, cognitive absorption, and flow. Mind wandering differs from IT mindfulness (Dernbecher and Beck 2017; Sun et al. 2016; Thatcher et al. 2018), because users who let their mind wander do not approach technology in an open, value-adding manner, but are unfocused and unobservant. In addition, the concept differs from cognitive absorption (Agarwal and Karahanna 2000; Goel et al. 2011) because mind wandering users are not narrowly focused on the system at hand. In the same way, mind wandering differs from flow (Animesh et al. 2011; Csikszentmihalyi et al. 2014; Koufaris 2002), because interacting with a system is not pleasurable per se. Moreover, being unfocused is not necessarily optimal for mind wandering users, because the activity might bear severe downsides (e.g., error susceptibility). The discrimination from related concepts shows that in contrast to other cognitive concepts, the content of wandering thoughts while using technology is not necessarily set in relation to the system at hand (e.g., thinking about web design), but on an unconstrained array of internal notions and feelings. However, the interaction with technology is considered a pivotal factor for this off-task brain activity (Bockarova 2016).

Accordingly, previous literature called to investigate technological characteristics and their associations with mind wandering in more detail (Sullivan et al. 2015). The need for further studies in this regard is in line with the appeal raised by Briggs (2015), who demands a more elaborated examination of human elements in IS research, namely human cognition and its relationships with technology-related aspects. Against this background, we seek to fill this gap by exploring the role of mind wandering while using technology. To address our objective, this study entails two research questions (RQs) that drive our research model and hypothesis development:

RQ1: *Does the type of system relate to mind wandering?*

RQ2: *Does mind wandering while using technology positively relate to creativity?*

8.3 Research Model and Hypothesis Development

We base the concept of mind wandering on existing literature on technology use that distinguishes two important types of systems, namely utilitarian systems (e.g., Davis 1989; Venkatesh et al. 2016) and hedonic systems (e.g., Lowry et al. 2013; e.g., van der Heijden 2004). Utilitarian systems are systems that "provide value that is external to the interaction between the user and system (e.g., improved performance)" (Lin et al. 2012). In contrast, hedonic systems "aim to provide self-fulfilling rather than instrumental value to the user, are strongly connected to home and leisure activities, focus on the fun aspect of using information systems, and encourage prolonged rather than productive use" (Lin et al. 2012). Based on these two systems, we propose a research model that investigates whether mind wandering varies in relation with the type of system. To demonstrate the relevance of mind wandering, we further include creativity as a dependent variable that is defined in the context of work as "the development of practical and new solutions to workplace challenges, providing a tangible and useful outcome for an organization" (Hirst et al. 2011). Finally, we include perceived usefulness, which is the "degree to which a person believes that using a particular system would enhance his or her job performance" (Davis 1989), as a moderating variable. The research model is shown in Figure 8.1.

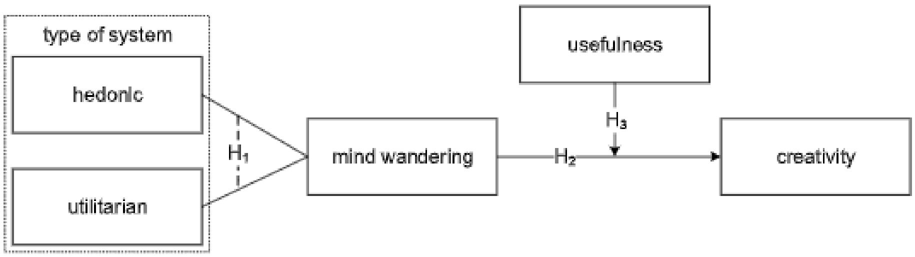

Figure 8.1. Research Model

Several studies report that the underlying type of system is related to cognitive concepts such as cognitive absorption (Wakefield and Whitten 2006) or flow (Bridges and Florsheim 2008). This relates to the assumption that there are different motivational factors involved (Lowry et al. 2015; van der Heijden 2004). Wu and Lu (2013) provide an excellent overview of the motivational aspects in both domains. Their review shows that external motivational factors, including job relevance or reward, are important aspects when it comes to utilitarian systems. In contrast, motivational factors such as enjoyment or playfulness are relevant in terms of hedonic systems.

Among others, Lowry et al. (2013) identified escapism as an important intrinsic motivator that plays a role with regards to hedonic systems. Escapism allows people to "get away from it all" (Huizinga 1949 as cited in Mathwick et al. 2001). In the context of online systems, escapism is defined as "using the online environment to avoid thinking about real life problems" (Yee 2006). This notion is well aligned with literature on mind wandering that suggests that letting your mind wander is a mental way to escape from given situations (Seli et al. 2015a; Smallwood 2013; Smallwood et al. 2018). Consequently, we assume that mind wandering while using technology also varies among hedonic and utilitarian systems. Combining the above arguments, we propose the following hypothesis (H):

> ***H1:*** *Using hedonic systems results in a higher degree of mind wandering compared to using utilitarian systems.*

Mind wandering has widely been identified as an important antecedent of creativity (Agnoli et al. 2018; Dijksterhuis and Meurs 2006; Fox and Christoff 2018; Gable et al. 2019). Earlier works on daydreaming have already suggested that a higher propensity to daydream leads to a higher degree of creativity (Singer 1974; Singer and Antrobus 1963). More recent literature on mind wandering indicates that the benefits of incubation intervals when performing a creative task are greater in undemanding tasks, which are known to give rise to mind wandering, than in demanding tasks (Baird et al. 2012). This is in line with the exploration/exploitation framework (Sripada 2018), which suggests that mind wandering is an important brain activity to foster exploration. Based on a current study on physicists and writers, Gable et al. (2019) show that some of the best ideas occur when the mind is wandering, which is commonly known as an "Aha"; or "Eureka"; moment. Also, the results of functional magnetic resonance imaging (fMRI) reveal that mind wandering activates the default mode network (Andrews-Hanna et al. 2014), which in turn leads to greater creativity (Wang et al. 2009). While we find accumulated evidence on the positive relationship between mind wandering and creativity, there are also studies that could not support this connection. For instance, Smeekens and Kane (2016) report no relationship between mind wandering and divergent thinking. Nevertheless, we follow previous literature that provides strong claims about the relationship between the two concepts (Fox and Beaty 2019) and assume that this relationship also holds in technology-related settings. Consequently, we propose our second hypothesis:

H2: *Mind wandering while using technology is positively related to creativity.*

Recent literature puts emphasis on the importance of distinguishing between deliberate and spontaneous mind wandering (Seli et al. 2015a; Seli et al. 2016c). Research from neuroscience suggests that deliberate mind wandering leads to a stronger integration between brain regions, including the prefrontal cortex (Golchert et al. 2017), which in turn supports an individual's capability to plan future events (Baird et al. 2011; Christoff et al. 2009). The distinction between deliberate and spontaneous thoughts is also emphasized with regards to creative thinking (Agnoli et al. 2018). Specifically, results show that deliberate mind wandering positively predicts creative performance and result in a higher tendency to come up with novel and useful ideas compared to spontaneous mind wandering. In addition, it is demonstrated that deliberate mind wandering, in interaction with awareness and describing facets, is a meaningful predictor of response originality and creative achievement. According to the insight that deliberate mind wandering is voluntary and involves both meta-awareness and control, it leads to the assumption of its purposefulness and usefulness. In technology-related settings, the concept of usefulness is well-understood (Davis 1989; Hess et al. 2014). In fact, previous literature shows that usefulness is an important moderating aspect in utilitarian settings (Davis 1989) as well as in hedonic settings (van der Heijden 2004). In line with this body of knowledge, we suggest that deliberate thoughts while using technology are related to creative outcomes, and that this relationship is strengthened by perceived usefulness. Thus, we propose:

H3: *The relationship between mind wandering while using technology and creativity is stronger as perceived usefulness increases.*

8.4 Methodology

Exploratory Study Design

Since the concept of mind wandering is yet not well-understood, we choose an exploratory approach in this study. To explore variances in terms of mind wandering and its correlation with creativity, we used an experimental technique to conduct exploratory research with a between-subject design. We applied a factorial survey methodology (Jasso 2006; Rossi and Anderson 1982; Wallander 2009) that has been successfully applied in similar research endeavors (e.g., Vance et al. 2015), because it allows a systematic variation as commonly used in experimental research and can be well applied as an online study. Consequently, we can apply this methodology to answer the proposed research questions with a significant number of participants.

Procedure of the Exploratory Study

The scenario-based study covered four phases. First, participants were informed about the general setting and the goal of the study. Second, the circumstances and initial situation (see 'context') were presented by description (details are provided in next paragraph). Third, the participants watched a video (about 30 seconds long) of a specific scenario. Each scenario had been recorded on a cell phone. To ensure a high level of involvement, we invited the participants to refer to the following situation based on what kind of technology they use daily (e.g., smartphone, tablet, or laptop). Fourth, the participants were asked to complete a questionnaire.

Context. As common in factorial survey, participants are put into specific situations that are relevant for the phenomenon that is investigated. Since this study seeks to shed further light into the differences between using hedonic systems and utilitarian systems, we created a scenario in which both types of systems can be used. Specifically, we introduced the participants to a workplace situation around 10 o'clock in the morning when employees usually enjoy a coffee break. Since a previous task had taken longer than expected, the participant began her/his break a little later than her/his colleagues and started paying attention to her/his cell phone. Based on this description, we asked the participants to put themselves into this situation as good as possible. Each participant had unlimited time to get familiarized with this situation and to immerse into the given context.

Scenarios. Following the contextual introduction, each participant watched one of four videos, which are briefly described in the following paragraphs (more details for each scenario, including screenshots of the videos, are attached in the Appendix):

Scenario/Condition 1 ("Gaming"): A common type of hedonic use of technology is playing (mobile) games (e.g., Lin et al. 2012). To mimic this type of use, we showed the game "Froggy Jump" by Invictus Games Limited, which is a popular mobile game where the goal is to navigate a jumping frog through obstacles to gain points.

Scenario/Condition 2 ("Facebook"): Another important type of hedonic use relates to social media use. To imitate this type, we selected Facebook and showed a video where the participant quickly navigates through commercials, comments, and postings.

Scenario/Condition 3 ("Booking"): To represent utilitarian use of technology, we provided a video that shows a booking process for a railway ticket. Here, the participant saw the subsequent steps of booking a ticket, starting with entering the point of departure and destination and ending with paying and reviewing the ticket.

Scenario/Condition 4 ("Email"): Finally, to represent a second example of utilitarian use, we showed a video of writing an email to a professor to register for a workshop. In this scenario, the participant saw a complete composition of a short email that was sent to the professor at the end.

Subject Background Information

We collected data from 208 participants. The subjects were either full-time employees (48.1%), part-time employees (29.1%), students (29.8%), or miscellaneous (12.0%). The participants' average age was 29 years (M = 29.85, SD = 11.31), 50 percent were male and 50 percent were female. Overall, the participants indicated that they could understand the given situations (M = 4.0 on a five-point Likert scale), which also suggests that the scenarios were comprehensible and relevant to the participants. There were no statistically significant differences in the demographic variables across the conditions.

Measurement of Variables

We used established measurement scales for mind wandering (WAND), perceived usefulness (PU), and creativity using seven-point Likert scales. An overview of the items is given in the following table. It summarizes the descriptive statistics and the reliability coefficients by means of Cronbach's alpha.

Mind wandering (Oschinsky et al. 2019; Wati et al. 2014)	**In this situation…**	
	WAND 1	…my mind wandered.
	WAND 2	…I thought about something, which was not related to the situation.
	WAND 3	…I was daydreaming.
	WAND 4	…I did not concentrate on the situation.
Perceived Creativity (Hirst et al. 2011)	**This situation supports me …**	
	CREA 1	…to seek new ideas and ways to solve problems.
	CREA 2	…to generate ideas revolutionary to the field.
	CREA 3	…to be creative and innovative.
	CREA 4	…to try out new ideas and solutions.
Perceived Usefulness (Agarwal and Karahanna 2000)	**PU 1**	…to enhance my effectiveness.
	PU 2	…to enhance my productivity.
	PU 3	…to guide my work-related activities.
	PU 4	…to improve my performance.

Table 15. Measurement Instrument

Mind wandering is an internal mental experience and can be measured based on self-reports (Smallwood and Schooler 2015). To investigate psychometric attributes of mind wandering, we selected four items from existing multi-measure scales (Oschinsky et al. 2019; Wati et al. 2014). Perceived creativity was measured using a four-item scale proposed by Hirst et al. (2011). Usefulness was measured as suggested by Agarwal and Karahanna (2000).

Variable	Mean	SD	kurtosis	skew	α
CR1	3.490	1.796	-1.108	0.050	.95
CR2	3.332	1.753	-0.974	0.170	
CR3	3.370	1.781	-1.064	0.182	
CR4	3.399	1.831	-1.010	0.278	
PU1	3.567	1.827	-1.084	0.096	.93
PU2	3.466	1.878	-1.064	0.207	
PU3	3.341	1.776	-0.835	0.325	
PU4	3.433	1.822	-1.020	0.217	
WAND1	3.476	1.966	-1.282	0.153	.81
WAND2	3.678	2.059	-1.333	0.051	
WAND3	3.274	2.009	-1.222	0.353	
WAND4*	3.644	2.200	-1.466	0.139	
Note. * Item dropped to enhance reliability.					

Table 16. Mean, SD, Kurtosis, Skew, Cronbach's α

8.5 Results

Mind Wandering across Scenarios

To investigate how mind wandering differs across groups, we performed a one-way ANOVA. The results show a statistically significant effect of the scenarios on mind wandering at the $p < .0001$ level for the four conditions [$F(3, 204) = 8.01$, $p < .001$].

Predictor	Sum of Squares	df	Mean Square	F	p	partial η^2	partial η^2 90% CI [LL, UL]
(Intercept)	821.86	1	821.86	307.63	.000		
condition	64.22	3	21.41	8.01	.000	.11	[.04, .17]
	545.00	204	2.67				
Note. LL and UL represent the lower limit and upper limit of the partial η^2 confidence interval, respectively.							

Table 17. Fixed-Effects ANOVA Results Using Mind Wandering as the Criterion

A post hoc analysis using the Tukey's HSD test indicates no statistically significant difference between mind wandering in condition 1 (Gaming) and in condition 2 (Facebook) (.35, 95%-CI[-.51, 1.22]). The degree of mind wandering significantly decreases between condition 1 and condition 3 (Booking) (-.83, 95%-CI[-1.61, -.06]) and condition 4 (Email) (-1.06, 95%-CI[-1.92, -.20]). Similarly, condition 2 (Facebook) differs significantly from condition 3 (Booking) (-1.18, 95%-CI[-2.01, -.35]) and condition 4 (Email) (-1.41, 95%-CI[-2.32, -.49]). Finally, there was no significant difference between condition 3 (Booking) and condition 4 (Email) (-.22, 95%-CI[-1.04, .59]). Consequently, the results support our first hypothesis (H_1). A summary of means, standard deviations, and adjusted p-values is summarized in Table 18 and Table 15

Condition	**N**	**M**	**SD**	**(1)**	**(2)**	**(3)**
(1) Gaming	54	3.90	1.53			
(2) Facebook	42	4.25	1.50	.721		
(3) Booking	68	3.07	1.79	.028	.001	
(4) Email	44	2.84	1.63	.008	.000	.889
Note. M indicates mean. SD indicates standard deviation.						

Table 18. Means, Standard Deviations, and Adjusted p-Values

	Self-reported creativity	
Variable	**b**	**95% CI**
(Intercept)	1.81**	[.88, 2.73]
WAND	-.11	[-.35, .13]
PU	.33**	[.10, .56]
WAND x PU	.07*	[.01, .13]
F	33.68***	
R2	.33	
Adj. R^2	.32	
Note. N = 208. CI = confidence interval. * p < .05. ** p < .01. *** p < .001		

Table 19. Predictors of Creativity

Since the results of the regression analysis suggest a statistically significant interaction effect of mind wandering while using technology and perceived usefulness on creativity, we further conducted a floodlight analysis of the simple effect of perceived usefulness on mind wandering, highlighting regions where that simple effect is statistically significant (Spiller et al. 2013). As shown in Figure 8.2, with a higher degree of mind wandering, the moderating effect of perceived usefulness increases. More specifically, the floodlight analysis shows that when mind wandering is above ≈ 3.1 (on a seven-point Likert scale), the impact of perceived usefulness becomes statistically significant.

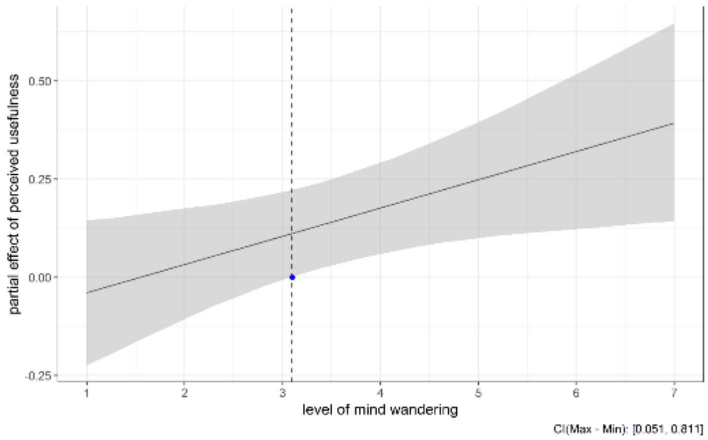

Figure 8.2. Effect of Perceived Usefulness on Mind Wandering

8.6 Discussion

Discussion of the Results

Mind wandering allows further insights into human cognition and behavior in technology-related settings. Therefore, this study seeks to expand previous efforts to understand the role of mind-related concepts. Specifically, this research put further light in variations of mind wandering while using technology under specific conditions and its effect on perceived creativity.

In terms of RQ1 (*Does the type of system relate to mind wandering?*), our results suggest a statistically significant difference between the use of hedonic and utilitarian systems when it comes to mind wandering. Both utilitarian conditions indicate a lower level of mind wandering (Booking: M = 3.07, SD = 1.79; Email: M = 2.84, SD = 1.63) compared to the hedonic conditions (Gaming: M = 3.90, SD = 1.53; Facebook: M = 4.25, SD = 1.50). These results are in line with previous literature that has demonstrated that the type of system has a statistically significant correlation with cognitive aspects (Wakefield and Whitten 2006).

With regards to RQ2 (*Does mind wandering while using technology positively relate to creativity?*), we have mixed results. While the variation of mind wandering was in line with our expectations, we could not support a positive (direct) relationship between mind wandering and creativity ($b = -.11$, $p = .367$). This result points to the theoretical assumption that a certain amount of intention and purposefulness is required in order to create new solutions and stimulate divergent thinking. We account for that by including perceived usefulness, which is a pivotal concept in IS research (Davis 1989). In doing so, we found a small but statistically significant relationship between mind wandering while using technology and perceived creativity moderated by perceived usefulness ($b = .07$, $p = .025$). Our results show that mind wandering is part of a more complex process, which requires some degree of deliberation to yield positive outcomes. This is in line with existing literature that highlighted the importance of distinguishing deliberate and spontaneous thoughts (Seli et al. 2015a; Seli et al. 2016c). Therefore, our results also confirm previous studies that were not able to find statistically significant direct relationships between mind wandering and creativity (Smeekens and Kane 2016) and points to the complex nature of cognitive processes while using technology.

Implications for Theory

Although individuals spend up to 50 percent of their waking time letting their mind wander, IS research has only taken initial efforts to study mind wandering and related associations. Therefore, our study is an important step toward a better understanding of human cognition in technology-related settings. This is important because mind wandering explicitly acknowledges thoughts that are decoupled from current situations. This makes it an important supplement to established concepts in IS research that focus on the here and now, including IT mindfulness (Dernbecher and Beck 2017; Sun et al. 2016; Thatcher et al. 2018) or cognitive absorption (Agarwal and Karahanna 2000). Our research contributes to a more holistic perspective on mental activities that are relevant to explain IS-related phenomena. Consequently, future research can benefit from the combined efforts of introducing the mind-related concept of mind wandering to IS research and carefully select from either one to investigate a technology-related phenomenon in greater detail. Moreover, we know only little about their explanatory power when used complementarily. Future research should investigate if mind wandering and related concepts (e.g., mindfulness or flow) have mutual benefits or if they cancel each other out.

While we believe that there are many research areas that can benefit from mind-related concepts, we assume that using different approaches—for example, mind wandering and cognitive absorption—can also be of particular interest for those researching the dark side of technology (Tarafdar et al. 2013). This relates to the fact that individuals can detach and 'dream away' in possible stressful situations. Moreover, the danger of using hedonic systems in a dysfunctional manner is well known (Soror et al. 2015). With the ubiquity of technology, many potential drawbacks, including addiction, work overload, disrupted work-life balance, or technostress, can occur. In this respect, mind wandering while using technology could be an important coping mechanism (Christoff et al. 2016). In addition, by following a balanced view of both the benefits of technology use and the implications of mind wandering, future research can help to understand how to both maximize positive results of mind wandering and reduce its negative consequences.

This research also contributes to a growing body of knowledge in the field of NeuroIS (Dimoka et al. 2011; Riedl and Léger 2016). More specifically, by providing initial evidence on a possible relationship between mind wandering and creativity, this research substantiates the usefulness of neurological tools for future investigation and triangulation. Research has started to develop classifiers that allow for the development of neuroadaptive systems (Krol et al. 2016). Based on our results, it is advisable to take the same path when it comes to mind wandering. Having a neuroadaptive system in place that can positively enhance mind-wandering activities while using technology can be an important step toward enhancing future work-related IT.

An increasing body of research is concerned with hedonic systems (Lowry et al. 2013; van der Heijden 2004; Wu and Lu 2013). This research adds to this stream of knowledge by investigating a new cognitive concept, namely mind wandering, in relation to the underlying type of system. Therefore, we provide empirical evidence that using hedonic systems and favoring escapism can be useful for work-related aspects. This is in line with early works on hedonic motives (Huizinga 1949) and more recent literature that suggests the use of gamification elements to positively influence outcome variables (Liu et al. 2017). This also contributes to existing literature on gamification at work (Suh et al. 2017). Specifically, we encourage future research to investigate how mind wandering while using technology relates to the recurrence principle (Liu et al. 2017).

Implications for Human Computer Interaction

Although this research primarily seeks to understand the relationship between technology use and mind wandering, it is also beneficial for design-related research and human computer interaction. Most importantly, it indicates that, apart from the characteristic of a specific task, the design and the corresponding use experience might relate to mind wandering. Specifically, we assume that specific designs or design elements invite individuals to let their thoughts drift off. Consequently, an IT artifact designed for utilitarian purposes (e.g., an Enterprise Resource Planning system) should consider this aspect to decrease mind wandering, because it negatively correlates with productivity (Wati et al. 2014). In contrast, artifacts that are designed to accelerate creativity should in turn stimulate mind wandering because it significantly increases creativity when combined with usefulness. Thus, our results also suggest that the design should allow for some degree of usefulness to positively correlate with creativity. We thus encourage future research to develop and test design theories considering mind wandering while using technology.

Mind wandering is a concept that allows us to shift our attention toward the humanness in IS research. Because it is a predecessor to creativity (Agnoli et al. 2018; Gable et al. 2019), it can also be considered a pivotal capability to foster innovation, which can barely be substituted by machines today. Therefore, research that is concerned with the design of emerging technologies, including the anthropomorphism of devices and systems, can draw from our insights. With regards to human computer interaction, designers are invited to consider the ubiquity of mind wandering while using technology and thus design systems that acknowledge both on-task and off-task thoughts. Regarding the design of future systems, mind wandering is a cognitive concept that can promote anthropomorphism.

Implications for Practice

Our research also has important implications for practice. First and foremost, this research highlights the vital role of cognitive states and mind-related concepts in work-related settings. While numerous studies exist that seek to inform organizations on how to increase productivity, this study primarily informs organizations on the usefulness of mental escapes. We demonstrate that mind wandering can be correlated with creativity, which can have an association with performance increases in the long term (Dane 2018). Consequently, organizations should take mind wandering into consideration when designing future workplaces. More specifically, organizations are encouraged to give more room for mental escapes; for example, by including hedonic aspects in their work environments. This is particularly relevant for jobs that are reliant on creative outcomes. In contrast, jobs that depend on performance and productivity should be designed to avoid mind wandering.

8.7 Limitations

As every study, the results of this study should be interpreted in light of its limitations. We observed variations of mind wandering while using technology under specific conditions based on an exploratory research design. Consequently, more research is required to draw further conclusion in terms of causal relationships. Future research could however build on these initial insights to investigate the effect of specific systems or design features in a controlled setting (e.g., in a laboratory experiment). Moreover, the outcome variable was measured on a perceptual level in our study, which could also be triangulated in a controlled setting using +creative tasks to approximate creativity as an outcome variable. In addition, this study shows that the relationship between technology and mind wandering is complex in its nature. Therefore, future research is advised to acknowledge complex mechanisms including non-linear effects or additional moderating variables.

8.8 Conclusion

In summary, we align with previous IS research (Sullivan et al. 2015; Wati et al. 2014) and make a case for the importance of mind wandering in technology-related settings. Based on the results of an exploratory investigation, we show that mind wandering while using technology varies when using hedonic systems or utilitarian systems respectively. Moreover, we demonstrate that in combination with a certain degree of usefulness, mind wandering has a significantly predicts creativity, which demonstrates that "not all those who wander are lost". We hope that our work encourages scholars to consider mind wandering in their future research.

8.9 References

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9. Paper 3: Does the Type of Mind Wandering Matter?

Title	**Does the Type of Mind Wandering Matter? Extending the Inquiry about the Role of Mind Wandering in the IT Use Experience**
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Table 20. Fact Sheet Publication

Does the type of mind wandering matter? Extending the inquiry about the role of mind wandering in the IT use experience

Purpose *- This study sought to distinguish characteristics of cognitive processes while using technology. It identifies similarities and differences between mind wandering and cognitive absorption in technology-related settings to develop a deeper understanding of the role that mind wandering plays when using information technology.*

Design/methodology/approach *- Data was gathered using an online survey including responses from 619 English-speaking adults in 2019. We applied a confirmatory factor analysis and used a robust variant of maximum likelihood estimator with robust standard errors and a Satorra-Bentler scaled test statistic. The data analysis procedure was conducted with the R environment using the psych package for descriptive analysis, and lavaan to investigate the factorial structure and the underlying correlations.*

Findings *- We discuss the benefits of carefully differentiating between cognitive processes in Information Systems research and depict avenues how future research can address current shortcomings with a careful investigation of neurophysiological antecedents.*

Originality *- To date, mind wandering has been explored as a single phenomenon, though research in reference disciplines has begun to distinguish varieties and how they distinctly impact behavior. We demonstrate that this distinction is also important for our discipline by showing how two specific types of mind wandering (i.e., deliberate and spontaneous mind wandering) are differently correlated with sub-dimensions of cognitive absorption, a well-studied construct.*

Keywords: *Cognition, Mind Wandering, Cognitive Absorption, Temporal Dissociation, Enjoyment, Default Mode Network.*

9.1 Introduction

Information systems (IS) researchers are often interested in the role that cognitive processes play in human behavior related to information technology (IT). Cognition is a broad term for thought, experience, and the senses, and thus encompasses crucial thought processes such as attention, memory, reasoning, and judgement. Researchers analyze cognition and cognitive processes from different perspectives, notably by drawing from techniques used in the fields of neuroscience, psychology, education, and computer science. To date, the study of cognitive processes has been identified as foundational to research in digital innovation, decision support, and especially human-computer interaction (Davern et al., 2012). However, IS researchers have only recently begun to earnestly investigate the role that internally-directed cognitive processes play in technology-related settings (Riedl and Léger, 2016; Thatcher et al., 2018).

One widely-studied example in the IS discipline is the construct of cognitive absorption. In their seminal paper, Agarwal and Karahanna (2000) defined cognitive absorption as a state of deep engagement with software when users lose a sense of external attention. Today, it is recognized as a conceptualization of the IT use state (Burton-Jones and Straub, 2006; Sullivan and Davis, 2020; Venkatesh et al., 2012). Agarwal and Karahanna (2000) highlighted five dimensions of the phenomenon: temporal dissociation, focused immersion, heightened enjoyment, control, and curiosity. Sullivan and Davis (2020) explored ways that internally-directed cognitive processes, such as mind wandering, play in influencing the well-studied cognitive absorption construct. They found that there is a curve-linear relationship between the two, where mind wandering can have a negative effect on cognitive absorption to a point when it turns positive. This conclusion is not necessarily supported by the literature. Given that mind wandering can impair one's ability to engage with a task, it may negatively influence the ability to experience cognitive absorption (Zhang et al., 2017; Smallwood et al., 2007a). However, there are studies hinting at the fact that its presence may actually facilitate cognitive absorption when a user engaged in IT use due to the link between mind wandering and a loss of sense of time and place (Braboszcz and Delorme, 2011), as well as mind wandering's propensity to facilitate creative thought (Gable et al., 2019).

Both mind wandering and flow, the related construct which inspired Agarwal and Karahanna's cognitive absorption construct (2000), are associated with activity of the brain's executive and default mode networks (DMN) (Ulrich et al., 2014; Ulrich et al., 2016; Golchert et al., 2017). Though the activation of similar underlying brain networks does not suggest that the constructs share an underlying equivalency, it nonetheless suggests that mind wandering may play a role in shaping the IT use experience. The expected relationship between these constructs is thus inconclusive, though it is possible that this is due to the lack of clarity in the mind wandering construct. In this paper, we further refine this relationship described by Sullivan and Davis (2020) with evidence that the relationship between mind wandering and cognitive absorption may be influenced by the variety of mind wandering reported. Learning more about the relationship between internally-directed cognitive processes, such as mind wandering, and states of IT use, such as cognitive absorption, can give insight into the mental antecedents of IT use. Such insights can eventually inform how to effectively design and organize information systems. By identifying the contexts in which the correlates of mind wandering are present, we can identify the contexts where mind wandering may affect the way that people use IT.

Psychologists studying mind wandering have distinguished its varieties, most notably a distinction between spontaneous and deliberate components (Carriere et al., 2013; Seli et al., 2016c). We investigated whether the two varieties of mind wandering differently affected degrees of experienced cognitive absorption. The results of our survey study (n = 619) show that the degree of reported deliberate and spontaneity sub-dimensions of mind wandering were correlated differently with sub-dimensions of cognitive absorption. In this study, we focus on two specific sub-dimensions of cognitive absorption, namely enjoyment and temporal dissociation. These sub-dimensions have been well studied in previous IS literature as well as related disciplines, and can be considered important antecedents for IS-related concepts such as technology use and adoption as well as performance and creativity (Sullivan and Davis, 2020; Agarwal and Karahanna, 2000; Smallwood and Schooler, 2015; Conrad and Newman, 2019; Lee et al., 2012; Mazzoni et al., 2017; Rutkowski et al., 2007; Brooks and Longstreet, 2015; Baird et al., 2012; Baird et al., 2011). Moreover, both seem relevant when designing systems that motivate or avoid boredom (Oschinsky et al., 2019). We are led to conclude that future work related to mind wandering in IS would benefit from exploring the varieties of mind wandering experienced during technology use. We also highlight the importance of distinguishing cognitive processes and call for a neuroscientific study of internal mental processes which are associated with cognitive constructs commonly used in IS research. To address our objective, this study is guided by two research questions (RQs):

RQ1: *How do varieties of mind wandering relate to mood (e.g., enjoyment)?*

RQ2: *How do varieties of mind wandering impact our temporal perception?*

The remainder of this paper is structured as follows. First, we provide a background on how information systems research and cognitive neuroscience have investigated mind wandering so far (section 2.1 and 2.2.). Based on existing literature, we highlight a need to further explore varieties of mind wandering and develop our hypothesis (section 2.3). In section 3, we provide details about our research methodology and present the results in section 4. We conclude with a discussion of our results (section 5) and conclude by highlighting avenues for future research.

9.2 Background and Hypotheses

Mind wandering and IS research

It is common to notice mind wandering during lectures, while reading, meditating, driving, taking a shower or even when simply staring out the window (Baldwin et al., 2017; Zhang et al., 2017). Mind wandering is a common experience during which our attention becomes detached from the external environment and turns to our internal notions and feelings (Fox and Christoff, 2018; Smallwood and Schooler, 2015; Giambra, 1995). Mind-wandering episodes are characterized by an easeful way to move away from ongoing tasks and a seemingly haphazard manner to switch from topic to topic (Posner and Petersen, 1990; Schooler, 2002; Schooler et al., 2011; Giambra, 1989). As such, it is defined as “a mental state, or a sequence of mental states, that arise relatively freely due to an absence of strong constraints on the contents of each state” (Christoff et al., 2016, p. 719).

Mind wandering predominantly occurs during the resting state, in non-demanding circumstances and during task-free activity (Buckner and Vincent, 2007; Smith et al., 2009) and is seen as is highly undesirable in many situations (Smallwood et al., 2007a; Smallwood and Schooler, 2015; Smeekens and Kane, 2016). It is promoted by stress and substance abuse (Epel et al., 2013; Sayette et al., 2012; Smallwood et al., 2007b), and is often associated with a lack of awareness, unhappiness, poor performance, errors, disruption, disengagement, and carelessness (Baldwin et al., 2017; Drescher et al., 2018; Zhang et al., 2017). Although mind wandering can have various undesirable consequences, studies have also demonstrated that it offers benefits (Mooneyham and Schooler, 2013). It has been shown to positively relate to creativity, the planning of the future, and positive mood (Agnoli et al., 2018; Baird et al., 2012).

With an increasing interest in mind-wandering episodes, several distinct characteristics and subtypes have been discussed. First, mind wandering is a state, however, researchers also investigated the tendency to mind wander as a trait (Seli et al., 2016b, 2016a). As a state, mind wandering has conventionally been studied using various real-time reporting techniques such as experience sampling probes (Forster and Lavie, 2009). When investigating mind wandering traits, researchers have asked participants to report on levels of mind wandering throughout the day as they go about their regular business (Seli et al., 2015). It has been demonstrated that people reliably report both state and trait mind wandering, and that there is a general correspondence between the varieties of measures used (Seli et al., 2016b, 2016a).

Second, a distinction has been made between deliberate (i.e., intentional) and spontaneous (i.e., unintentional) mind wandering (Seli et al., 2016c). This distinction goes back to Giambra (1989, 1995), who argued that voluntary shifts of attention involve a higher degree of control compared to involuntary shifts. The intention to begin or to continue to mind wander implies meta-awareness and purposefulness, which is not present when it is spontaneous. Various studies show that this distinction causes different effects. Agnoli et al. (2018) demonstrate that deliberate mind wandering positively predicts creative performance, whereas spontaneous mind wandering is negatively associated with it. In contrast, spontaneous mind wandering seems to be associated with negative consequences such as reduced performance.

Over the last six years, IS researchers have acknowledged the ubiquity and complex nature of mind wandering while using technology (Wati et al., 2014; Conrad and Newman, 2019; Oschinsky et al., 2019; Bockarova, 2016; Sullivan and Davis, 2020). They began to study how mind-wandering episodes shape a technology user's response to external stimuli or her or his primary task performance (Bockarova, 2016). For instance, Sullivan et al. (2015) showed that mind wandering while using IT correlates significantly with creativity and knowledge retention. They developed a domain-specific definition understanding technology-related mind wandering as "task-unrelated thought which occurs spontaneously, and the content is related to the aspects of computer systems" (Sullivan et al., 2015, p. 4). They clarified that an IS research agenda on this concept has yet to emerge. We believe that this conceptualization is too specific because the content of wandering thoughts is not necessarily set in relation to the system at hand (e.g., thinking about web design), but on an unconstrained array of internal notions and feelings. Thus, we broaden their definition and see mind wandering while using technology as "task-unrelated thought which occurs spontaneously, and related to the aspects of information systems".

Because the interaction with technology is considered a pivotal factor for the cognitive process of mind wandering in an IS context (Bockarova, 2016), some scholars have called to investigate contextual characteristics, such as technological characteristics, and their associations with mind wandering in more detail (Sullivan et al., 2015). This position is in line with the more general demand raised by Briggs (2015) for a more elaborated examination of human elements in IS research, namely human cognition and its relationships with technology-related aspects. Other IS scholars highlighted the benefits of more deeply exploring brain functionality when exploring new IS constructs, even when neuroscience tools are not employed (Riedl et al., 2017). By exploring the reference literature on mind wandering from psychology and neuroscience, we can better understand how this construct relates to research from the IS discipline. Against this background, we seek to fill this gap by exploring the role of mind wandering while using technology and by highlighting important sub-dimensions and boundaries of the concept. Furthermore, by exploring this relationship we may reveal a framework for understanding cognitive constructs used in IS research.

Brain networks, mind wandering, and cognitive absorption

Though some research on mind wandering has been conducted from a behavioral perspective, much of the extant research on the topic takes a neurophysiological perspective. Cognitive neuroscience is the scientific study of how the brain produces thoughts, emotions and ideas, usually through the application of neuroethologies such as functional magnetic resonance imaging (fMRI), positron emission tomography (PET), or electroencephalography (EEG) (Newman, 2019). Brains consist of a series of cells which are interconnected and work together to conduct brain functions. Though the connections between networks of cells are dynamic and incredibly numerous (estimated to number around 86 trillion connections), many cell networks are organized at a large scale and are possible to study (Hebb, 2005). For IS scholars, the study of cognitive neuroscience promises to add deeper insight about the antecedents of IT behavior (Riedl and Léger, 2016). In the case of mind wandering, which has not yet been well-studied in IS, the reference disciplines of neuroscience and psychology can offer insights into what role it may play in influencing IT behavior.

It is believed that the mind wandering phenomenon is the result of two distinct brain networks: the default mode network (DMN) and frontoparietal control network (Fox et al., 2015; Christoff et al., 2009; Golchert et al., 2017). The DMN is responsible for the consistent 'default mode' of the brain and was originally discovered by observing the resting state during neuroimaging experiments (Raichle, 2015; Raichle et al., 2001; Buckner and Vincent, 2007). The DMN has been associated with inwardly-focused cognitive functions, ranging from future thinking tasks (Beaty et al., 2018) to the encoding of experience information and its level of detail (Sormaz et al., 2018). In the early days following its discovery, it was also hypothesized that the DMN was responsible for spontaneous thoughts (Raichle et al., 2001), a hypothesis which was later supported with strong evidence and accepted by the cognitive neuroscience community (Fox et al., 2015).

As neuroimaging evidence emerged over time, however, it became increasingly clear that the DMN alone was insufficient to capture the basis of spontaneous thoughts and mind wandering. Executive regions, specifically frontoparietal regions associated with control, were soon found to play an important role in the process (Fox et al., 2015). Executive functions are cognitive processes which contribute to higher thinking such as working memory, selective attention, and response inhabitation (Diamond, 2013). The frontoparietal control network is associated with goal-directed behavior, a subset of broader executive functioning (Niendam et al., 2012). It has been suggested that the activation of the default mode and frontoparietal control networks during mind wandering episodes is the result of coupling with the default mode network, where the control networks guide and evaluate between various streams of conscious thoughts (Fox and Christoff, 2014; Smallwood and Schooler, 2015).

Though a meta-analyses of neuroimaging studies found consistency in the relationship between the two networks (Fox et al., 2015), the causal relationship between the networks is not yet conclusive and may depend on the context during which mind wandering takes place (Seli et al., 2018). For instance, the demandingness of a task may influence how the networks interact. An association between increased cognitive control abilities and decreased mind wandering has been observed in cognitive demanding situations (Rummel and Boywitt, 2014; McVay and Kane, 2009), however, an association between increased cognitive control abilities and more off task thoughts has also been observed in environments where participants had non-demanding tasks (Levinson et al., 2012). Findings such as these have led researchers to scrutinize a variety of contexts during which mind wandering occurs (Smallwood and Andrews-Hanna, 2013; Seli et al., 2018), including the conditions during which it may be spontaneous or deliberate (Seli et al., 2016c).

A recent neuroimaging study explored the differences in the brain between situations of reported deliberate and spontaneous mind wandering and found significant differences in brain between the states (Golchert et al., 2017). In addition, using neuroimaging, Golchert et al. (2017) observed that differences in patterns representative of the integration between the DMN and the frontoparietal control network were associated with the intentionality of the participants (i.e., whether the mind wandering was reported to be deliberate). This finding lends support to the notion that executive control is important to constraining deliberate mind wandering, though not spontaneous mind wandering (Golchert et al., 2017), a notion which is further supported by other studies which have found a relationship between intentional mind wandering which depends on task difficulty (Seli et al., 2016c).

By contrast, there has been limited work conducted on the neurophysiological correlates of the cognitive absorption construct. Léger et al. (2014) investigated the cognitive absorption construct as participants played a serious game and found a significant positive association between EEG alpha oscillation activity and reported cognitive absorption as well as a negative relationship between EEG beta activity and the construct. These results suggest that the cognitive absorption construct is associated with a relaxed state and moderate levels of task load. A short review conducted by Michailidis et al. (2018) investigated the role of flow, the phenomenon on which cognitive absorption is based, in video games, and found results that both corroborated this conclusion and conflicted with it. Some studies have suggested that the loss of self-reflective thoughts during flow experiences is the result of reduced activity of in the prefrontal cortex, which contains the brain's executive networks (Dietrich, 2004; Bavelier et al., 2012; Ulrich et al., 2014), as well as decreased activity in brain regions associated with the DMN (Ulrich et al., 2016). Others have instead suggested an association with emotional reward processing (Yoshida et al., 2014) or attentional mechanisms (Harris et al., 2017). At very least, there is evidence to support the notion that flow and cognitive absorption can be contrasted between states of boredom and heightened brain activity, which can be observed by relative decreased or increased activity in the DMN and prefrontal networks. Both cognitive absorption and mind wandering are therefore complex, multi-faceted cognitive phenomena which are associated with similar processes of the DMN and prefrontal networks. It is thus possible that the mind wandering process relates to extant IS research concerning artifacts that involve sustained attention and intervention, such as clickbaits (Aswani et al., 2018; Osatuyi and Hughes, 2018), online learning (Conrad and Newman, 2019; Sullivan et al., 2015) or fake news (Ross et al., 2018). It is also possible that mind wandering relates to creativity processes, such as those triggered during group collaboration software use (Seeber et al., 2017). Future research in mind wandering might benefit from investigating the presence of mind wandering during the use of these artifacts.

Hypothesis Development

Both mind wandering and cognitive absorption are cognitive phenomena, which could impact user engagement during technology use. Given the academic attention to varieties of mind wandering (Fox and Christoff, 2018; Seli et al., 2018) and the call for a greater focus on cognitive factors in IS research (Briggs, 2015), we were led to investigate the relationship between varieties of mind wandering and the sub-dimensions of the well-studied IS construct. With a greater understanding of the associations between the varieties of mind wandering and the sub-dimensions of cognitive absorption, we might infer instances when varieties of mind wandering influence IT use.

Since the main purpose of this study is the investigation of varieties of mind wandering and their relation on cognitive absorption, we deliberately distinguish specific sub-dimensions of cognitive absorption instead of using cognitive absorption as a conglomerate. Previous literature has followed similar paths. For instance, Burton-Jones and Straub (2006) only selected one specific sub-dimension of cognitive absorption to investigate the relationship to system use. Likewise, Saadé and Bahli (2005) only use three out of five dimensions to investigate cognitive absorption within a learning context. In this line of argument, we select two specific sub-dimensions of cognitive absorption that are associated with varieties of mind wandering.

In their recent study, Sullivan and Davis (2020) reported correlations between mind wandering and the various cognitive absorption sub-dimensions. They discovered that mind wandering was positively correlated with temporal disassociation and curiosity; but no relationship was found between it and focused immersion or enjoyment. It was also reported to be negatively correlated with control (Sullivan and Davis, 2020). The positive correlation between mind wandering and temporal disassociation is not surprising, as prominent understandings of the mind wandering concept concern disengagement from sensory input and present environmental factors (Smallwood and Schooler, 2015).

However, it was surprising that Sullivan and Davis (2020) did not observe correlations between mind wandering and enjoyment. In contrast, Oschinsky et al. (2019) found that hedonic IT system use is associated with increased mind wandering, though not in the case of utilitarian IT use. In addition, enjoyment has also been identified as a product of some varieties of mind wandering, especially those that are deliberate rather than spontaneous in nature (Seli et al., 2016a). It is possible that varieties of mind wandering are similarly distinguished by the way that they interact with the enjoyment sub-dimensions of the cognitive absorption construct, and that the findings of Sullivan and Davis (2020) are explained by the lack of specificity about the variety of mind wandering that they observed. In this study, we focus on two important considerations of mind wandering that has been established in previous literature (Smallwood et al., 2011; Franklin et al., 2013; Fox and Christoff, 2018; Schooler et al., 2011). First, how does mind wandering relate to mood? Second, how does it impact our temporal perception? Since Killingsworth and Gilbert (2010) proposed that a “wandering mind is an unhappy mind”, research has substantiated and refined this claim (e.g., Franklin et al., 2013). While previous studies primarily focused on happiness, we assume similar effects can be observed in terms of enjoyment. Consequently, we propose that spontaneous episodes of mind wandering (MWT-S) are positively correlated with enjoyment (H1a) while deliberate episodes (MWT-D) are primarily negatively correlated with enjoyment (H1b).

***H1a**: MWT-S is positively correlated with enjoyment.*

***H1b**: MWT-D is negatively correlated with enjoyment.*

Similarly, mind wandering has been consistently identified by the de-coupling or diversion of attention from imminent experience and towards self-generated thoughts (Smallwood and Schooler, 2006; Mooneyham and Schooler, 2013). This does not always impact experience or performance negatively however, as several studies suggest that such shifts in attention away from external experience helps individuals on autobiographical planning (Baird et al., 2011) or develop creativity (Mooneyham and Schooler, 2013). Consequently, mind wandering can have a significant effect on temporal disassociation, which is part of cognitive absorption. Since both varieties of mind wandering relate to perceptual decoupling (Smallwood and Schooler, 2015; Annerer-Walcher et al., 2020; Schooler et al., 2011; Zedelius and Schooler, 2018), we assume that it likewise positively correlates with temporal disassociation. We thus propose that both MWT-S and MWT-D positively correlated with temporal disassociation (H2a and H2b).

***H2a**: MWT-S is positively correlated with temporal disassociation.*

***H2b**: MWT-D is positively correlated with temporal disassociation.*

9.3 Methodology

Participants

Since the focus of this research is to develop a better understanding of general perceptions and IS-related traits, we used a survey-based methodology instead of neurological tools and interpret the results in light of the cognitive neuroscience and cognitive psychology literature. Our approach has been recommended for IS researchers when exploring novel constructs (Riedl et al., 2017, p. 13) and is also consistent with previous literature which explored varieties of mind wandering (e.g., Carriere et al., 2013). This research is part of a larger project on mind wandering where we gathered data using an online survey on Amazon's Mechanical Turk's website. The data was collected in 2019 from English speaking countries (United States of America, Canada, United Kingdom, Australia, and New Zealand). From the overall number of participants (N = 700), we excluded participants who finished their survey in more than 15 minutes, to avoid uniform or defective answers by checking the overall time that participants took to answer our questions (Galesic and Bosnjak, 2009). Consequently, 619 answers are used here. The participants had an average age of 36 years (M = 36.67, SD = 11.56). In this sample, 54.1% of the participants are male and 44.7% are female. The remaining 1.2% did not indicate or identify themselves as male or female. Most participants (above 50%) received some form of college degree. More than 59.3% have a full-time job while 13.7% held a part-time job, and 27.0% indicated other forms (e.g., being a student). Most participants reported working more than 15 years at their company (M = 15.75, SD = 11.20). A detailed overview of the demographics is provided in Table 21.

Dimension	**Classification**	**Percentage**
Age	18-28	21.0%
	29-38	38.6%
	39-48	22.5%
	48-58	12.8%
	58-68	3.5%
	68-78	1.3%
	NA	0.3%
Gender	Male	54.1%
	Female	44.7%
	NA	1.2%
Education	Less than High School	1.1%
	High School	11.8%
	Some College	24.6%
	2-Year College Degree	13.3%
	4-Year College Degree	35.4%
	Master's Degree	11.0%
	Doctoral Degree	1.2%
	Professional Degree	1.6%
Years working at the organization	1-15	49.8%
	16-30	36.8%
	31-45	11.8%
	46-60	1.4%
	NA	0.2%
Job	Full-time	59.3%
	Part-time	13.7%
	Other (e.g., Student)	27.0%

Table 21. Demographics, N = 619

Measurements

To explore this phenomenon, we chose to compare measures of MWT-S and MWT-D (Carriere et al., 2013) and correlated them with the selected sub-dimensions of the cognitive absorption construct (Agarwal and Karahanna, 2000). By asking questions about general perceptions of mind wandering and cognitive absorption experiences during technology use, we can learn about commonalities and relationships between the constructs. We adapted the items proposed by Agarwal and Karahanna (2000) to operationalize enjoyment and temporal dissociation. All items were measured on a 7-point Likert scale. To quantify MWT-D and MWT-S, we adapted existing scales (Carriere et al., 2013; Agarwal and Karahanna, 2000) using three items to measure MWT-D and ten items to measure MWT-S. All items are on the trait level. An overview is given in Table 22.

Construct	Item	Question
MWT-S		When using technology,…
(Carriere *et al.*, 2013)	MWT-S1	… I find my thoughts wandering spontaneously.
	MWT-S2	… my thoughts tend to be pulled from topic to topic.
	MWT-S3	… I mind wander even when I'm supposed to be doing something else.
	MWT-S4	… I have difficulty controlling my thoughts.
	MWT-S5	… I find it hard to switch my thoughts off.
	MWT-S6	… my thoughts are disorganized and 'all over the place'.
	MWT-S7	… I find it difficult to think about one thing without another thought is entering my mind.
	MWT-S8	… I find my thoughts are distracting and prevent me from focusing on what I am doing.
	MWT-S9	… I have difficulty slowing my thoughts down and focusing on one thing at a time.
	MWT-S10	… I find myself flitting back and forth between different thoughts.
MWT-D		When using technology,…
(Carriere *et al.*, 2013)	MWT-D1	… I allow my thoughts to wander on purpose.
	MWT-D2	… I enjoy mind-wandering.
	MWT-D3	… I find mind-wandering is a good way to cope with boredom.
Enjoyment		When using technology,…
(Agarwal and Karahanna,	ENJ1	… I always have fun to interact with it.
2000)	ENJ2	… I always have a lot of enjoyment.

	ENJ3[2]	… I always enjoy using it.
	ENJ4[1,2]	… I always get bored.
Temporal Dissociation (Agarwal and Karahanna, 2000)		When using technology,…
	TD1	... time always appears to go by very quickly.
	TD2	… I always lose track of time.
	TD3	… time always flies.
	TD4	... I always end up spending more time that I had planned.
	TD5	… I am always spending more time on it than I intended.
[1] reverse item [2] dropped to increase reliability		

Table 22. Questionnaire

The data analysis procedure is conducted with the R environment (R Core Team, 2018) using the *psych* package (Revelle, 2019) for descriptive analysis, and *lavaan* (Rosseel, 2012) to investigate the factorial structure and the underlying correlations.

To ensure the validity of our measurement model, we first investigated the reliability of each construct based on Cronbach's alpha MWT-S ($\alpha = .95$), MWT-D ($\alpha = .84$), and temporal dissociation ($\alpha = .91$). To increase the reliability of enjoyment, we dropped ENJ3 and ENJ4 for the further analysis which led to $\alpha = .92$. An overview of the descriptive statistics is provided in Table 23.

Construct	**Item**	**M**	**SD**	**Skewness**	**Kurtosis**	**α**
MWT-D	MWT-D1	3.33	1.84	0.29	-1.07	.84
	MWT-D2	3.31	1.85	0.27	-1.13	
	MWT-D3	3.90	1.88	-0.15	-1.20	
MWT-S	MWT-S1	3.34	1.75	0.20	-1.00	.95
	MWT-S2	4.08	1.72	-0.30	-0.75	
	MWT-S3	4.23	1.82	-0.36	-0.90	
	MWT-S4	4.02	1.82	-0.21	-1.03	
	MWT-S5	4.03	1.85	-0.18	-1.09	
	MWT-S6	3.92	1.84	-0.13	-1.07	
	MWT-S7	3.20	1.77	0.37	-0.95	
	MWT-S8	4.08	2.07	-0.12	-1.34	
	MWT-S9	3.35	1.87	0.38	-0.98	
	MWT-S10	3.82	1.85	0.00	-1.16	
Temporal Dissociation	TD1	4.61	1.73	-0.44	-0.72	.91
	TD2	4.92	1.65	-0.62	-0.37	

	TD3	4.88	1.72	-0.68	-0.41	
	TD4	5.12	1.62	-0.80	-0.03	
	TD5	4.91	1.73	-0.67	-0.44	
Enjoyment	ENJ1	5.00	1.40	-0.54	0.04	.92
	ENJ2	4.93	1.43	-0.55	0.10	

Table 23. Descriptive Statistics (Mean (M), Standard Deviation (SD), Skewness, Kurtosis, and Cronbach's Alpha (α))

Discriminant validity was assessed based on the Fornell-Larcker criterion (c.f. Table 24). Since all squared correlations are larger than the average variance extracted, discriminant validity is given.

	MWT-D	**MWT-S**	**Temporal Dissociation**	**Enjoyment**
MWT-D	.646			
MWT-S	.224	.670		
Temporal Dissociation	.030	.150	.665	
Enjoyment	.007	.017	.104	.856

Note. The numbers on the diagonal are the average variance extacted (AVE). Off digagonal elements are the squared correlations between the constructs. For discriminant validity, diagonal elements should exceed the off-diagonal elements.

Table 24. Discriminant Validity (Fornell-Larcker)

Since some participants did not complete our survey, the results are susceptible to non-response bias (Armstrong and Overton, 1977). To test whether this, we followed previous literature (Shiau and Chau, 2016) and compared early respondents with late respondents[1]. For that we extracted the responses of the first 10% of the sample (62 observations) and the responses of the last 10% in our sample and conducted a series of two-sided *t*-tests on demographic variables. A comparison of age, gender, and education yield in no significant differences ($p > .05$). We thus concluded that non-response bias was not a problem.

9.4 Results

We applied a confirmatory factor analysis including all four factors to investigate the correlations between them. We use a robust variant of maximum likelihood estimator with

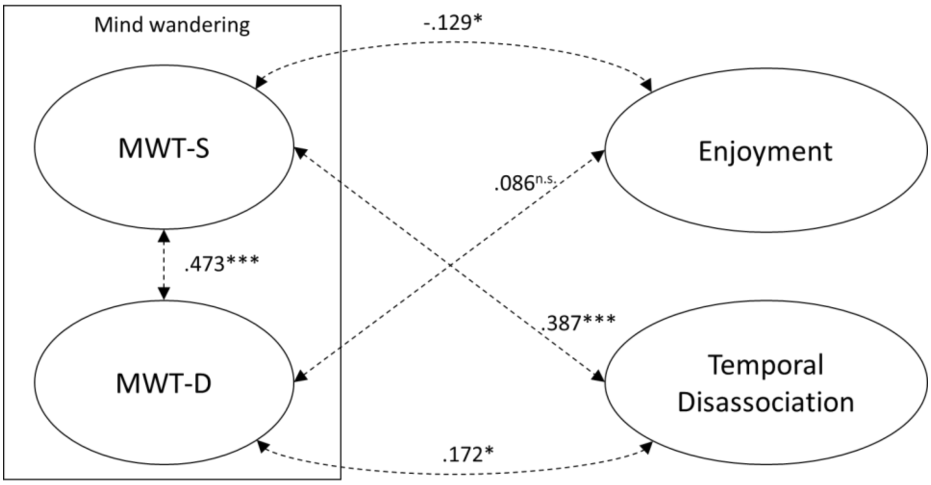
[1] We would like to thank one annyonmous reviewer for raising a potential issue related to non-respondent bias and for suggesting following the procedure by Shiau and Chau (2016).

robust standard errors and a Satorra-Bentler scaled test statistic (i.e., MLM) and report the results as suggested by Kline (2016). The results suggest a significant χ^2 (164, N = 619) = 668.273, p = .000. The Comparative Fit Index (CFI = .939), Tucker-Lewis Index (TLI = .929), the Root Mean Square Error of Approximation (RMSEA = .070), and the Standardized Root Mean Square Residual (SRMR = .043) indicate a good model fit. The results related to the measurement model is summarized in Table 25. The standardized loadings are sufficiently high (> .721) and significant (p < .001).

Construct	**Item**	**λ**	**se**	**z**	**p**	**95% confidence interval**	
MWT-S	MWT-S1	.842	.015	55.575	.000	.813	.872
	MWT-S2	.867	.013	65.628	.000	.841	.893
	MWT-S3	.866	.013	64.630	.000	.840	.893
	MWT-S4	.820	.017	47.714	.000	.786	.854
	MWT-S5	.727	.025	28.977	.000	.677	.776
	MWT-S6	.808	.018	44.944	.000	.773	.843
	MWT-S7	.834	.018	46.350	.000	.798	.869
	MWT-S8	.804	.018	44.018	.000	.768	.839
	MWT-S9	.811	.017	47.428	.000	.777	.844
	MWT-S10	.822	.017	48.888	.000	.789	.855
MWT-D	MWT-D1	.722	.025	29.040	.000	.673	.771
	MWT-D2	.844	.024	34.519	.000	.796	.892
	MWT-D3	.839	.021	39.600	.000	.798	.881
Enjoyment	ENJ1	.960	.023	41.744	.000	.915	1.006
	ENJ2	.890	.029	31.100	.000	.834	.946
Temporal Dissociation	TD1	.749	.024	31.015	.000	.702	.797
	TD2	.756	.025	30.430	.000	.707	.805
	TD3	.910	.013	71.931	.000	.885	.934
	TD4	.721	.029	24.728	.000	.664	.778
	TD5	.907	.013	67.461	.000	.880	.933

Table 25. Measurement Model (Standardized Loading (λ), Standard Error (se), z-Value, p-Value and Confidence Interval

The results related to the correlations between all factors is shown in Figure 9.1. Both dimensions of mind wandering correlate significantly (ϕ = .473, p < .001). With regards to enjoyment, the results show a negative correlation with MWT-S (ϕ = -.129, p < .01) and a non-significant correlation with MWT-D (ϕ = .086, p > .1). In terms of temporal dissociation, the results show a significant correlation with MWT-S (ϕ = .387, p < .001) and positive correlations with MWT-D (ϕ = .172, p < .01).



Note. Double-sided arrows indicate correlations. χ^2(164, *N* = 619) = 668.273, CFI = .939, TLI = .929, RMSEA = .070, SRMR = .043. ***: p < 0.001, **: p < 0.05, *: p < 0.01, n.s.: not significant

Figure 9.1. Results of the Factor Model

Table 26 summarizes our results with regards of the proposed hypothesis. H1a could not be supported as the data suggested a negative correlation. H1b could also not be supported as we could not infere a significant relationship at all. H2a and H2b can both be supported.

Hypothesis	**Support**
H1a: MWT-S is positively correlated with enjoyment.	no
H1b: MWT-D is negatively correlated with enjoyment.	no
H2a: MWT-S is positively correlated with temporal disassociation.	yes
H2b: MWT-D is positively correlated with temporal disassociation.	yes

Table 26. Summary Hypothesis

9.5 Discussion

Discussion of the results

Our results indicate that the two sub-dimensions of perceived mind wandering relate differently to enjoyment, though not in the way originally supposed. Specifically, our study provides initial evidence that spontaneous mind wandering is negatively related with enjoyment while deliberate mind wandering is not. The finding of a negative association between spontaneous wandering and enjoyment is in line with Killingsworth and Gilbert (2010) who proposed that a "wandering mind is an unhappy mind", following their investigation of happiness and mind wandering. The lack of a positive correlation between deliberate mind wandering is possibly an effect of the MWT-D item, which is related to the prevention of boredom. This nonetheless suggests that it may be useful to distinguish between enjoyable mind wandering when investigating this construct in IS research. It also raises a question about whether deliberate mind wandering may specifically play a mediating role in constructs related to enjoyment.

Both MWT-S and MWT-D were found to be correlated with temporal dissociation. This is not surprising because the mind wandering and cognitive absorption constructs are used to describe phenomena where attention is directed from the outside world towards inwardly-focused ideas (Sullivan and Davis, 2020), hinting at perceptual decoupling from the external environment. The temporal dissociation captured by the original cognitive absorption construct (Agarwal and Karahanna, 2000) similarly reflects the inward direction of attention of mind wandering. This finding is consistent with findings by Sullivan and Davis (2020) who reported a correlation between temporal dissociation and mind wandering, significant at the 0.01 level. Mind wandering experiences may consistently reflect temporal dissociation and may similarly influence IT use.

With regards to theory development, we interpret this research to lend evidence to the importance of distinguishing the varieties of mind wandering when conducting research in IT use or user experience. In line with Seli et al. (2018), future IS research on mind wandering would benefit from viewing mind wandering as a heterogeneous construct united by family resemblances rooted in common neurophysiology. Distinct varieties of mind wandering may interact differently with various well-studied IS constructs, though may consistently reflect temporal dissociation. This extends the current view of mind wandering in the IS discipline, which has so far investigated the construct as a singular phenomenon. Furthermore, the finding of negative correlation between spontaneous mind wandering and enjoyment, but no such correlation with deliberate mind wandering, suggests that the presence of spontaneous mind wandering specifically may have a moderating effect on the degree of enjoyment experienced during technology use.

On the importance of distinguishing cognitive processes

So far, we focused on two distinct types of mind wandering to demonstrate different effects on sub-dimensions of cognitive absorption. However, this raises an issue which has implications for IS research in cognitive processes broadly. When studying cognitive processes, such as those related to attention, memory, or language, it is critical to precisely distinguish the variety of the process and its context. We argue that this is particularly relevant for cognitive constructs that have already been used as multi-dimensional concepts in previous IS literature such as IT mindfulness (Thatcher et al., 2018).

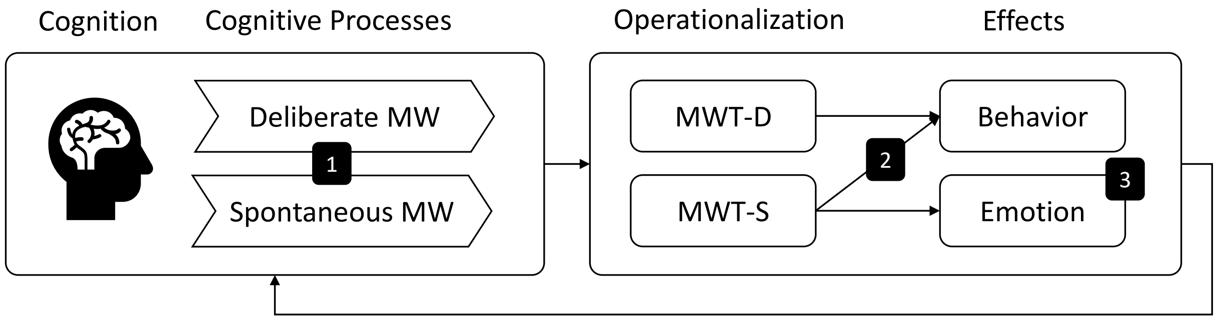


Figure 9.2. Issues Related to the Operationalization of Cognitive Processes

Figure 9.2 conceptualizes the proposition that behavioral effects while using technology (right box) are built on cognitive processes (left box). Since cognition research is wide-ranging, IS scholars commonly refer to specific sub-processes in this regard, such as deliberate or spontaneous mind wandering. Those processes are operationalized and put into context by including the resulting effects (e.g., technology use behavior).

Following the above example, we identify three potential pitfalls that can occur if cognitive processes are not carefully distinguished in advance. First (point 1), specific effects of interest (e.g., technology use behavior) may not be adequately explained due to inaccurate conceptualizing of cognitive processes. In other words, relevant relationships might not be established, because the underlying mechanism (i.e., the cognitive process that is responsible for the relationship) is not explicit. Consequently, some amount of the explained variance might not be leveraged if scholars oversee the distinct sub-process of the overall cognitive processes.

Second (point 2), interrelationships between sub-processes and other more complex relationships cannot be considered if such distinctions are not made. In case of mind wandering, we assume that both types (deliberate and spontaneous) correlate with cognitive absorption but do so differently with various effects. Therefore, it is important to operationalize the sub-dimensions accordingly to conduct more detailed analysis with regards to specific effects.

Finally (point 3), accurately distinguishing cognitive processes can lead to profound new knowledge about humans' relationship with IT. IS research is increasingly drawing knowledge from other disciplines, such as neuroscience, and there are greater efforts to conduct interdisciplinary research (Riedl and Léger, 2016). Such efforts promise to not only create new areas of inquiry for IS researchers, but also offer new insights that could improve the accuracy of models or inform the psychological or neurological origins of IS constructs and further expand the discipline. While we use mind wandering as an example in this study, the above points generalize to cognitive processes broadly, and the opportunities at hand are relevant to most cognitive processes used in the IS discipline.

Limitations

There are limitations to these findings, which must be considered when interpreting the results. First, though we observed a distinction between two varieties of mind wandering and a sub-dimension of the cognitive absorption construct, it is important to note that many of the sub-dimensions were not observed to be correlated with mind wandering at all (Appendix A). This contrasts with findings by Sullivan and Davis (2020) who found correlations between mind wandering and control and curiosity (though not enjoyment or focused immersion). This can in-part be accounted for by differences in the measures employed, though raises potential concerns about the consistency of mind wandering in relation to the cognitive absorption construct.

A second limitation is that the analysis conducted investigated perceptions about mind wandering and cognitive absorption during technology use, rather than use during a specific information use task. As discussed, the effects of varieties of mind wandering may be different depending on the specific context employed. Past and ongoing work in IS research investigates the differences between real-time experience and perceptions of mind wandering experiences (Conrad and Newman, 2019). By refraining from asking participants to identify a specific IT use instance, it is possible that the results reflect general perceptions, rather than causal relationships between the constructs in a specific IT context.

Future work

As IS researchers become more interested in the study of inwardly directed cognitive processes it is critical that they pursue clarity about the constructs being investigated. In this paper we presented evidence that two varieties of mind wandering (spontaneous and deliberate) may differently relate to cognitive absorption and consequently IT use. It is desirable to extend this research to findings in different IT use contexts. For example, Seli et al. (2018) point to literature where mind wandering has been observed to be beneficial to goal-directed thinking (Baird et al., 2011) and creativity (Baird et al., 2012), but also detrimental to successful learning (Wammes et al., 2016) and completion of driving tasks (Yanko and Spalek, 2014). The varieties of mind wandering reported by researchers in psychology has varied greatly in terms of content intentionality, task relatedness and relationship to stimuli, which has been partially responsible for these seemingly contradictory findings (Seli et al., 2018).

Research on mind wandering in the IS domain is in its nascent stages, which may be a benefit to researchers interested in pursuing questions related to it. By specifying the varieties of mind wandering in the context of an IT use task, we may discover ways that different varieties produce different effects, though may also discover commonalities between such contexts. If there is such a family of mind wandering constructs, does it have implications for IT design? What is the role of using different kinds of technologies such as voice assistance systems? By conducting inquiries to a many different IS phenomena and being specific about the mind wandering features being explored, we may discover a general theory about the role that mind wandering plays in IT use and the conditions under which mind wandering is either beneficial or a hindrance.

All of this underscores a more important point however, which is that the varieties of IS constructs studied in IT use settings are fundamentally the result of underlying cognitive mechanisms which could better explain the phenomenon in question. In the example explored in this paper, both the mind wandering and cognitive absorption constructs have been associated with processes of the DMN and executive brain networks. By studying the role that these networks play in an IT use setting, researchers may discover improved constructs for explaining user experience generally. The consistency of temporal dissociation may give insight into antecedents which underlie both the mind wandering and cognitive absorption constructs. Future work may also benefit by exploring the relationship between temporal dissociation and the performance of attentional mechanisms during IT use.

9.6 Conclusion

This research was motivated by a desire to better understand the role that mind wandering may play in IT use. We have evidence that mind wandering may be most relevant to IT use contexts when temporal dissociation is present, and that the variety of mind wandering experienced by users may be affected by hedonic experience. Moving forward, future research in mind wandering during IT use would benefit from exploring varieties of mind wandering and potentially its underlying psychophysiological mechanisms. Mind wandering is still a new field of research in the reference disciplines and is in its nascent stages in IS. By exploring the antecedents of constructs such as mind wandering and cognitive absorption, we may yet uncover better explanations about how we use IT and potentially design technologies which are better suited to humans' cognitive processes.

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9.8 Appendix A: Cognitive Absorption

Agarwal and Karahanna (2000) introduced cognitive absorption to the IS domain as a construct which includes five sub-dimensions: curiosity, control, temporal disassociation, focused immersion, and heightened enjoyment. While cognitive absorption has gained significant attention in numerous studies (e.g., Saadé and Bahli, 2005), there are also authors which suggest that the concept is tightened during specific situations and might be best observed by measuring the balance between task difficulty and the ability to attain a task (Léger et al., 2014). To test the validity of cognitive absorption as originally proposed, we conducted confirmatory factor analysis to investigate whether the data support a five-dimensional second order conceptualization and juxtaposed the results to a model with five first order constructs. All items were measured as suggested by Agarwal and Karahanna (2000). We dropped curiosity 1 (“CU1”) and two enjoyment items (“E3”, “E4”) to enhance the reliability of the constructs.

We carried out the analysis using the MLM estimator and compared both models based on the χ^2, the CFI, the TLI, the RMSEA, and the SRMR. An overview of the results is shown in Table 27. Although both models did not exhibit high degrees of fit, there is a clear indication that the first order model works better as it outperforms the 2nd order model regarding all fit measures considered. We also carried out an analysis of variance to compare both models yielding a significant χ^2 test ($p < .01$).

Model	χ^2	df	CFI	TLI	RMSEA	SRMR
1st order	655.450	94	.869	.833	.114	.092
2nd order	539.161	73	.877	.846	.121	.106

Table 27. Fit Statistics for Cognitive Absorption (1st Order Model and 2nd Order Model)

Based on this insight, we conclude that cognitive absorption is not necessarily a second order model in every situation and can be likewise observed with specific sub-dimensions. This is in line with Burton-Jones and Straub (2006) who already argued that it is critical to “balance parsimony with completeness” (p. 237, footnote 7) and only included focused immersion in their study. Thus, our study adds to this line of argument both on a conceptual level (as argued in the main article) and on an empirical level (as shown above). While we fully agree that an act of balancing sub-dimensions can be defensible (Burton-Jones and Straub, 2006, Appendix A), we also acknowledge that providing the results of a model that includes all sub-dimensions can also be an important contribution to inform future research. Consequently, we report an additional model that includes all sub-dimensions of cognitive absorption here. The complete model is shown in Figure 9.3.

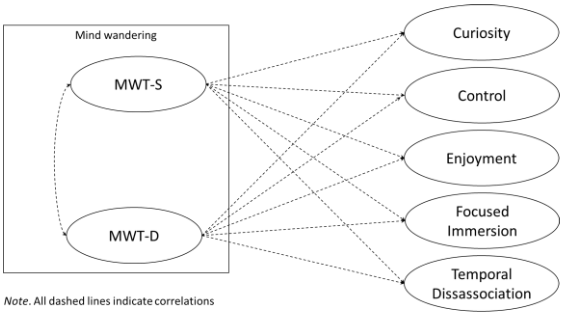

Figure 9.3. Complete Model

We conducted a CFA to estimate the model parameter using the MLM estimator. The results suggest a significant χ^2 test (384, N = 619) = 1559.907, p = .000. The Comparative Fit Index (CFI = .887), Tucker-Lewis Index (TLI = .872), the Root Mean Square Error of Approximation (RMSEA = .079), and the Standardized Root Mean Square Residual (SRMR = .095) indicate a considerable model fit.

Table 28 summarizes the results related to the correlation model. The results indicate a non-significant relationship between deliberate mind wandering (MWT-D) and control (p = .062), focused immersion (p = .339), and enjoyment (p = .097). In contrast, the remaining sub-dimensions (curiosity and temporal dissociation) significantly correlate with deliberate mind wandering (p = .001 and p = .001 respectively). With regards to spontaneous mind wandering, control and curiosity do not correlate significantly (p = .524 and p = .275). On the other hand, focused immersion (p < .001), temporal dissociation (p < .001), and enjoyment (p = .005) significantly correlate with spontaneous mind wandering.

		Coefficient	Standard error	z	p
MWT-D	CO	.099	.052	1.869	.062
	CU	.208	.079	3.377	.001
	FI	-.053	.088	-0.956	.339
	TD*	.172	.087	3.262	.001
	ENJ*	.087	.088	1.661	.097
MWT-S	CO	-.031	.058	-0.638	.524
	CU	.060	.085	1.091	.275
	FI	-.512	.105	-9.313	.000
	TD*	.387	.099	7.775	.000
	ENJ*	-.129	.094	-2.803	.005

Note. * Constructs used in the main model of this study (c.f. Figure 9.1). Control (CO), Curiosity (CU), Focused Immersion (FI), Temporal Disassociation (TD), Enjoyment (ENJ)

Table 28. Correlation Model

10. Paper 4: Scale Development and Cross-validation

Title	**Mind Wandering in Information Technology Use: Scale Development and Cross-validation**
Authors	Frederike Marie Oschinsky[1] Michael Klesel[1,2] Björn Niehaves[1] [1] University of Siegen, Siegen, Germany. [2] University of Twente, Enschede, The Netherlands.
Publication Type	Journal Paper
Publication Outlet	Data Base for Advances in Information Systems
Status	Under Review (3rd round)

Table 29. Fact Sheet Publication

Mind wandering in information technology use: Scale development and cross-validation

Abstract. *Because our minds frequently tend to drift away from the present situation, an investigation into mind wandering while using information technology (IT) is critical to allowing research on Information Systems (IS) to provide a better understanding of human behavior. Despite growing interest in mind-wandering episodes in various domains, the discipline of IS still lacks a validated measurement instrument that can fully account for all facets of the phenomenon. Our work addresses this gap and presents the results of a comprehensively developed measurement instrument. Using existing literature and the results of a pilot study (N = 35), a field study (N = 364), and a cross-validation sample (N = 336), we developed a new instrument that allows mind wandering while using technology to be measured either as a state (MWS) or as a trait with two subtypes (MWT-D: deliberate, and MWT-S: spontaneous). Whereas MWS captures a momentary mental state or a sequence of mental states that arise relatively freely while using technology in a given moment, MWT-D and MWT-S capture either intentional or unintentional, internally focused thoughts in technology-related settings in everyday life. This tool will enable future researchers to further investigate the effects of mind wandering in technology-related settings and to study these effects using IS-relevant variables, such as task performance and creativity.*

10.1 Introduction

Mind wandering can be described as a shift in attention away from a primary task and toward dynamic, unconstrained, spontaneous thoughts (Andrews-Hanna et al., 2018; Smallwood & Schooler, 2006) – or as the mind's capacity to drift away aimlessly from external events and toward internally directed thoughts (Giambra, 1989). Given that mind-wandering episodes are considered to represent a failure of attention and control (Baldwin et al., 2017; Drescher et al., 2018; Mooneyham & Schooler, 2013; Smallwood, Fishman, & Schooler, 2007; Zhang et al., 2017), their potential to yield beneficial outcomes has been widely neglected. Only in the last decade have studies highlighted the advantages of mind wandering, which include more-effective brain processing, pattern recognition, and associative thinking as well as increased creativity (Baird et al., 2012; Fox & Beaty, 2019; Smallwood & Schooler, 2015; Smeekens & Kane, 2016). Recent research has shown mind wandering to be a seminal human mode of thinking (and even a desirable one) that allows us to consider future events, solve problems, and form new ideas (e.g., in the digital workplace).

The emphasis on attentional engagement in the research on Information Systems (IS) follows the implicit assumption that our thoughts are continuously focused (Addas & Pinsonneault, 2018; Agarwal & Karahanna, 2000; Devaraj & Kohli, 2003). However, a growing body of knowledge suggests otherwise – namely, that our minds regularly tend to proceed in a seemingly haphazard manner, with thoughts jumping from one topic to another. More specifically, evidence demonstrates that our thoughts drift away for up to half of the day (Christoff et al., 2016; Killingsworth & Gilbert, 2010; Smallwood & Schooler, 2015) and that the mind is actually not always tethered to the present moment or task (Golchert et al., 2017). During the current COVID crisis, with people constantly using technology to perform tasks, mind wandering affects nearly everyone: Employees working from home may find themselves thinking about something completely unrelated to the task at hand, and students attending online lectures may become inattentive or bored. Neglecting an investigation into mind wandering thus leaves several phenomena related to the use of information technology (IT) largely unexplored – phenomena that could serve as indicators of various deficits in performance (e.g., in IT management and IT operations), of disturbed team dynamics (e.g., concerning trust and accountability), or of weakened IT security (e.g., with smart-device usage and data management) in addition to phenomena related to enhanced technology-mediated creativity (e.g., in webinars and online workshops). Studying internally directed thought also opens the door to studies in related disciplines, such as marketing, business, and consumer behavior. Against this background, research in complex technology-related contexts can benefit both from a clear conceptualization of the cognitive process of mind wandering and from a comprehensive measurement instrument that can be used to capture the phenomenon.

Because interest in mind wandering has grown significantly in psychological and neuroscientific research (Fox & Beaty, 2019), different measurement scales have been proposed. However, the operationalization of mind wandering in IS-related conditions remains underdeveloped and incomplete (Oschinsky et al., 2019; Sullivan et al., 2015; Sullivan & Davis, 2020; Wati et al., 2014). In particular, existing scales are limited in terms of the extent to which they address relevant aspects of mind wandering, including the determination of its stability while using technology (i.e., whether it should be viewed as a trait or a state) (Seli, Risko, & Smilek, 2016a) and of the differences in its degree of intentionality (i.e., deliberate vs. spontaneous mind wandering) (Seli, Risko, & Smilek, 2016b). We examine mental stability more closely because a state is a momentary condition that corresponds to thinking and feeling and a trait is linked to the human personality and can be defined as a habitual pattern of behavior, thought, or emotion. Neglecting stability and intentionality is detrimental to research because it hampers theorization and renders explanatory power unused (Smallwood & Schooler, 2015, for further discussion). It is worth noting that several existing scales have been developed based on distinct populations (e.g., mentally disordered people) which are usually not considered in IS research. In line with this, only few authors have investigated the efficacy of existing mind-wandering scales in the domain of IS research. Since valid and reliable measures are, however, a prerequisite for theory development (Gregor, 2006, 2014; MacKenzie et al., 2011; Moore & Benbasat, 1991), we seek to address this shortcoming by conducting a comprehensive instrument-development and validation procedure.

We contribute to the existing literature by developing an instrument for measuring mind wandering in technology-related settings. Specifically, we acknowledge the richness of mind-wandering episodes and provide a scale that differentiates between mind wandering as a trait and as a state and that reveals its level of intentionality (i.e., deliberate or spontaneous mind wandering). Additionally, we provide a validated short scale of the instrument, that researchers can easily implement in subsequent studies or practitioners effectively transfer to their workplace. As our motivation is to guide future IS research, our instrument opens the door to future studies in various well-researched areas, including research on acceptance, adoption, and design.

To address our objective, the subsequent sections are structured as follows: In section two (Materials and methods), we present our methodological approach. Moreover, we briefly review the current literature on mind wandering. In section three (Results), we show the results of our pilot test, field study, and cross-validation sample. Finally, we conclude by reflecting on our findings in section four (Discussion), which highlights the study's limitations and suggests fruitful avenues for future research.

10.2 Materials and methods

Conceptualization

When we work on a task, our thoughts often deviate from it and drift away. Indeed, while reading this manuscript, the reader's attention is likely to switch to unrelated thoughts and feelings. In these mind-wandering moments, we often end up somewhere entirely different from where we intended. The dynamic nature of thought, which allows us to escape from external demands, is reflected in the experience of mind wandering, which can be described as the progression of easy, spontaneous thought experiences that are more constrained than when dreaming but less constrained than when producing creative forms of thought (Christoff et al., 2016). According to Christoff et al. (Christoff et al., 2016, p. 719), mind wandering can also be defined as *a mental state, or a sequence of mental states, that arise relatively freely due to an absence of strong constraints on the contents of each state*.

Mind wandering predominantly occurs during a resting state, when performing a task-free activity, or in non-demanding circumstances (Buckner & Vincent, 2007; Christoff et al., 2016; Northoff, 2018; Smallwood & Schooler, 2015). In fact, research has found that our minds trail off during up to 50 percent of our waking time (Killingsworth & Gilbert, 2010), at which point they switch to self-generated thoughts and feelings (Smallwood & Schooler, 2015). Although they are familiar to every member of our species (Smallwood et al., 2018), surprisingly little is known about the occurrence of these moments of distraction.

Mind wandering goes hand in hand with both costs and benefits. Its association with unhappiness and its susceptibility to error highlights the high cost with which it can be associated. Mind wandering can be enhanced by stress and substance abuse (Epel et al., 2013; Sayette et al., 2012; Smallwood, O'Connor et al., 2007) and can also be a symptom of losing awareness or control, thereby causing it to be seen as a cause of poor performance, disengagement, or carelessness (Drescher et al., 2018; Mooneyham & Schooler, 2013; Smallwood & Schooler, 2015). Spontaneous mental escape is objectionable in many settings (e.g., when driving) (Baldwin et al., 2017; Zhang et al., 2017) yet is quite natural due to the automaticity that some tasks elicit. Nevertheless, this escape is desired (e.g., when relaxing) or even requested (e.g., when completing creative work) in numerous situations. In creative contexts, our minds wander to our benefit by leading to enhanced moods or to the ability to solve problems (Baird et al., 2012; Franklin et al., 2013; Wati et al., 2014). Mind wandering helps to impart significance to personal experiences and facilitates our planning and pattern recognition (Smallwood & Schooler, 2015). Furthermore, it can provide mental breaks and relieve boredom (ibid.). Given its complex nature, strategies for minimizing the downsides of mind wandering while preserving its productive elements remain undeveloped.

Mind wandering and external distraction reflect distinct albeit related constructs in which attention shifts away from task-relevant information (Unsworth & McMillan, 2014). When attention is decoupled from the environment and switches to mind wandering, we are less likely to process external information, regardless of whether the distractors are task-relevant or irrelevant (e.g., smartphone flashes or beeps). Although mind-wandering episodes and external distractions provide independent contributions to working-memory capacity and to fluid intelligence (i.e., decoupling theory), what is important is their shared variance because lapses of attention are strongly related both to cognitive abilities and to attention (i.e., attention-control theory). The context appears decisive when dealing with task performance: For instance, Robison and Unsworth (Robison & Unsworth, 2015) revealed that in noisy rooms, external distractions must be ignored, whereas in silent rooms, zoning-out must be avoided.

IS researchers acknowledge the relevance of mind wandering, which can take many forms and lead to functional outcomes in technology-related settings (e.g., performance) (Conrad & Newman, 2019; Oschinsky et al., 2019; Sullivan et al., 2015; Wati et al., 2014). While using technology, the user's mind can shift away from an ongoing task (e.g., data management) or event (e.g., a video conference) and toward self-generated thoughts and feelings as well as toward internally directed attention. Sullivan et al. (2015) demonstrated that mind wandering influences the functional outcomes of interacting with technology (i.e., creativity). The authors developed a domain-specific definition for technology-related mind wandering as "task-unrelated thought which occurs spontaneously and the content is related to the aspects of computer systems" (Sullivan et al., 2015, p. 4) and concluded that mind wandering can occur when a user thinks about email, social media, or other online activities instead of solving a work problem (ibid.). Moreover, Oschinsky et al. (2019) revealed a significant difference between the use of the hedonic system (e.g., while playing a mobile game) and of the utilitarian system (e.g., while composing an email) when it comes to mind wandering and concluded that the design of a system influences brain activity, which is known to effect antecedents of IT behavior and thus actual IT use (ibid.).

Distinguishing between intentional and unintentional mind wandering implies a possible difference in subjective experience. There can, for example, be an uncontrolled and spontaneous shift or a voluntary and thereby deliberate shift of attention (L. M. Giambra, 1989). Spontaneous episodes lack a conscious initiation, and during these episodes, participants are likely unaware that they are mind wandering. In contrast, intentional episodes are associated with the aim of beginning mind wandering and metacognitive awareness (Giambra, 1993; Giambra, 1995; Golchert et al., 2017; Seli, Carriere, & Smilek, 2015; Seli, Risko, & Smilek, 2016b; Seli, Smallwood et al., 2015). Whereas the difference between intentional and unintentional mind wandering is well-known to current scholars, the differentiation between the trait and its state is only rarely mentioned (Seli, Risko, & Smilek, 2016a): Spontaneous mind wandering reflects unintentional engagement in internally focused thought, whereas deliberate mind wandering is willful and intentional. However, when studying mind wandering, this distinction is of particular interest because it can traceably occur either in a particular situation at a specific point in time (i.e., while using technology) or as a distinguishing characteristic that belongs to the individual (i.e., in technology-related settings in everyday life). Consequently, to deepen the body of knowledge on mental escapes in IS research, it is necessary to acknowledge mind wandering that occurs both in a specific situation while using technology (i.e., a state) and as a personal characteristic (i.e., a trait).

Despite notable advances in studying mind wandering, its underlying mechanisms remain largely unclear. Although recent neural investigations claim to demonstrate the neural correlations between spontaneous activities that cover various brain regions (including the default mode network (DMN)) (Andrews-Hanna et al., 2014; Golchert et al., 2017; Northoff, 2018; Raichle & Snyder, 2007), conceptualizing spontaneous thought as a consequence of a single brain system appears difficult (Smallwood et al., 2018). Since self-reported measurement remains an efficient and appropriate method of assessing the appearance of mind-wandering experiences, refining the corresponding measurement instruments continues to be an important goal for research in this area (Smallwood & Schooler, 2015). This refinement can be achieved by highlighting the varying levels of stability of the construct (i.e., a trait or a state) and by developing scales that allow for more-detailed future research on phenomena related to mind wandering.

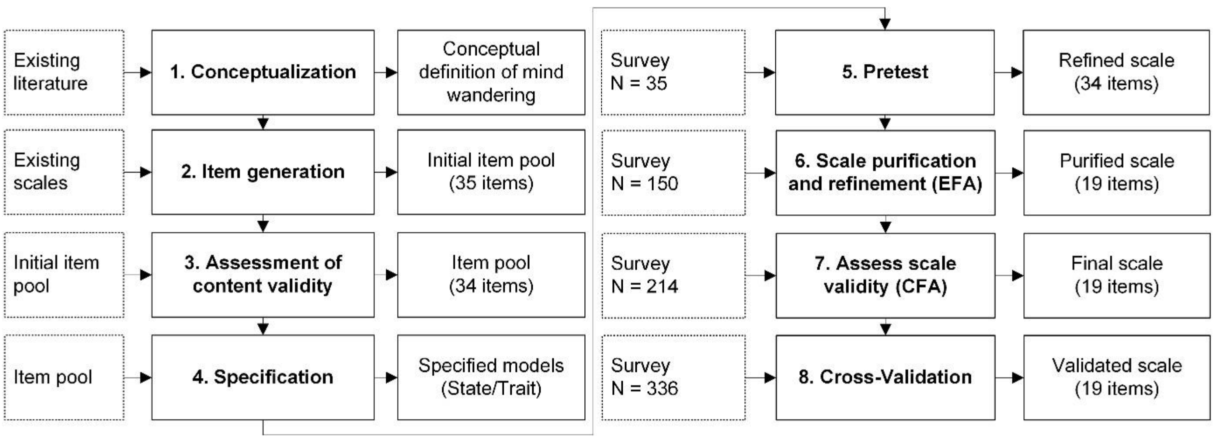

Figure 10.1. Measurement-Development Procedure

Development procedure

We followed the guidelines of acknowledged IS scholars to ensure that the procedure was comprehensive (MacKenzie et al., 2011; Moore & Benbasat, 1991), and we proceeded in eight steps (cf. Figure 10.1). After the construct of interest had been defined in the previous section (Step 1), we began the development process by collecting a pool of existing items (Step 2). Next, the content validity of the items was assessed (Step 3). Thereafter, we specified the measurement model (Step 4). Once the measurement instrument had been formally specified, we conducted a pretest to assess the psychometric properties of our instrument's attributes (Step 5). Based on the survey data, we purified and refined the scale by means of an Exploratory Factor Analysis (EFA) (Step 6). We conducted a final assessment of the scale validity by means of a Confirmatory Factor Analysis (CFA) (Step 7). Finally, we cross-validated our results (Step 8).

Item generation

In the development of our measurement instrument, we reviewed existing literature to identify scales (an overview is presented in Table 30).

Stability	Scale	Domain	Items (Scoring)	Instruments	Results (Observations)
Trait	(Mrazek et al., 2013)	Psychology	5 (6-point)	Mind-Wandering Questionnaire (MWQ)	$\alpha = .850$ (N = 663)
	(Carriere et al., 2013)		4 (7-point)	Mind Wandering: Deliberate (MW-D)	$\alpha = .902$ (N = 246*)
	(Carriere et al., 2013)		4 (7-point)	Mind Wandering: Spontaneous (MW-S)	$\alpha = .875$ (N = 246*)
	(Mowlem et al., 2016)		15 (4-point)	Mind-Excessively-Wandering Scale (MEWS)	$\alpha = .960$ (N = 81)
State	(Oschinsky et al., 2019)	Information Systems	4 (7-point)	Adaption of MWQ	$\alpha = .810$ (N = 90)
Trait and State	(Wati et al., 2014)	Information Systems	6 (7-point)	Adaption of MWQ	$\alpha = .934$ (N = 84)

Note. The results are based on the same sample.

Table 30. Overview of Existing Measurement Scales

Mrazek et al. (2013) aimed to create a validated scale for measuring the trait of task-unrelated thought. To achieve this goal, they reviewed the Daydreaming Frequency Scale (DDFS), the Attention-Related Cognitive Errors Scale (ARCES), and the Mindful Attention Awareness Scale (MAAS) and studied the interruption of task focus by task-unrelated thought (Study 1). The authors reported on four studies from across different educational establishments (N = 663), which resulted in the development of the five-item Mind-Wandering Questionnaire (MWQ), which uses a 6-point Likert scale. The questionnaire's reliability analysis yielded a Cronbach's alpha of 0.850. Although the scale was the first to demonstrate high internal consistency and convergent validity, the authors did not validate it in adult samples and did not include mind wandering that had occurred during a specific situation or task.

Carriere et al. (2013) developed measures of deliberate and spontaneous mind wandering using both the existing scales in the Spontaneous Activity Questionnaire (SAQ) and the Memory Failure Scale (MFS) as well as MAAS and ARCES (Study 1). However, the measurement of inattentiveness, attentional control, and memory failure fell short as the authors had overlooked a crucial distinction: Mind wandering can be a choice to deliberately direct a conscious train of thought away from the task at hand, or it can be a spontaneous focusing of attention on a train of thought that is wholly unrelated to the present experience (as mentioned in Step 1). Accordingly, the authors measured mind wandering via two distinct four-item scales (i.e., Mind Wandering: Deliberate (MW-D), and Mind Wandering: Spontaneous (MW-S)) (Study 2). Both scales were scored using a 7-point Likert scale. An international sample (N = 246) was conducted and yielded a Cronbach's alpha of .902 for MW-D and of .875 for MW-S. The authors replicated the findings of Studies 1 and 2 with an international sample (N = 167) (Study 3) and obtained a Cronbach's alpha of .882 for MW-D and of .842 for MW-S. Based on these results, we expected the two scales to also be meaningful in our study. However, this instrument was not able to evaluate mind wandering that had occurred during a specific situation or task. Instead, it dealt exclusively with mind wandering on a trait level.

Mowlem et al. (2016) validated their newly developed Mind-Excessively-Wandering Scale (MEWS) by taking into account the distinction between deliberate and spontaneous mind wandering. The scale contained 15 items, which were scored on a 4-point Likert scale. A study consisting of 81 adults with attention deficit hyperactivity disorder (ADHD) – an impairment known to lead to a high tendency to daydream (Study 2) – yielded a Cronbach's alpha of .960. Of course, the mental characteristics of the respondents were also taken into account. Moreover, the measurement instrument was again limited to the trait level and was not able to evaluate the mental condition corresponding to momentary thinking and feeling. Nevertheless, we expected that the scale would be valuable in extending our measurement of trait variables due to its sound psychometric properties.

The first attempt to develop an IS-specific scale was made in 2014, when Wati et al. (2014) measured mind wandering in relation to task performance. The authors used the scale developed by Mrazek et al. (2013) and worded each item to fit in a technological setting. Specifically, they adopted existing items by adding "When I was using the websites to complete the tasks…" to the beginning of the scale. The six items were scored on a 7-point Likert scale. The reliability analysis yielded a Cronbach's alpha of .934. However, in terms of the stability of mind wandering, the scale was noticeably not entirely consistent. While most items aimed to measure a state of mind in a specific situation in which technology is used (i.e., a state), the statement "...sometimes I have trouble concentrating on the task" implied a more general condition during task completion (i.e., a trait). However, we found the scale helpful as it was the first to measure mind wandering in a specific situation while using technology (i.e., a state).

In a later paper, Sullivan et al. (2015) also introduced a scale for "mind wandering (technology-related)," which included items for technology-related thoughts, such as "I thought about checking my email" and "I thought about checking my social media (e.g., Facebook)." While this approach can be helpful in specific technology-related settings, we assumed that mind-wandering thoughts are so manifold that the strong emphasis on technology-related thought was likely too limiting for many settings in IS research, and we therefore did not include this scale in our further analysis. Instead, our discussion of this deviating scale led us to conclude that in IS research, using technology (e.g., email, social media, online shopping, online gaming) is the core condition in which to assess the likelihood of mind wandering, whereas the content of the episode is indefinite and not necessarily IS-specific.

Finally, Oschinsky et al. (2019) used the scale developed by Wati et al. (see above) for specific situations in which technology was being used (e.g., booking a railway ticket online). The authors selected four items to be scored on a 7-point Likert scale. The reliability analysis yielded a Cronbach's alpha of .810. Notably, only the state was measured, and the trait was ignored. Consequently, the subtypes of mind wandering (i.e., deliberate and spontaneous) were neglected. However, we valued the scale's contribution and considered its state-level items.

While acknowledging that the existing scales either had not been applied in the IS domain or had excluded the intentionality of this mental state (i.e., deliberate vs. spontaneous), we saw great potential in comprehensively adapting existing items for our field to allow for theorizing and to provide a more-detailed understanding of mind wandering in technology-related settings. Moreover, after we identified missing components of the scales in our prior research ([left out for review]), we adapted them in a comprehensible manner. For instance, we provided appropriate introductory sentences and presented a technology-related scenario. Our approach was supported by the independent validation of our field study and was also in line with that of prior studies (see in particular the work of Seli, Carriere, & Smilek, 2015). Nevertheless, it would be possible to add additional items in the future as well as to sharpen our understanding of the state dimension.

Based on existing literature, we identified three final dimensions pertaining to the cognitive experience of internally-focused thought in technology-related settings: (1) Mind Wandering as a State (MWS), which was defined as a momentary mental state or a sequence of mental states that arise relatively freely while using technology in a given moment; (2) Mind Wandering as a Trait: Deliberate (MWT-D), which was defined as intentional engagement in internally focused thought in technology-related settings in everyday life; and (3) Mind Wandering as a Trait: Spontaneous (MWT-S), which was defined as unintentional engagement in internally focused thought in technology-related settings in everyday life. Although the distinction between spontaneous and deliberate mind wandering could hold at both the trait- (Seli, Carriere, & Smilek, 2015) and the state level, we did not further divide MWS because we did not collect any thought probes that asked the technology-users to report on their momentary cognitive experiences in the laboratory (Seli, Risko, Smilek, & Schacter, 2016); rather, we had collected only self-reports. This method is in line with that of other IS research (Sullivan et al., 2015; Wati et al., 2014). However, future studies should investigate probe-based reports that integrate more context-specific questions to measure the state-dimension of mind wandering.

Assessment of content validity

Both the simplicity and the wording of the items were examined using face-validity checks performed by two researchers. We included all 35 items in an initial pool, from which we eliminated one redundant statement ("…my mind wandered") to ensure content validity (Step 3). To further strengthen the content validity of the items, we next created small adaptations that appeared to fit the construct definition (following the work of Wati et al.

(2014) and Oschinsky et al. (2019)) and worded each item to fit with a technological setting (e.g., by adding “While using technology…” to the beginning of the scale). We attempted to assess the construct validity of the various scales and to identify any items that may still have been ambiguous or misleading. The level of agreement in categorizing and wording the items was high, which indicated a high potential for good reliability coefficients. To that end, all researchers also expressed doubt regarding whether the use of the statement “…I use alcohol or drugs to slow down my thoughts and stop constant mental chatter” (Mowlem et al., 2016) was an appropriate way to measure the construct. However, as the item is part of the original scale, we did not discard it from our analysis.

Measurement specification

We specified the factors based on their stability (state and trait) (Step 4). In order to measure mind wandering as both a state and a trait, we split the procedure into two parts: The first part was a scenario-based setting that allowed us to measure mind wandering as a state, whereas the second part was a post-questionnaire that allowed us to raise questions that went beyond the scope of the specific scenario and thereby to measure mind wandering as a trait. The existing measurement instruments identified seven state items and 27 trait items. In line with most existing scales, we used a 7-point Likert scale ranging from “strongly disagree” (1) to “strongly agree” (7). Moreover, we followed the existing literature and operationalized each concept as a reflective common factor.

Ethical and data collection

For the data collection, we implemented a scenario-based study whose protocol is approved by the local ethics committee of the University of Siegen (ER-16/2019). It was performed in accordance with the relevant regulations and data-protection guidelines.

In line with previous literature (Oschinsky et al., 2019), the quantitative vignette study comprised five phases. The sample characteristics are presented for each step in the following sections (either in the pretest or in the main studies). First, the participants were welcomed and informed about the general setting and the study’s procedures. Second, the participants were assigned to a technology-related scenario and watched a video of ca. 30 seconds about booking a railway ticket online. The video showed the steps of booking the ticket, which began with entering the point of departure (e.g., London) and the destination (e.g., Romford) into the respective fields and ended with paying for and confirming the booked tickets (exhibits are provided in the appendix). Afterward, we conducted a manipulation check that tested whether the participants were able to ascertain what they saw (i.e., "… you were booking a railway ticket."). The participants were watching the task of booking a train ticket as a video recording to account for a uniform handling of the task and to prevent distortions (e.g., common method bias). We aimed for ensuring that our results were not influenced by the context of measurement for those who might be unfamiliar with an electronic interface. Third, the participants were asked to complete a questionnaire consisting of the trait- and state items (as presented in Table 30 the full questionnaire is provided in the appendix). On the one hand, the questions addressed the specific technology-related task in the scenario (i.e., a state); on the other hand, they began with the statement "While using technology…," thereby indicating technology use in general (i.e., a trait). Fourth, the participants had to pass an attention check before continuing with the dependent variables and demographics. In the check, we controlled for age, gender, educational level, job title, years of work experience, and honesty while completing the survey. Finally, the participants were thanked and received an online code for financial compensation.

10.3 Results

Pretest

Since we adapted several items from related disciplines for IS research, we conducted a pilot study (Step 5) to ensure that the questions were understandable. Moreover, the pilot study allowed us to investigate the psychometric properties of our data, including the distributional assumptions of the items. We assumed that an investigation into mind wandering required some degree of habitual use of technology because if individuals use technology rarely or for the first time, the demands are too high to let the mind wander (Ferratt et al., 2018). In other words, habitual use of technology was expected to lead to some degree of cognitive ease, which is a prerequisite for wandering thoughts (Fox & Beaty, 2019). Consequently, we only collected data from individuals (N = 35) who had indicated that they used their smartphone daily. The participants of the pilot test had an average age of 23 years (M = 23.40, SD = 22.65), 31.4 percent were male, 68.6 percent were female, and they had an average work experience of four years (M = 4.20, SD = 4.73).

The participants were invited to comment on the length, wording, layout, and instructions of the survey. Only very minor changes (e.g., pagination) were proposed. We concluded that the instructions were easy to follow and that the manipulation- and attention checks were worded appropriately. Next, we analyzed the descriptive statistics of each item to gain an understanding of the psychometric properties of our instrument's attributes. Specifically, we investigated reliability and checked whether the questions tended to be normally distributed. Cronbach's alpha ranged from between .69 and .94, indicating a sufficient degree of reliability. Furthermore, we investigated the scale range of each item to ensure that the full range (i.e., from 1 to 7) was used. Afterward, we adjusted some items and included "always" (e.g., "…I always lose track of time.") to make participants more likely not to provide moderate answers to avoid skewness. Overall, we found no indication for dropping an item from the pool and kept all items for the field study.

Scale purification and refinement (Exploratory Factor Analysis)

Procedure. After adjusting the items, the field study was carried out. An online survey was provided to individuals from five English-speaking countries (i.e., United Kingdom, United States, Australia, New Zealand, and Canada). Roughly 34 percent dropped out after failing an attention check, which resulted in a total number of 364 participants.

The analysis was conducted in two steps (Steps 6 and 7), and we therefore randomly assigned observations to two sub-samples. One part of our data (N = 150) was used to purify the scale, and the second part (N = 214) was used to assess the validity of the scales. A series of t-tests was applied to ensure that the sample remained sociographically homogenous, thereby causing the different parts of our data to be of different sizes.

		Study 1 (EFA)	**Study 2 (CFA)**	**Study 3 (Cross)**	
Country	**Canada**	1	13	4	17
	Other	7	11	28	39
	UK	60	70	3	73
	USA	82	120	301	421
Total		150	214	336	550
Age group	**18–30**	53	76	70	146
	31–45	60	96	151	247
	46–60	27	25	76	101
	60	3	4	18	22
	NA	7	13	21	34
Total		150	214	336	550
Gender	**0**	NA	1	NA	1
	1	84	109	179	288

	2	65	101	154	255
	3	1	3	3	6
Total		150	214	336	550
Years of work experience	**1–5**	31	48	30	78
	11–15	27	29	52	81
	6–10	29	35	61	96
	> 15	55	85	167	252
	NA	8	17	26	43
Total		150	214	336	550
Education	**2**	18	24	36	60
	3	45	66	61	127
	4	20	34	45	79
	5	44	64	143	207
	6	16	23	34	57
	7	NA	1	8	9
	8	4	2	5	7
	1	3	NA	4	4
Total		150	214	336	550

Table 31. Participants According to Their Country

Sample. The average age of the 150 participants was 35 years (M = 35.15, SD = 11.52), 56.0 percent were male, 43.3 percent were female, and 0.7 percent selected “other” for “gender.” Most participants indicated a daily use of technology (M = 6.80 (7 = “I use my smartphone daily.”)). Participants had an average work experience of 14 years (M = 14.53, SD = 10.48).

Results. The suitability of the selected items for the study was assessed by considering bivariate correlations, inverse correlations, the Kaiser–Meyer–Olkin (KMO) value, and the Bartlett test. The KMO value (> .9) revealed that the partial correlations between the variables were small. In addition, the highly significant Bartlett test (p < .000) revealed that the items were uncorrelated with each other. Therefore, the prerequisites for applying an EFA is met (Loehlin, 2004).

To investigate the number of constructs of mind wandering, a principal component analysis was conducted using VARIMAX rotation. Parallel analysis was employed to determine the number of factors. The results of the parallel analysis suggested a three-component solution (cf. Figure 10.2).

In the next step, we analyzed the extracted factor loadings. Based on the rotated matrix, five items needed to be excluded due to overly high cross-loadings (MWT3, MWT4, MWT22, MWT24, and MWT26). For the sake of purification and parsimony, we refined the threshold and set the minimum correlation between an item and the factor to .7.

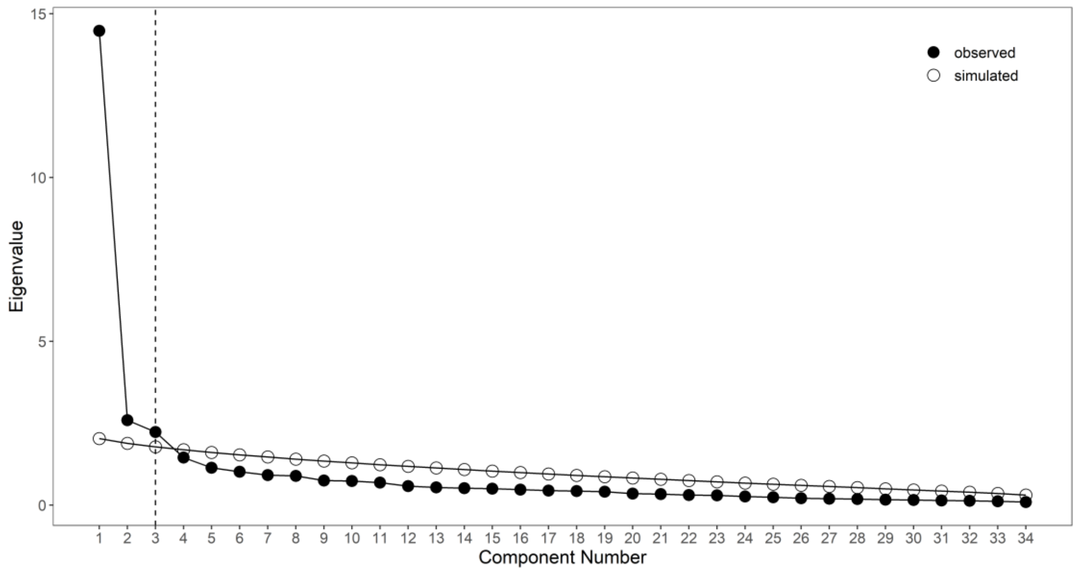

Figure 10.2. Results from the Parallel Analysis

Consequently, ten items loaded sufficiently on Factor 1 (MWT9, MWT10, MWT12, MWT13, MWT14, MWT16, MWT20, MWT21, MWT23, and MWT25). MWT11 ("… it feels like I don't have control over when my mind wanders.") was not included due to its high correlation with MWT13 ("… I have difficulty controlling my thoughts.") ($r = 0.78$). We labelled this factor "mind-wandering trait: spontaneous" (MWT-S). Three items loaded sufficiently on Factor 3 (MWT5, MWT6, and MWT7). We labelled this factor "mind-wandering trait: deliberate" (MWT-D). Finally, six items loaded sufficiently on Factor 2 (MWS1, MWS2, MWS3, MWS5, MWS6, and MWS7). We labelled this factor "mind-wandering state" (MWS). In sum, the EFA resulted in a scale with three factors and 19 items (cf. Table 32).

Assessment of scale validity (Confirmatory Factor Analysis)

Procedure. In line with the previous results, we specified three different models: a one-factor model for MWS, a two-factor model for MWT (which combined MWT-D and MTW-S), and a three-factor model with all three constructs (MWS, MWT-D, and MWT-S). All constructs were specified as reflective factors.

Item	Factor 1	Factor 2	Factor 3	Communality
MWT21	.787	.244	-.026	.680
MWT13	.739	.207	.060	.593
MWT20	.739	.238	.293	.689
MWT9	.727	.162	.299	.644
MWT23	.725	.293	.027	.612
MWT25	.708	.169	.308	.624
MWT12	.706	.248	.375	.701
MWT14	.704	.192	.028	.534
MWT10	.704	.154	.406	.684
MWT16	.702	.220	.201	.582
MWT11	.699	.189	.155	.548
MWT1	.683	.292	.252	.615
MWT2	.663	.241	.011	.498
MWT15	.630	.139	.324	.521
MWT19	.629	.145	.215	.463
MWT24	.601	.425	-.048	.544
MWT4	.573	.167	.490	.596
MWT3	.567	.136	.402	.502
MWT17	.567	.193	.365	.492
MWT18	.533	.076	.162	.316
MWT27	.520	.297	.021	.359
MWT22	.437	.354	.238	.373
MWS4	.381	.608	-.019	.515
MWS3	.283	.729	.215	.657
MWS1	.264	.727	.169	.626
MWS5	.235	.862	.182	.832
MWS6	.223	.716	.111	.574
MWT8	.219	.214	.572	.421
MWS2	.214	.820	.218	.766
MWT26	.202	.253	.263	.174
MWT7	.196	.143	.723	.582
MWT6	.152	.144	.822	.720
MWS7	.071	.738	.208	.593
MWT5	.028	.130	.812	.677

Note. The loadings of the remaining items are printed in bold.

Table 32. Factor Loadings and Communalities

The results of multiple Shapiro–Wilk tests suggested that our data were not normally distributed, and we thus used a robust version of the Maximum Likelihood (ML) estimator with the Satorra–Bentler scaled test statistic (MLM), the R environment (R Core Team, 2018), and the lavaan package (Rosseel, 2012).

Sample. Using data from 214 participants, we conducted a Confirmatory Factor Analysis (CFA) to further evaluate our initial measurement instrument (Step 7). The participants had an average age of 34 years (M = 34.41, SD = 11.64), 50.9 percent were male, 47.2 percent were female, 0.5 percent selected "other" for "gender," and the remaining 1.4 percent left the question blank. All participants indicated that they used their smartphone daily (M = 6.95 (7 = "I use my smartphone daily.")). The participants had an average work experience of 14 years (M = 14.25, SD = 11.45).

Results. We evaluated the three models based on widely used fit measures (Hoyle, 2012): the overall test (χ^2), the comparative fit index (CFI), the Tucker–Lewis Index (TLI), the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR).

	Item		**References**
MWS	MWS-1	I thought about something, which was not related to the situation.	(Oschinsky et al., 2019)
	MWS-2	I found myself distracted by other things in mind.	(Wati et al., 2014)
	MWS-3	I had so many things in mind.	(Oschinsky et al., 2019; Wati et al., 2014)
	MWS-5	My mind wandered.	
	MWS-6	I was daydreaming.	(Oschinsky et al., 2019)
	MWS-7	I did not concentrate on the situation.	
MWT-D	MWT-5	I allow my thoughts to wander on purpose.	(Carriere et al., 2013)
	MWT-6	I enjoy mind wandering.	
	MWT-7	I find mind wandering is a good way to cope with boredom.	
MWT-S	MWT-9	I find my thoughts wandering spontaneously.	
	MWT-10	My thoughts tend to be pulled from topic to topic.	
	MWT-12	I mind wander even when I'm supposed to be doing something else.	

	MWT-13	I have difficulty controlling my thoughts.	(Mowlem et al., 2016)
	MWT-14	I find it hard to switch my thoughts off.	
	MWT-16	My thoughts are disorganized and `all over the place'.	
	MWT-20	I find it difficult to think about one thing without another thought entering my mind.	
	MWT-21	I find my thoughts are distracting and prevent me from focusing on what I am doing.	
	MWT-23	I have difficulty slowing my thoughts down and focusing on one thing at a time.	
	MWT-25	I find myself flitting back and forth between different thoughts.	

Table 33. Questions and Scales from the Derived Measurement Instrument

An overview of the fit measures is presented in Table 34. Model 1 appropriately fits the data. Both the overall test (χ^2(9)= 11.479, p = .244 (χ^2/df = 1.275)) and descriptive-fit measures (CFI = .992, TLI = .987, RMSEA = .046, and SRMR = .031) implied a good fit. In terms of Model 2, the overall test was significant (χ^2(64)= 128.085, p = .000 (χ^2/df = 2.001)). Since the literature demonstrates that the overall test is sensitive to the sample size, we further investigated the descriptive-fit measures, which suggested an acceptable fit (CFI = .954, TLI = .944, RMSEA = .079, and SRMR = .055). Consequently, we assumed that the model fit appropriately with the data. Finally, we investigated Model 3. Again, the overall test was significant (χ^2(149)= 230.079, p = .000 (χ^2/df = 1.544)).The remaining fit indices supported an acceptable fit (CFI = .957, TLI = .950, RMSEA = .058, and SRMR = .057). To conclude, all single models yielded satisfactory values. The overall model consisting of MWS, MWT-D, and MWT-S had strong explanatory power and offered discernible added value against the background of the theoretical considerations.

Model (M)	**df**	χ^2	**p**	χ^2/df	**CFI**	**TLI**	**RMSEA**	**SRMR**
M1 (State)	9	11.479	.244	1.275	.992	.987	.046	.031
M2 (Trait)	64	128.085	.000	2.001	.954	.944	.079	.055
M3 (State/Trait)	149	230.079	.000	1.544	.957	.950	.058	.057

Table 34. Fit Indices

Cross-validation

Procedure. To cross-validate our results (Step 8), we collected another sample with N = 336 subjects. An online survey was provided to individuals from five English-speaking countries (i.e., United Kingdom, United States, Australia, New Zealand, and Canada). We specified the three models: MWS, a combination of MWT-D and MTW-S, and a combination of all three constructs (MWS, MWT-D, and MWT-S). We applied the exact same estimation procedure as before.

Sample. On average, the participants were 39 years old (M = 39.45, SD = 11.29), 53.3 percent were male, 45.8 percent were female, and .9 percent did not indicate a gender. The participants indicated a very high level of technology use (M = 6.50, SD = 1.39) and had an average work experience of 17 years (M = 17.67, SD = 11.27).

Results. The results suggest that all three models fit well with the empirical data. A non-significant overall test (χ^2(9)= 14.246, p = .114 (χ^2/df = 1.583)) as well as the results of the descriptive-fit measures (CFI = .993, TLI = .989, RMSEA = .064, and SRMR = .017) implied a good fit for Model 1. In terms of Model 2, the overall test was significant (χ^2(64)= 223.006, p = .000 (χ^2/df = 3.484)). Nevertheless, the descriptive-fit measures suggested an acceptable fit (CFI = .931, TLI = .916, RMSEA = .107, and SRMR = .050). Consequently, we assumed that the model fit the data appropriately. Finally, we investigated Model 3. Again, the overall test was significant (χ^2(149)= 337.542, p = .000 (χ^2/df = 2:265)). Nevertheless, the remaining fit indices supported an acceptable fit (CFI = .950, TLI = .942, RMSEA = .076, and SRMR = .043).

Model (M)	df	χ^2	p	χ^2/df	CFI	TLI	RMSEA	SRMR
M1 (State)	9	14.246	.114	1.583	.993	.989	.064	.017
M2 (Trait)	64	223.006	.000	3.484	.931	.916	.107	.050
M3 (State/Trait)	149	337.542	.000	2.265	.950	.942	.076	.043

Table 35. Fit Indices (Cross-Validation)

Reliability and factor loadings

To investigate the reliability of the factors, we investigated Cronbach's alpha (Cronbach, 1951), the omega of the coefficients (ω_1 (Bollen, 1980), ω_2 (Bentler, 1972, 2009), ω_3 (McDonald, 1999)), and the average variance extracted (AVE) (Fornell, C. Larcker, D. F., 1981) using the semTools package (Jorgensen et al., 2018). Since the results of all α and the coefficients ω were above .8, we assumed a sufficient reliability for all factors. Moreover, the AVE (> .5) confirmed this assumption. The results of our factor analysis are illustrated in Figure 10.3.

Coefficient	α		ω1		ω2		ω3		AVE	
Study	1	2	1	2	1	2	1	2	1	2
MWS	.863	.949	.866	.950	.866	.950	.865	.950	.524	.760
MWT-D	.810	.847	.812	.849	.812	.849	.810	.848	.591	.655
MWT-S	.944	.954	.944	.954	.944	.954	.943	.953	.630	.675
Total	.916	.952	.947	.971	.947	.971	.960	.977	.593	.700

Note. Study 1: Initial CFA. Study 2: Cross-validation. MWS = Mind wandering as a state. MWT-D: Mind wandering as a trait (deliberate). MWT-S: Mind wandering as a trait (spontaneous).

Table 36. Reliability Coefficients

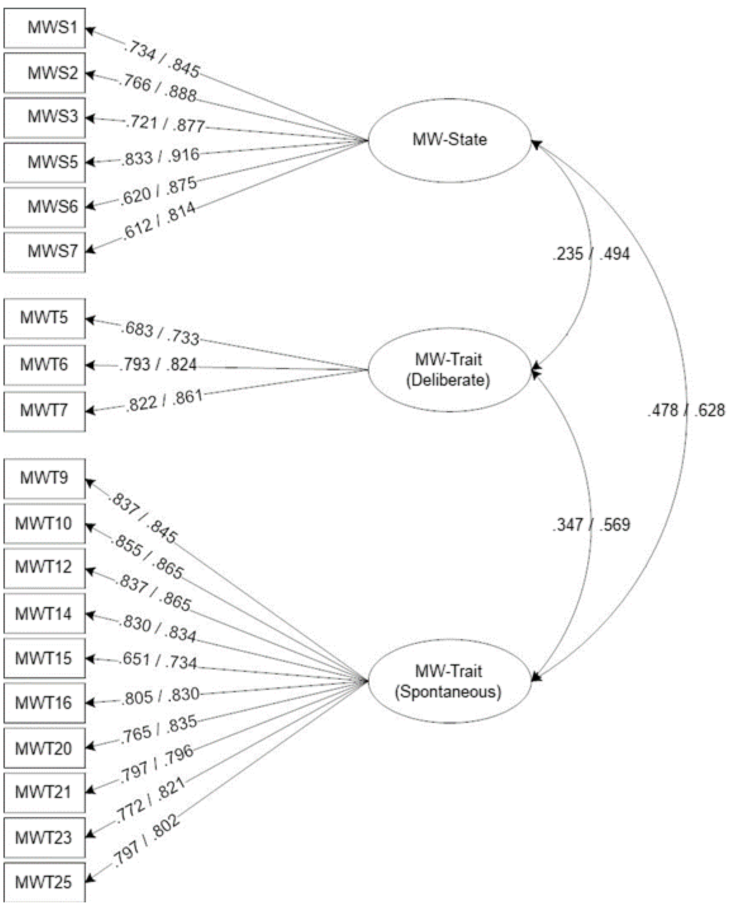

Figure 10.3. Item Loadings and Factor Correlations

We carried out additional tests to reduce the risk of bias effects. More specifically, we tested for the late-response bias,[2] which belongs to the group of non-response biases. We applied a series of two-sided t-tests between the first and last 10% of respondents, with the first 10% representing the first respondents and the last 10% representing the late respondents. We considered socio-demographic variables (i.e., gender, age, work experience, and education), and the differences between all these variables were all non-significant ($p > .56$). Consequently, we assumed that late-response bias was not a major concern for this study.

10.4 Discussion

Interim summary

The present study developed and validated a new measurement instrument that will enable future researchers to investigate the concept of mind wandering while using technology. We drew from existing scales and highlighted important differences in terms of the stability (i.e., a trait vs. a state) and intentionality (i.e., deliberate vs. spontaneous) of the concept. The process included surveying existing instruments, choosing appropriate items, and undertaking a thorough scale-development and validation procedure. Based on empirical data from a pretest ($N = 35$), a field study ($N = 364$), and a cross-validation sample ($N = 336$), we were able to develop a 19-item instrument consisting of three scales that offer a high degree of confidence in their content- and construct validity. Since we specifically adopted the measurement instrument for IS research, it can now be used for a broad variety of research that is concerned with mind wandering in technology-related settings.

Research agenda for mind wandering while using information technology

The theoretical implications of our work are manifold. Mind-wandering episodes while using technology can have a significant impact on outcome variables such as creativity and knowledge retention. While interest in this cognitive process has steadily grown in the IS discipline over the past five years, mind wandering while using technology remains largely neglected as a subject of research. As pointed out by Sullivan et al. (2015), the use of technology has become an integral part of work, education, and leisure time in the digital age, and the relationship between mind-wandering episodes while using technology and the outcomes of these episodes (e.g., task performance) requires further investigation. Most

[2] We would like to thank the anonymous reviewer who directed our attention to this potential bias effect.

notably, it remains unclear how technology-users maintain their attention while interacting with technology and whether this attentional focus is necessary or even promising when it comes to achieving certain results (e.g., creativity). Although studies on how attention can shift between external technology-related stimuli have been frequently conducted in the IS discipline (e.g., Speier et al., 2003), research on how our thoughts can shift between external events and internal off-task items is relatively new (Smallwood & Schooler, 2015). Therefore, our work satisfies the scientific need for additional insights into the understanding of the nature, dimensionality, and effects of mind-wandering experiences while using technology and into the understanding of the technology-related outcomes of such experiences.

As task-unrelated thought is a vital element of the human cognition and constitutes a core area of IS research (Briggs, 2015), this paper offers a significant theoretical and methodological extension to the existing literature. By making an explicit distinction between the stability (i.e., a state vs. a trait) and intentionality (i.e., deliberate vs. spontaneous) of mind wandering, the study allowed for a detailed exploration of technology-related phenomena from different perspectives and therefore opens the door to a more-detailed analysis and a better understanding of technology use in future IS research by accounting for specific human abilities, skills, and characteristics. For example, research on post-adoption behavior that has already applied related cognitive concepts (Sun et al., 2016; Thatcher et al., 2018) can utilize our scales to investigate the role of mind wandering with regard to adoption behavior and the changing nature of technology use. Existing theories in this domain can thereby be extended and further developed. Similarly, research on job-related outcomes – such as innovation behavior and creativity – can be explored in greater detail (Fox & Beaty, 2019). For example, research on explorative behavior while using IT (Bagayogo et al., 2014; Burton-Jones & Grange, 2012) can incorporate mind wandering as a new concept that has the potential to explain behavior associated with the enhanced use of technology (e.g., continuous use). In addition, our study contributes to research on utilitarian and hedonic motives (Lowry et al., 2013; van der Heijden, 2004) as scholars can utilize our instrument to investigate the use of the hedonic system (e.g., in serious gaming or in social-media use).

It is important to emphasize that a vast amount of theorization is involved when investigating mind wandering in an empirical setting. In line with previous literature (Seli, Risko, & Smilek, 2016a, 2016b), the present research provides evidence of the manifold nature of mind wandering. Not only can it be used as a state or trait, but it is also inherently different from intentionality. Consequently, future research is encouraged to carefully consider how to investigate both spontaneous and deliberate mind wandering. This consideration is particularly critical as deliberate mind wandering is assumed to lead to positive outcomes (e.g., creativity) (Agnoli et al., 2018), whereas unintentional mind wandering is often associated with negative outcomes (e.g., car accidents) (Baldwin et al., 2017; Zhang et al., 2017).

Our work contributes to practice and management because the use of validated measurement instruments can provide cost-efficient and highly relevant insights into and reflections on the determinants of IT behavior in the workplace (e.g., by focusing on memory distortion, attention, or performance). Our instrument can be used to both discover and promote desired mind-wandering episodes (e.g., while completing creative tasks in the digital workplace) or to detect and reduce unwanted mental states (e.g., during online lectures). The use of our measurement instrument can aid in solving divergent-thinking tasks or in addressing attention loss and can thereby contribute to a more-productive use of working time and resources. In the long run, this contribution can help lead to financial profit as well as more-satisfied and more-innovative employees.

This being said, our findings are also relevant when it comes to designing IT artifacts with the aim of positively affecting the accomplishment of a specific task (e.g., by increasing an employee's creativity). Future IS studies that distinguish among the different subtypes of mind wandering in technology-related settings have the potential to deepen our understanding of why and how an IT artifact can influence the antecedents of IT behavior or the behavior itself. Among other things, these studies could test the effects of a system's richness. In addition to designing specific hardware or software, researchers could also study how the environment of a technology-user would have to be designed to encourage creative episodes via deliberate mind wandering, which could be tested, for example, in rooms that stimulate soft fascination and that thereby support both perceptual decoupling during mind-wandering episodes and the maintenance of a pleasant train of thought that promotes divergent thinking. Of course, this research becomes even more promising if our measuring instrument is triangulated with neurophysiological data and behavioral measurements. As design-science research represents an integral field of the IS discipline, our work provides valuable input that can be used to inform appropriate design decisions.

Limitations

As with every study, the research presented in this contribution has limitations, and future research is invited to further expand on our knowledge of mind wandering. First, within the scope of this initial study, we could only address English-speaking samples, which suggests that the sample was drawn from countries with great cultural similarities. Therefore, we encourage future research to collect additional data from various countries with different cultural backgrounds to obtain insights into the robustness of the mind-wandering scale across countries. This approach is particularly relevant for mental states like mind wandering because job demands and the habits of technology use can vary significantly across countries (Dinev et al., 2009; Straub et al., 1997). Second, cognitive variables such as mind wandering cannot be fully captured via self-reported measures as they depend on memory and meta-awareness (Smallwood & Schooler, 2015). Probe-based reports could thus constitute an important subject of future studies, which could also integrate more context-specific questions to capture the state-dimension of mind wandering. Moreover, triangulation is recommended to reduce operationalization bias and increase validity. Neurophysiological measures have great potential to complement subjective measures. In particular, neurophysiological tools – including eye-tracking and brain imaging (Andrews-Hanna et al., 2018; Golchert et al., 2017) – appear promising. This approach is part of a growing strand of research that emphasizes the relationship between the neurosciences and IS research (NeuroIS) (Dimoka et al., 2011; Riedl & Léger, 2016). Furthermore, a validated scale that integrates existing scales and distinguishes between different facets of mind wandering would also prove useful beyond the boundaries of the IS discipline. In fact, related disciplines – such as psychology, educational science, and management sciences – could benefit from our results and use our instrument in various contexts. Our scales could also benefit from more interdisciplinary work, for example, to develop frameworks or models and further push the boundaries of the field.

10.5 References

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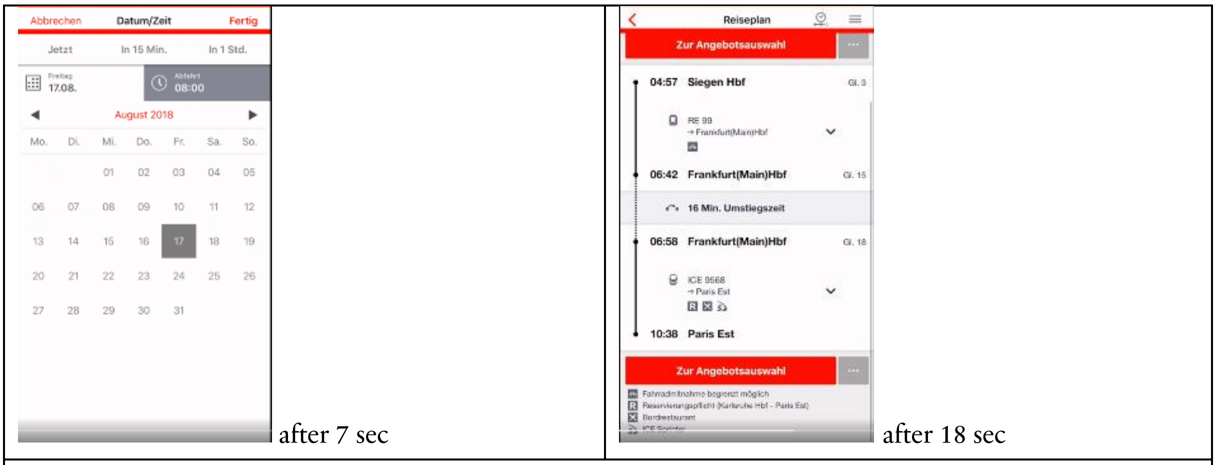
10.6 Appendix



Note. The video covered all phases of the booking process, e.g., choosing a date, selecting a connection, or payment.

Figure 10.4. Screenshots of the Booking Process in a National Railway Company

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1	MWT1	1																																	
2	MWT2	0.69	1																																
3	MWT3	0.62	0.43	1																															
4	MWT4	0.57	0.38	0.57	1																														
5	MWT5	0.23	0.06	0.39	0.42	1																													
6	MWT6	0.43	0.23	0.33	0.43	0.66	1																												
7	MWT7	0.45	0.28	0.38	0.42	0.54	0.68	1																											
8	MWT8	0.24	0.16	0.4	0.4	0.42	0.39	0.38	1																										
9	MWT9	0.59	0.5	0.54	0.6	0.23	0.39	0.31	0.41	1																									
10	MWT10	0.63	0.47	0.57	0.61	0.31	0.45	0.41	0.43	0.68	1																								
11	MWT11	0.57	0.47	0.44	0.5	0.18	0.3	0.26	0.35	0.68	0.57	1																							
12	MWT12	0.69	0.56	0.65	0.7	0.32	0.39	0.41	0.45	0.71	0.72	0.57	1																						
13	MWT13	0.61	0.49	0.45	0.46	0.12	0.2	0.23	0.33	0.62	0.58	0.78	0.6	1																					
14	MWT14	0.43	0.46	0.38	0.36	0.11	0.16	0.2	0.2	0.47	0.49	0.48	0.52	0.53	1																				
15	MWT15	0.4	0.35	0.36	0.52	0.29	0.34	0.3	0.32	0.55	0.6	0.39	0.5	0.47	0.55	1																			
16	MWT16	0.58	0.49	0.48	0.51	0.22	0.3	0.27	0.32	0.53	0.59	0.54	0.62	0.5	0.52	0.57	1																		
17	MWT17	0.46	0.32	0.35	0.54	0.29	0.36	0.3	0.34	0.53	0.55	0.43	0.54	0.37	0.56	0.63	0.54	1																	
18	MWT18	0.37	0.42	0.3	0.33	0.2	0.29	0.23	0.21	0.33	0.39	0.36	0.33	0.34	0.51	0.44	0.44	0.4	1																
19	MWT19	0.38	0.41	0.37	0.42	0.26	0.29	0.21	0.29	0.44	0.49	0.42	0.46	0.42	0.58	0.57	0.58	0.59	0.46	1															
20	MWT20	0.6	0.47	0.55	0.62	0.23	0.35	0.4	0.34	0.67	0.62	0.55	0.68	0.51	0.63	0.61	0.62	0.63	0.44	0.58	1														
21	MWT21	0.68	0.53	0.5	0.48	0.08	0.16	0.27	0.15	0.6	0.61	0.55	0.62	0.61	0.47	0.43	0.59	0.38	0.37	0.45	0.61	1													
22	MWT22	0.37	0.32	0.31	0.44	0.22	0.26	0.36	0.3	0.41	0.38	0.3	0.39	0.35	0.32	0.51	0.4	0.42	0.24	0.47	0.54	0.44	1												
23	MWT23	0.52	0.51	0.48	0.44	0.17	0.21	0.26	0.18	0.56	0.5	0.46	0.57	0.51	0.62	0.59	0.54	0.51	0.37	0.48	0.6	0.67	0.41	1											
24	MWT24	0.51	0.5	0.44	0.43	0.11	0.11	0.18	0.29	0.5	0.43	0.54	0.5	0.53	0.36	0.34	0.52	0.32	0.38	0.37	0.46	0.59	0.44	0.58	1										
25	MWT25	0.59	0.49	0.59	0.56	0.23	0.38	0.35	0.34	0.62	0.7	0.51	0.65	0.56	0.51	0.6	0.53	0.51	0.36	0.46	0.66	0.58	0.45	0.55	0.41	1									
26	MWT26	0.2	0.18	0.18	0.25	0.15	0.26	0.22	0.25	0.24	0.25	0.34	0.3	0.3	0.11	0.23	0.23	0.27	0.07	0.32	0.29	0.15	0.3	0.15	0.19	0.3	1								
27	MWT27	0.47	0.47	0.3	0.29	0.14	0.21	0.19	0.25	0.36	0.47	0.37	0.38	0.43	0.4	0.29	0.34	0.25	0.29	0.38	0.41	0.52	0.39	0.48	0.39	0.43	0.25	1							
28	MWS1	0.44	0.42	0.29	0.39	0.28	0.27	0.23	0.28	0.41	0.29	0.36	0.45	0.33	0.32	0.32	0.35	0.35	0.25	0.32	0.45	0.35	0.37	0.43	0.38	0.36	0.34	0.36	1						
29	MWS2	0.42	0.29	0.36	0.31	0.28	0.34	0.31	0.3	0.32	0.36	0.29	0.43	0.32	0.38	0.32	0.42	0.39	0.21	0.33	0.44	0.38	0.45	0.41	0.41	0.4	0.27	0.35	0.64	1					
30	MWS3	0.43	0.36	0.3	0.42	0.2	0.32	0.29	0.28	0.38	0.44	0.36	0.46	0.35	0.38	0.39	0.47	0.44	0.3	0.35	0.47	0.35	0.42	0.37	0.42	0.38	0.32	0.28	0.59	0.73	1				
31	MWS4	0.35	0.3	0.26	0.38	0.14	0.13	0.22	0.22	0.29	0.3	0.41	0.36	0.44	0.41	0.33	0.36	0.33	0.23	0.37	0.41	0.45	0.39	0.48	0.51	0.35	0.25	0.37	0.5	0.55	0.46	1			
32	MWS5	0.5	0.39	0.28	0.36	0.23	0.32	0.3	0.32	0.39	0.4	0.36	0.48	0.37	0.35	0.34	0.41	0.36	0.25	0.3	0.44	0.39	0.42	0.37	0.47	0.37	0.25	0.3	0.67	0.78	0.73	0.54	1		
33	MWS6	0.44	0.37	0.3	0.29	0.14	0.25	0.25	0.26	0.37	0.42	0.29	0.37	0.3	0.24	0.28	0.31	0.26	0.2	0.2	0.33	0.4	0.35	0.32	0.4	0.34	0.19	0.32	0.5	0.55	0.56	0.44	0.72	1	
34	MWS7	0.33	0.17	0.31	0.26	0.31	0.25	0.18	0.33	0.25	0.27	0.26	0.33	0.25	0.24	0.24	0.22	0.29	0.13	0.19	0.28	0.19	0.21	0.34	0.37	0.25	0.12	0.25	0.54	0.61	0.51	0.41	0.66	0.5	1

Table 37. Indicator-Correlation Matrix (Exploratory-Factor Analysis)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	MWS1	1																		
2	MWS2	0.58	1																	

3	MWS3	0.49	0.61	1																
4	MWS5	0.62	0.61	0.59	1															
5	MWS6	0.42	0.41	0.49	0.54	1														
6	MWS7	0.46	0.52	0.38	0.51	0.41	1													
7	MWT5	0.07	0.02	0.07	0.12	0.04	0.14	1												
8	MWT6	0.18	0.12	0.19	0.2	0.07	0.13	0.55	1											
9	MWT7	0.17	0.12	0.14	0.16	0.08	0.19	0.57	0.64	1										
10	MWT9	0.35	0.26	0.31	0.33	0.26	0.16	0.13	0.32	0.27	1									
11	MWT10	0.39	0.26	0.35	0.43	0.28	0.1	0.16	0.3	0.28	0.76	1								
12	MWT12	0.31	0.34	0.36	0.34	0.24	0.15	0.17	0.35	0.35	0.78	0.76	1							
13	MWT13	0.28	0.22	0.3	0.32	0.27	0.17	0.1	0.22	0.26	0.72	0.71	0.7	1						
14	MWT14	0.27	0.22	0.23	0.26	0.14	0.15	0.16	0.25	0.26	0.53	0.53	0.49	0.54	1					
15	MWT16	0.35	0.24	0.28	0.41	0.33	0.12	0.03	0.2	0.18	0.61	0.67	0.64	0.68	0.51	1				
16	MWT20	0.31	0.26	0.32	0.41	0.3	0.18	0.1	0.2	0.2	0.63	0.66	0.61	0.59	0.61	0.65	1			
17	MWT21	0.31	0.29	0.28	0.36	0.24	0.09	0.04	0.26	0.19	0.61	0.63	0.68	0.68	0.5	0.69	0.57	1		
18	MWT23	0.24	0.14	0.16	0.22	0.18	0.05	-0.01	0.22	0.15	0.6	0.6	0.59	0.66	0.53	0.67	0.59	0.71	1	
19	MWT25	0.35	0.25	0.29	0.37	0.26	0.07	0.05	0.26	0.2	0.65	0.69	0.61	0.61	0.54	0.67	0.65	0.65	0.69	1

Table 38. Indicator-Correlation Matrix (Confirmatory-Factor Analysis)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	MWS1	1																		
2	MWS2	0.76	1																	
3	MWS3	0.75	0.77	1																
4	MWS5	0.79	0.8	0.8	1															
5	MWS6	0.7	0.77	0.77	0.82	1														
6	MWS7	0.67	0.78	0.71	0.72	0.72	1													
7	MWT5	0.28	0.34	0.35	0.38	0.38	0.29	1												
8	MWT6	0.32	0.32	0.33	0.37	0.33	0.24	0.62	1											
9	MWT7	0.37	0.4	0.35	0.42	0.39	0.29	0.62	0.71	1										
10	MWT9	0.51	0.51	0.5	0.56	0.49	0.39	0.42	0.52	0.53	1									
11	MWT10	0.49	0.51	0.54	0.55	0.5	0.41	0.38	0.41	0.47	0.8	1								
12	MWT12	0.49	0.51	0.51	0.52	0.47	0.39	0.39	0.41	0.51	0.8	0.8	1							
13	MWT13	0.44	0.49	0.47	0.45	0.51	0.46	0.28	0.33	0.4	0.69	0.69	0.71	1						
14	MWT14	0.35	0.33	0.37	0.39	0.36	0.25	0.27	0.36	0.38	0.59	0.63	0.58	0.65	1					
15	MWT16	0.4	0.44	0.46	0.44	0.44	0.39	0.27	0.31	0.37	0.65	0.68	0.69	0.7	0.64	1				
16	MWT20	0.4	0.44	0.45	0.44	0.41	0.34	0.31	0.35	0.4	0.68	0.69	0.71	0.7	0.67	0.8	1			
17	MWT21	0.41	0.43	0.42	0.43	0.46	0.42	0.22	0.26	0.37	0.6	0.64	0.63	0.73	0.57	0.7	0.67	1		
18	MWT23	0.43	0.44	0.43	0.45	0.47	0.41	0.21	0.26	0.37	0.63	0.67	0.68	0.73	0.61	0.7	0.65	0.76	1	
19	MWT25	0.45	0.43	0.46	0.49	0.41	0.35	0.34	0.39	0.47	0.69	0.72	0.69	0.59	0.59	0.64	0.65	0.68	0.72	1

Table 39. Indicator-Correlation Matrix (Cross-Validation)

Full Questionnaire (English)

General Introduction

Dear participant, your participation will take approximately 6-8 minutes and will help us to understand the relationship between technology use and daydreaming. Please note that we treat your answers anonymously and confidentially. The data is exclusively used for this research project. All questions relate to your opinion and assessment. Hence, there are no right or wrong answers. To ensure data quality, we included several attention checks. Therefore, we ask you to be focused while answering. You will receive the financial compensation only if you pass all attention checks and successfully finish this survey. Thank you very much for participating in this study.

State Introduction

In the following, we present you a video that shows a booking process using a mobile app. Please try to put yourself in the given situation as good as possible. If you are more familiar with similar booking processes (e.g., booking a flight, or booking a hotel) please keep those processes in mind when you answer the following questions. [Exemplary picture of a train ride from Siegen, Germany, to Paris, France; Source: Google Maps]

State Video

[Video of the booking process using the application of a railway company; see Figure 4]

Manipulation Check	
To what extent do the statements apply to the situation, you just experienced?	
… you were playing a game.	7-point Likert scale (Strongly Disagree – Neutral – Strongly Agree)
… you were using Facebook.	
… you were booking a railway ticket.	
… you were writing an e-mail.	
State Questions	
When I was booking the railway ticket …	
… I thought about something, which was not related to the situation.	7-point Likert scale (Strongly Disagree – Neutral – Strongly Agree)
… I found myself distracted by other things in mind.	
… I had so many things in mind.	
… I was easily distracted by unnecessary information in mind.	
… my mind wandered.	
… I was daydreaming.	

… I did not concentrate on the situation.

Trait Introduction

Technology use in general: After this specific situation, we now invite you to answer questions that are more generic and relate to your everyday use of technologies. Please indicate, how often you use the following technologies:

Personal Computer (PC)		7-point Likert scale (Never – Neutral – Daily)
Laptop		
Smartphone		
Tablet		
Other:	*Space for writing*	
Trait Questions		
When using technology …		
… sometimes I have trouble concentrating on the task.		7-point Likert scale (Strongly Disagree – Neutral – Strongly Agree)
… I have difficulty maintaining focus on simple or repetitive work.		
… I do things without paying full attention.		
… I find myself listening with one ear, thinking about something else at the same time.		
… I allow my thoughts to wander on purpose.		
… I enjoy mind-wandering.		
… I find mind-wandering is a good way to cope with boredom.		
… I allow myself to get absorbed in pleasant fantasy.		
… I find my thoughts wandering spontaneously.		
… my thoughts tend to be pulled from topic to topic.		
… it feels like I don't have control over when my mind wanders.		
… I mind wander even when I'm supposed to be doing something else.		
… I have difficulty controlling my thoughts.		
… this is only an attention check. Please just select strongly agree.		
… I find it hard to switch my thoughts off.		
… I have two or more different thoughts going on at the same time.		

… my thoughts are disorganized and 'all over the place'.
… my thoughts are ‘on the go’ all the time.
… if my mind is ‘on the go’ at bedtime, I have difficulty falling off to sleep.
… I experienced ceaseless mental activity.
… I find it difficult to think about one thing without another thought is entering my mind.
… I find my thoughts are distracting and prevent me from focusing on what I am doing.
… I try to distract myself from my thoughts by doing something else or listening to music.
… I have difficulty slowing my thoughts down and focusing on one thing at a time.
… I find it difficult to think clearly, as if my mind is in a fog.
… I find myself flitting back and forth between different thoughts.
… I use alcohol or drugs to slow down my thoughts and stop constant ‘mental chatter’.
… I can only focus my thoughts on one thing at a time with considerable effort.

Dependent Variables

Focused Immersion — 7-point Likert scale (Strongly Disagree – Neutral – Strongly Agree)

When using technology …
… I am able to block out most other distractions.
… I am absorbed in what I am doing.
… I get distracted by other attentions very easily.
… my attention does not get diverted very easily.

Enjoyment

When using technology …
… I always have fun to interact with it.
… I always have a of enjoyment.
… I always get bored.
… I always enjoy using it.

Temporal Dissociation

When using technology …
… I always lose track of time.

… time always flies.

… I am always spending more time on it than I actually intended.

… time always appears to go by very quickly.

… I always end up spending more time that I had planned.

Control

When using technology …

… I feel in control.

… I feel that I have no control over my interaction with it.

… it allows me to control my interaction.

Curiosity

When using technology …

… using it excites my curiosity.

… interacting with it makes me curious.

… using it arouses my imagination.

Creativity

When using technology …

… I seek new ideas and ways to solve problems.

… I generate ideas revolutionary to the field.

… it is a good role model for innovation/creativity.

… I try new ideas and approaches to a problem.

Personal Innovativeness

How do you deal with new technology?

If I hear about a new information technology, I will look for ways to experiment with it.

Among my peers, I am usually the first to try out new information technologies.

In general, I am hesitant to try out new information technologies.

I like to experiment with new information technologies.

Attention checks [**Random assignment of one check.**]

Please indicate whether the sum of two and two is four.

Please indicate whether four divided by two is two.

Please indicate whether the sum of two and two is six.

Please indicate whether the sum of two and two is ten.

Please indicate whether the seven minus two is three.

Demographics

How old are you? (Years)	*Space for writing*
What is your gender?	Male, Female, Diverse
What is your highest level of education?	Less than High School, High School/GED, Some College, 2-Years College Degree, 4-Years College Degree, Master's Degree, Doctoral Degree,

	Professional Degree (JD, MD)
What is your profession?	Part-time, Full-time, Marginal, Student, Job-seeking, Others: *Space for writing*
How many years of work experience do you have? (Years)	*Space for writing*
How honestly did you answer the questions?	5-point Likert scale (Very Honesty – Neutral – Very Dishonest)
Further Comments	
If you have any further comments, please feel free to add them in the following box. We will be reviewing them and consider them for future research.	*Space for writing*
General Farewell to the Participants	
[Contact information]	

Table 40. Full Questionnaire (English)

11. Paper 5: On How Mind Wandering Facilitates Creative Incubation

Title	**On How Mind Wandering Facilitates Creative Incubation While Using Information Technology: A Research Agenda for Robust Triangulation**
Authors	Frederike Marie Oschinsky[1] Björn Niehaves[1] René Riedl[2,3] Michael Klesel[1,4] Selina C. Wriesnegger[5] Gernot R. Müller-Putz[5] [1] University of Siegen, Siegen, Germany. [2] University of Applied Sciences Upper Austria, Steyr, Austria. [3] Johannes Kepler University Linz, Linz, Austria. [4] University of Twente, Enschede, The Netherlands. [5] Graz University of Technology, Graz, Austria.
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Table 41. Fact Sheet Publication

On How Mind Wandering Facilitates Creative Incubation While Using Information Technology: A Research Agenda for Robust Triangulation

Abstract. *Our minds tend to frequently drift away from present technology-related situations and tasks. Against this background, we seek to provide a better understanding of mind-wandering episodes while using information technology and its link to decisive variables of Information Systems research, such as performance, creativity, and flow. Since the academic literature still lacks reliable and validated measurements that can fully account for all facets of mind-wandering episodes while using information technology, our work addresses this gap by presenting a way to triangulate data in the context of a digital insight problem-solving task. This new approach enables researchers to further investigate the effects of spontaneous thought in technology-related settings and is a promising building block for the development of neuroadaptive systems.*

Keywords: *Technology Use, Mind Wandering, Creative Incubation, Insight, Triangulation, Experience Sampling, Behavioral Markers, Neuroimaging.*

11.1 Introduction

Information Systems (IS) research studies how to reason or interact with information technology (IT). Building on that, Neuro-Information-Systems (NeuroIS) seeks to understand the development, use, and impact of IT by including neurophysiological knowledge [1]. The emphasis is set on understanding how humans interact with IT, e.g., for designing neuroergonomic or neuroadaptive systems. Studies test for externally-focused concentration and internally-directed attention, as cognition is not limited to the processing of events in the environment. While intrinsically-generated thoughts such as mind wandering (MW) become increasingly relevant, however, measuring them comes along with methodological challenges. As NeuroIS research successfully coped with similar obstacles (e.g., studying technostress; see [2–5]), the triangulation of neurophysiological data and self-reports seems a particularly promising avenue.

MW is described as a shift in attention away from a primary task and toward dynamic, unconstrained, spontaneous thoughts [6, 7] – or as the mind's capacity to drift away aimlessly from external events and toward internally directed thoughts [8]. The emphasis on attentional engagement in IS research follows the implicit assumption that our thoughts are continuously focused [9–11]. However, a growing body of knowledge suggests the opposite – namely, that our minds regularly tend to proceed in a seemingly haphazard manner. Therefore, neglecting MW leaves important IT phenomena largely unexplored. It is complex in nature and can have both negative and positive effects. For example, MW can be a necessary and useful cognitive phenomenon that offers potential for technology-mediated creativity (e.g., in webinars). In contrast, it can go along with various deficits in performance (e.g., IT management), disturbed team dynamics (e.g., trust), or weakened IT security (e.g., data management). Building on the findings of current research on digital stress (e.g., on information overload or interruptions), and based on the increasing demand for healthy breaks and distraction-free phases at work, we focus on the potential of wandering thoughts. Research in complex technology-related contexts can benefit from both a clear conceptualization of MW and comprehensive triangulation that adequately captures its characteristics. Against this background, our study is novel because it addresses measurement of intrinsically-generated thought while using technology. Without reliable and valid measurement, it is hardly possible to understand whether to expect negative or positive consequences; moreover, it is difficult to design systems that either increase or reduce MW episodes. Against this background, the research question of this work-in-progress paper is: Which procedure is most suitable for measuring MW while using IT? In order to answer this question, we will briefly introduce the theoretical background as well as the neurophysiological correlates of the relevant concepts, propose a procedure for triangulation, and close with an outlook on our next steps.

11.2 Theoretical Background

Solving complex problems is often associated with creativity, as the solution seems new and useful. Looking at the creative process [12], insight problem-solving is often associated with incubation. Incubation stands for taking a step back from the problem, and for allowing the mind to wander. In this phase, unconscious thought processes take over, e.g., while going for a walk, taking a shower, or in Newton's case, while sitting under a tree. This stage is followed by illumination (i.e., "Eureka!"), as well as verification (or implementation), where we build, test, analyze, and evaluate the idea. Considering incubation is central when dealing with internally-directed attention, because it helps understand whether and why past studies have shown that letting the mind wander in this phase can lead to greater creativity [13]. The benefits of incubation appear to be greater when being engaged in an undemanding task, where MW is found to be more frequent, than in a demanding task or no task at all (ibid.). Therefore, task difficulty can be used as a manipulation in our experiment.

According to Christoff et al. [14], MW is "(…) a mental state, or a sequence of mental states, that arises relatively freely due to an absence of strong constraints on the contents of each state and on the transitions from one mental state to another" (p. 719). It often occurs during tasks that do not require sustained attention [15]. Literature refers to it as unguided, unintentional, task-unrelated, or stimulus-independent thought [16]. Because empirical evidence expresses concern to describe MW as unguided [17], unintentional [18, 19], or stimulus-independent [20–22], we follow the family-resemblances perspective by Seli et al., which treats it as a heterogeneous construct [16]. Against this background, it becomes all the more important to clearly measure and describe the specific aspects of MW when investigating it in technology-related settings. Given that MW is considered to represent a failure of attention and control [23–27], their potential to yield beneficial outcomes has been widely neglected. Only in the last decade have studies highlighted its advantages, which include more-effective brain processing, pattern recognition, and associative thinking as well as increased creativity [13, 15, 20, 28, 29]. Recent IS research shows that MW relates to enjoyment [30, 31], creativity [13, 32] as well as performance and knowledge retention [20, 33, 34].

Evidence shows that deep absorption undermines creativity, whereas distraction can enhance it [13, 35]. This speaks in favor of taking breaks, appreciating boredom, and doing simple, monotonous things when agonizing. In this context, the benefit of incubation seems greatest when being engaged in an undemanding task, compared to a demanding task or no task at all [15]. Because undemanding tasks evidently open the door for MW as attentional demand reduces MW [36], we expect that the success of incubation (i.e., insight problem-solving while using IT) relates to the opportunity for MW.

11.3 Methodology

MW is studied mostly by using thought sampling and questionnaires [15]. Facing the potential shortcomings of subjective self-reports (e.g., common methods, social desirability, subjectivity [37] (p. 688)), we depict triangulation as a more promising strategy, in which one applies different methods, types of data, and perspectives to the same phenomenon to achieve a higher validity of the results and to reduce systematic errors. In specific, we will conduct an experiment, in which we will triangulate neurophysiological data and self-reports. Because literature introduces several different methods of estimating MW, we briefly summarize the overview by Martinon et al. [34].

Experience Sampling. The gold standard measure estimates thoughts and feelings as they occur. However, the data relies on subjective inquiry. There are three groups: First, online experience sampling gathers self-reports of the participants' ongoing experience 'in the moment' while they are completing other activities. Either the probe caught method (open / closed) requires participants to be intermittently interrupted, often while performing a task, and describe the content of their experience. The self-caught method asks them to spontaneously report their mental state (e.g., MW) as soon as they notice it, e.g., by pressing a button. This accounts for meta-awareness. Second, retrospective experience sampling gathers data immediately after a task has been completed. The reports can be biased, as they rely on memory. Third, the assessment of disposition encompasses multiple dimensions of experience and includes personality traits.

Behavioral Markers. Behavioral indices provide evidence of the nature of an ongoing thought at a specific moment of time or in a particular task. They deliver additional insight into the processes underlying different aspects of experience and are a less subjective measure of the observable consequences associated with performing dull, monotonous tasks. There are numerous potential tasks, such as the Sustained Attention Response task (SART), the Oddball task, reading (comprehension) tasks, breath counting tasks, the Complex Working Memory task (CWM), or the Instructed Mind Wandering task (IMW). Task complexity can be varied. However, in isolation, behavioral markers struggle to provide evidence on underlying causal mechanisms, being only a superficial description of the nature of experience.

Neurophysiological Tools. Neurophysiological measures allow for a more detailed picture of whether participants' attention is directed externally or internally, by illustrating the level of engagement during different stages of ongoing thought [38]. They show that during MW, attention shifts from the processing of sensory input (suppression of external stimuli by perceptual decoupling) to internally-directed processes [39]. The measures include, but are not limited to, electroencephalography (EEG), eye-tracking, and functional magnetic resonance imaging (fMRI). First, EEG is a recognized brain imaging tool, which assesses MW non-invasively without interfering with a task [40]. The event-related potential (ERP) ("a waveform complex resulting from an external stimulus" [41]), and EEG oscillations ("the manifestation of the activity of populations of neurons in the brain" (ibid.)) can be assessed. During MW, perceptual input is reduced, pointing at P1-N1, P2, and P3 as discriminative ERP-features. Studies observe an increased activity of lower oscillation frequencies, namely theta and delta, as well as a decrease of higher frequencies, namely alpha and beta [40]. Second, fMRI measures brain activity by detecting changes associated with blood flow. It controls for individual variation, e.g., in the Default Mode Network (DMN), but it is highly intrusive (for details on the concept of intrusiveness in NeuroIS research, see [42]), more expensive than EEG, time-consuming, and does not allow for temporal conclusions on the milliseconds level as EEG. Third, eye tracking operates as a reliable "time-sensitive indicator of internal attention demands" by capturing specific eye behavior changes [39]. These psychophysiological changes are divided into three ocular mechanisms: visual disengagement, perceptual decoupling, and internal coupling (ibid.). Since eye-tacking is non-invasive, relatively inexpensive and has already been widely applied, recent studies increasingly integrate this tool [43] (p. 22). In the future, all of the three presented techniques offer great potential, for example, when it comes to developing machine learning estimators for MW detection, for non-invasive brain stimulations, or for building neuroadaptive systems that adapt to the mental state of technology users in real-time (e.g., [44–48]).

To the best of our knowledge, few studies have directly assessed the occurrence of MW during incubation [13]. Our work uses the incubation paradigm and seeks to enhance the meaningfulness and reliability of the involved measurement. Our proposed experiment will be based on the Unusual Uses Task (UUT) [13], a classic and widely used measure of divergent thinking [49]. It requires participants to generate as many unusual uses as possible for a common object, such as a food can, in a given amount of time. The originality of the responses is taken as an index of creative thinking [13]. The experimental procedure will replicate the work by Baird et al. [13]. Based on our past research [30–34], we propose to add neurophysiological measures, namely EEG and eye-tracking, to experience samplings [20, 30, 50–52]. The combination of self-reported information with the detailed measures of neural function promises to shed critical light on aspects of spontaneous thought while using IT.

Participants will be randomly assigned to work on two digital UUT problems (5 min each). They will tell their responses to the investigator who types them into a text box on a computer. After completing the baseline UUT, participants will be assigned to one of three groups (demanding task, undemanding task, rest) using a between-subjects design. The aim is to have approximately the same number of participants in the respective groups. Participants in the demanding-task condition will perform a 3-back task, whereas those in the undemanding-task condition will perform a simpler task (1-back). In the rest condition, participants will be asked to sit quietly. This step will be followed by incubation (12 min).

Next, all participants will answer a MW questionnaire [based on e.g.,20, 30, 50–52], and then work on the same two UUT again (5 min). Finally, they will be thanked, debriefed and receive financial compensation. At each point, the cognitive processes of the participants will be recorded with an EEG and eye tracking device. The tools' high temporal resolution (milliseconds level) will make it possible to determine thought patterns and to work out the typical course of a MW episode. The self-reports will serve to validate the findings. In addition, the assessment of creativity by two raters controls the behavioral correlate. The following research agenda is inspired by Dimoka et al. [53].

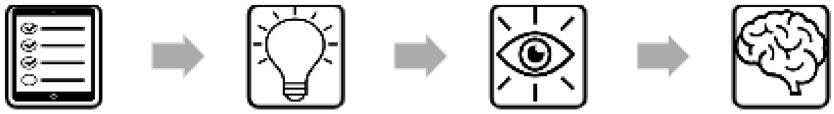

Figure 11.1. Research Agenda for Robust Triangulation

11.4 Outlook

Our work contributes to two crucial pillars of NeuroIS research [48], namely, to designing information systems and developing neuroadaptive systems. First, we make a call for future research focusing on the relation between technology and creativity from various perspectives, e.g., on other phase of the creative process besides incubation. Future work can enhance our neuroscientific models of creativity while using IT, and further develop creativity-promoting tools. Moreover, we strongly believe that neuroadaptive systems offer significant potential, both from a theoretical and practical viewpoint. Although coming up with systems that adapt to the users' mental states in real time might sound utopic for mainstream IS and management researchers, efforts are already being made (not only in NeuroIS, but also in other fields that have been existing longer, such as affective computing, physiological computing, and brain-computer interfacing). Our work is a first step towards automatically observing and interpreting MW, which could help design human-computer interaction tasks and IT artifacts to increase the users' performance, productivity, and creativity. Note that the group of users explicitly also comprises programmers and software designer (because they are also users of computer systems). Creativity is a critical talent or skill in digital innovation, and the potential of neuroscience for software engineering has been documented comprehensively in a recent review [54]. We see MW while using IT as a promising future research area based on the practical, methodological, and theoretical values our project offers.

Acknowledgements

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12. Paper 6: Detecting Mind-Wandering Episodes

Title	**Detecting Mind Wandering Episodes in Virtual Realities Using Eye Tracking**
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Table 42. Fact Sheet Publication

Detecting Mind Wandering Episodes in Virtual Realities Using Eye Tracking

Abstract. *Virtual Reality (VR) allows users to experience their environment differently and more immersively than traditional information systems (IS). Therefore, it is important to also study cognitive processes in VR settings. In this proposal, we focus on the concept of mind wandering, which is an emerging concept in IS research that can be studied using neurological measures such as eye tracking. Current literature suggests that mind wandering is a complex concept with different dimensions, namely deliberate and spontaneous mind wandering. While previous literature has provided initial evidence on the feasibility of eye tracking to approximate mind wandering, this study seeks to investigate how well eye tracking performs when it comes to a more nuanced perspective on mind wandering applied in an VR setting.*

Keywords: *Mind wandering, deliberate, spontaneous, virtual reality, eye tracking.*

12.1 Introduction

For decades, information systems (IS) researchers have acknowledged the importance of cognitive processes during technology use. Constructs such as cognitive absorption [1] or IT-mindfulness [2] have widely been applied and have uncovered significant effects in IS-related contexts. With the rise of NeuroIS, the importance of cognitive aspects in technology-related settings has again been emphasized.

This study focuses on mind wandering, which is a cognitive concept that has only recently gained significant attention in psychology and neuroscience [3]. Mind wandering refers to episodes where our mind shifts to internal thoughts. While it can have severe negative effects [4], there are also an increasing number of studies that have demonstrated positive aspects of mind wandering, including a higher degree of creativity [5, 6].

Several studies have investigated the concept of mind wandering in different scenarios, with various measurement techniques. However, little is known about mind wandering episodes in virtual reality (VR). Since a major driver of VR technologies relates to the fact that they affect and potentially even enhance our cognition, investigating mind wandering episodes in VR promises to generate further insights. To stress this argument, Thornhill-Miller and Dupont [7] "highlight[s] virtual reality (VR) as perhaps the safest, most fully developed of the emerging technologies of cognitive enhancement and as an underused tool for the enhancement of creativity in particular" (p. 102).

To better understand the relationship between VR and the concept of mind wandering, this study proposes an experiment to further investigate mind wandering in VR. The remainder is structured as follows: First, we briefly review the concept of mind wandering and how it is measured (section 2). In section 3, we propose the experimental setting that allows us to investigate mind wandering in VR. We conclude by reflecting on potential insights and future directions of this research.

12.2 Related Work

Mind wandering

IS research often assumes that technology users are continuously focused [1, 8, 9]. However, empirical evidence shows that peoples' thoughts frequently proceed in a seemingly haphazard manner and effortlessly jump from one topic to another [10–12]. For up to half of their waking time, minds are not tethered to the actual moment or task, but easefully disconnected from the external environment [13].

Mind wandering is commonly described as a shift of attention away from a primary task toward dynamic, unconstrained spontaneous thoughts [4, 14] and as the mind's capacity to move away aimlessly from external happenings [15]. According to Christoff et al. [10], mind wandering can be defined as: "a mental state, or a sequence of mental states, that arise relatively freely due to an absence of strong constraints on the contents of each state". While mind wandering has widely been considered a failure of attention and control [16–20], recent studies highlight its advantages, including more effective brain processing, pattern recognition, and creativity [5, 12, 21, 22]. Specifically, mind wandering can help consider future events, solve problems, and create new ideas, e.g., at the digital workplace. It predominantly occurs during a resting state, task-free activity, and non-demanding circumstance [10, 12, 23, 24].

Since mind wandering can be a decisive factor for how users process information when using technology, IS researchers have started to acknowledge its relevance [25–28]. Sullivan et al. [26] were first to show that mind wandering influences functional outcomes of interacting with technology (i.e., creativity). They developed a domain-specific definition for technology-related mind wandering, being "task-unrelated thought which occurs spontaneously and the content is related to the aspects of computer systems" [26]. Moreover, Oschinsky et al. [25] revealed a significant difference between hedonic system use and utilitarian system use when it comes to mind wandering. Their study showed that the design of a system influences mind wandering, which in turn is known to affect antecedents of IT behavior and thus actual IT use.

There is a potential relationship between mind wandering and cognitive load, which has been investigated in the IS discipline. Representations of goal-states can be cued by goal-related stimuli under high cognitive load [3]. On the contrary, episodes of spontaneous thought are connected to low-level attention and uncontrolled, automatic thinking. If mind wandering is taking place, we seem to lack the ability to terminate or suspend it – we are fully immersed and yet relaxed and calm. The important difference of focused thinking under high cognitive load and the potential trigger of mind wandering episodes under low cognitive load is not yet sufficiently explored in the domain of NeuroIS research, and it is possible that there is an inverse relationship between the two constructs.

Because the interest in mind wandering has significantly increased in psychological and neuroscientific as well as IS research [22], different measurement scales have been proposed. However, the operationalization of mind wandering in IS-related conditions is still immature and incomplete [25–27, 29]. For instance, only little research exists that investigates the neurophysiological measures (e.g., EEG) in the domain of IS research (i.e., NeuroIS). Since self-report measurement does not seem to be the most efficient and appropriate way to assess the appearance of mind wandering experiences, refining the corresponding measurement instruments continues to be an important goal for research in this area [12]. We seek to contribute to closing this gap and propose the inclusion of and triangulation with objective data through eye tracking.

Eye Tracking and Mind Wandering

We conducted a literature review to identify how previous studies have measured mind wandering. For this study, we focus on the underlying type of technology (computer vs. VR) as well as the measurement of mind wandering (self-reported and using eye tracking).

technology		measurement		example references
computer	virtual reality	self-report	eye tracking	
✓		✓		[25, 26]
	✓	✓		[30]
✓		✓	✓	[31–48]
	✓	✓	✓	(this study)

Table 43. Studies on Mind Wandering and Eye Tracking

Table 43 highlights a variety of mind wandering findings which were collected by using self-reports and eye tracking. A large proportion of this literature deals with the risks of automobile crashes due to driver mind wandering. For example, He et al. (2011) highlighted deficits in vehicle control while mind wandering [39]. Others emphasize the increased chance of mind wandering due to the emergence of autonomous driving systems and offered suitable predictors [38, 40].

Mind wandering was also assessed in the context of attention while performing reading and learning tasks. Bixler et. al (2014-2016) aim for a fully automated mind wandering detection system using a machine learning model. To approach this goal, the researchers pseudo-randomly probed participants to report mind wandering episodes while performing computerized reading tasks. Meanwhile, the machine learning model tried to predict mind wandering due to gaze data followed up by a learning process based on the self-reported data [31–34]. Our findings indicated, that large chunks of eye tracking literature centers around utilizing objective data to create neural networks or machine learning models [41, 42]. Other researchers also probing for mind wandering in attention-tasks, familiarized test subjects with massive open online courses. Establishing on prior knowledge on objective mind wandering detection equipment, Zhao et al. (2017), successfully detected mind wandering with a common webcam [48].

Most of the discussed research used eye tracking devices in the form of cameras below or above the computer monitor (e.g., Tobii eye tracking devices) to record mind wandering. Eye tracking has a number of advantages over other methods for mind wandering research. However, there is a gap when it comes to the investigation of mind wandering in VR. In the remainder of this paper, we will describe an experiment which seeks to bridge this gap.

12.3 Methods

Participants and Materials

30 participants will be recruited at two different universities located in Canada and Germany to participate in a mailroom sorting task. Stimuli delivery and eye tracking will be conducted using HTC Vive PRO Eye SRanipal SDK, will be developed using the Unity engine and delivered using SteamVR. Participants will be screened for normal or corrected-to-normal eyesight, use of upper limbs and proficiency in English or German. Participants will be informed that we are investigating mind wandering in a simulated work environment. We will seek approval from our university's research ethics board and each

session will last for 30 minutes in a controlled setting. At the completion of each session participants will receive CAD $15 or 15€.

Procedure

Participants will undergo a consent protocol, complete an initial demographic questionnaire and will then be fitted with the HTC Vive PRO Eye VR-system. Participants will then take part in a virtual corporate mail room sorting task where they are given a series of addressed virtual envelopes and asked to place them in the appropriate bin. Participants will be asked to repeatedly retrieve a letter using the VR wand, read the address, and determine which of 16 bins to place it. The virtual letters will contain a selection of information consisting of addressee, title, department, and address. Bins will be arranged according to department and will be clearly labelled at the base of each bin. Participants will not be required to walk during the routine.

Questionnaires and Physiological Measures

At three points throughout the experiment participants will be prompted with an experience sample where they will be asked about their degree of experienced mind wandering immediately preceding the sample [49]. Following the experiment, participants will complete a questionnaire about perceived degree of mind wandering throughout and its degree of spontaneity [50]. Task engagement times will be recorded by the software using events that record the time of letter retrieval and letter delivery, as well as task success (operationalized as the proportion of successful tasks/total number of tasks) and eye tracking engagements with task objects. During the time between each retrieval and delivery, eye fixation counts and fixation durations on 17 areas of interest will be recorded by the VR software.

Data Analysis

One of the challenges of eye tracking in a VR environment is that the environment is fluid and involves user-directed motion. This task was selected because though it creates a realistic simulation, it also constrains motion considerably and the equipment is optimized for such tasks. Eye fixation targets will consist of Unity objects which are pre-designed and modified for this VR environment. When eye fixations lock on to one of the programmed objects, a method will be called which records eye fixations and durations during which they are fixated on the object. Each participant is expected to yield between 5000 and 7000 trials which each correspond to a retrieval/delivery window. Analysis will be conducted on trials with time windows that completely precede the 30 seconds before a mind wandering probe samples. Trials will be labeled afterwards based on whether participants reported being in a state of mind wandering. The result is a largely automated process and manual intervention is only required to add data about the mind wandering state.

Two linear mixed effects investigations will be conducted on the resulting data. In the first investigation, fixation counts and fixation durations (for both target and non-target areas) as well as task duration will be investigated as fixed effects. Reported mind wandering will be investigated as the intercept variable. The reported mind wandering and on-task states will be treated as random effects to account for differences in number of trials and variances in reported mind wandering. This will identify variables which influence mind wandering. In the second investigation, the same variables will be investigated, though the mind wandering condition will be included as a fixed effect and task success as the intercept variable. Finally, multivariate linear regression will be used to assess the effects of the ex post measures on task success rates.

12.4 Outlook

As noted by Thornhill-Miller and Dupont [7], VR can be a promising technology to enhance cognitive processes. Consequently, this study seeks to extend current insights in terms of how to stimulate (or reduce) mind wandering episodes in technology-related settings. With a better understanding of the cognitive processes at play in everyday business tasks, we can uncover new insights into how to design our environments. Virtual reality promises to help create realistic, yet controlled environments which make new research directions possible. The results from this project can also inform organizations how to use VR to design processes that could be affected by mind wandering.

Perhaps the most promising way that this work can be further developed is to design and implement adaptive systems. Adaptive systems change based on a users' mental or physical state with the goal of improving an information system. When complete, we would have demonstrated eye-tracking correlates of mind wandering, which might be implemented to create such environments. In the future, we may extend this work to investigate how mind wandering interventions can change behavior, and whether these changes have implications to the productivity of organizations.

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13. Paper 7: Investigating the Role of Mind Wandering

Title	**Investigating the Role of Mind Wandering in Computer-Supported Collaborative Work: A Proposal for an EEG Study**
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Table 44. Fact Sheet Publication

Investigating the Role of Mind Wandering in Computer-Supported Collaborative Work: A Proposal for an EEG Study

Abstract. *Mind wandering is a mental activity that allows us to easefully escape from current situations and tasks. Being the opposite of goal-directed thinking, existing research suggests that mind wandering is an important antecedent of creativity and innovation behavior. Moreover, there is initial evidence that technology characteristics may influence mind wandering. Despite a growing academic interest in mind wandering, there is only limited research that provides insights into the relationship between technology characteristics and mind wandering. We seek to address this research gap by proposing a research model that investigates whether technology supported collaborative work has an impact on the degree of mind wandering. In this research-in-progress paper, we describe the use self-report measures and neurophysiological measures (specifically, Electroencephalography, EEG) to study mind wandering in an Information Systems research context. Ultimately, our research seeks to inform design science research in order to enhance creativity and innovation behavior.*

Keywords: *Mind Wandering, Technology Use, Distraction, Experimental Research, Creativity, Collaborative Systems, EEG.*

13.1 Introduction

Research has found great potential in conceptualizing and investigating the role of daydreaming [1] and mind wandering [2]. Several studies demonstrate that mind wandering is related to positive outcomes such as creativity [2–4]. At the same time, research also found negative consequences, particularly reduced performance [5–7]. A major reason for the increasing interest in mind wandering relates to the fact that it allows to derive thoughts and significant meaning without external influence (e.g., [8]). More specifically, the mental retreat from stressful and unpleasant situations allows for future planning and sense making of past events. Hence, its relevance has increased in our fast-paced times, where the perceived level of stress increases, among other reasons, due to the blurring of boundaries between the private and the business domain (e.g., [9, 10]).

Since many employees rely on the intensive use of information technology (IT), mind wandering is also relevant for Information Systems (IS) research [11–13]. Studies show that mind wandering has an impact on pivotal IS constructs, such as task performance and knowledge retention [12, 13]. Furthermore, research demonstrates that the degree of mind wandering varies among the use of hedonic and utilitarian systems [11]. Despite the increasing interest in technology-related mind wandering, or technology-induced mind wandering, current literature leaves important questions unanswered. Specifically, there is only limited research that investigates how technology can be designed in order to stimulate or inhibit mind wandering (c.f. strategy 1 [14]). Consequently, design and development of neuroadaptive systems is hampered [15].

Against this background, we propose a research model whose long-term goal is to shed light on how to design technology to influence users' mind wandering states. In the present research-in-progress paper, we investigate whether IT supported collaborative work has an impact on mind wandering and consequently on creativity. In addition to self-report measures, we suggest using EEG to measure users' mind wandering state.

The remainder is structured as follows: First, we briefly describe the extant literature on mind wandering and highlight current shortcomings. Second, we propose a research model that seeks to address the identified gap. Third, we describe our experimental procedure and conclude with final remarks on potential contributions of this research.

13.2 Theoretical Background

Literature from psychology shows that unconstrained mental processes are rather the norm than the exception. Specifically, evidence indicates that between one third and one half of our daily mental activity is unrelated to the external environment and off-task [16]. This finding instigated research on the exploration of the mind's capacity to wander, yielding in a new stream of research on mind wandering [2, 4, 16]. Mind wandering is commonly understood as "a shift of executive control away from a primary task to the processing of personal goals (p. 946)" [17].

Evidence from psychology and neuroscience illustrates that mind wandering occurs aimlessly during the resting state, in non-demanding circumstances and predominantly during task-free activities [18–23]. The state of decoupled attention is characterized by thinking exclusively about internal notions and feelings and by the temporal inability to process external information [24]. Due to this inability, it is often perceived as cumbersome [4, 24]. Mind wandering implies a lack of awareness and is a cause of poor performance, errors, disruption, disengagement, and carelessness [5–7]. Also, mind wandering is enhanced by stress, unhappiness and substance abuse, and consequently by states which are negatively connoted themselves [25–27]. However, research also studied mind wandering's positive outcomes. In essence, it was found that mind wandering positively affects creativity and innovative thinking [12, 28, 29], and it may lead to an increased ability to solve problems [13, 30]. In summary, evidence shows that mind wandering has negative and positive effects.

First attempts have been made to investigate the relationship between technology use and mind wandering. For that purpose, technology-related mind wandering has been defined as "task-unrelated thought which occurs spontaneously and the content is related to the aspects of computer systems" ([13], p. 4). A few IS studies provide empirical insights into mind wandering. Wati et al., who introduced the concept of mind wandering into IS research, demonstrate that user performance is influenced by an individual's focus ability and mind wandering [12]. At a later stage, the same research team studied the content of thought during mind wandering in technology-related and non-technology-related settings [13]. Their study indicates that mind wandering moderates the relationship between on-task thought and creativity; it was also found that mind wandering has a significant impact on task performance and knowledge retention. While these studies primarily focused on the moderating role of mind wandering, others provided initial evidence that depending on what kind of technology is used (e.g., hedonic or utilitarian systems) there are different levels of mind wandering [11]. Despite the valuable first research efforts in the IS discipline on mind wandering, IS research would benefit from a better understanding of *why* and *how* an IT artifact influences the degree of mind wandering, because these insights can inform design decisions of systems and applications, including the development of neuroadaptive systems. Methodologically, previous literature proposed and used various measurement instruments to study mind wandering.

Type of Measure		**References**
Self-report	Experience sampling	[31–34]
	Online	[11, 35]
Psychophysiological	Eye Tracking (ET)	[36–38]
	Skin Conductance Response (SCR)	[39]
	Electrocardiogram (ECG)	[40–42]
Brain Imaging Tools	Functional Magnetic Resonance Imaging (fMRI)	[32, 43]
	Electroencephalography (EEG)	[5, 42, 44]
	Magnetoencephalography (MEG)	[45, 46]

Table 45. Overview Measurement Instruments

In summary, mind wandering is an important psychological construct with relevance in the IS domain, and this construct, according to prior studies, has neurobiological correlates, both on the autonomous nervous system level (ET, SCR, ECG) and the central nervous system level (fMRI, EEG, MEG). Yet, there is a major research gap when it comes to the relationship between technology characteristics and their impact on the degree of mind wandering as well as potential outcome variables. Against this background, we propose a research model that seeks to shed further light on these relationships.

13.3 Research Model

Our research model is shown in Figure 13.1 and explained in the following.

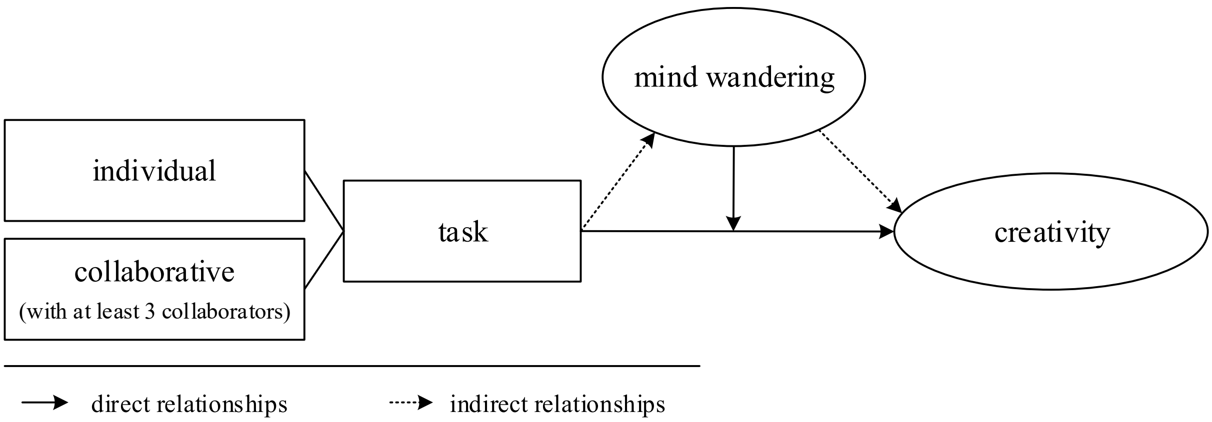

Figure 13.1. Proposed Research Model

We build on previous literature that repeatedly suggested that there is a strong relationship between mind wandering and creativity [2–4]. Consequently, we assume that this relationship is also given in the context of an IT supported task. Moreover, previous literature argued that un-demanding tasks and cognitive ease increase the degree of mind wandering (e.g., [29]). Stan and Christoff tellingly describe the state of mind wandering, they write: "we would find ourselves transitioning gently between thoughts, rather than being pressured toward them" ([47], p. 45). The logic of our model with respect to the task is built on the fact that in a collaborative task with at least three persons, there is a higher probability to fall in a state of mind wandering if compared to a state in which two persons work jointly on a task or in which one person works alone. This reasoning is based on the fact that a collaborative task can be spread on the shoulders of a number of persons, which increases the probability for cognitive ease, an antecedent of mind wandering [47]. Note that cognitive ease is less likely in two-person interactions because the two individuals are in a direct communication process, which is not the case in groups of three or more people (because it is possible that two persons interact, while the other person(s) may drift into a mind wandering state). Consequently, we argue that collaborative tasks (except those including two persons only) result in a higher degree of mind wandering compared to individual tasks in which a person has to complete a task alone.

13.4 Methodology

Experimental Design

Based on our research model, we use a between-subjects design in which we manipulate task execution (either individual or group of three people). We acquire data from healthy students and employees from a middle-size university in a German-speaking country to conduct the experiments. Each participant receives financial compensation.

Measurement instruments

Self-reported measures. We use established scales to measure self-report constructs. For creativity, we use the Creative Achievement Questionnaire [48]. Mind wandering is measured as suggested in previous literature [11, 12, 49].

Objective measures. Besides self-reported measures, we also use EEG to study mind wandering. While there are several instruments to collect neurophysiological data on mind wandering (c.f. Table 45), we use EEG because it has been successfully used most often in this domain [40–42]. For an introduction into EEG from an IS perspective, please see Müller-Putz et al. [50]. Time-frequency analyses, spectral features as well as more sophisticated methods like connectivity measures will be derived from the EEG. Comparison of different rounds, e.g., round 1 with round 4 and others can be used to derive evidence of neural correlates.

Experimental task

The investigator welcomes the participants, presents them the informed consent procedure, and fits them with the EEG cap and scalp electrodes. Next, s/he will ask them to accomplish a 20-minute creative task. In line with previous literature, we use the title task [3, 51] to measure divergent thinking capabilities. We schedule 4 minutes and 1-minute break per round, resulting in a total of 20 minutes. The test is specifically designed to foster creative ideas. It requires coming up with alternative titles for widely known books or movies. We chose two books and two movies well known to German speaking people. The participants are asked to either independently come up with as many titles as possible (the 'individual' group) or to perform the same task two further participant (the 'collaborative' group). They are assured that their answers will neither be graded nor publicized. To ensure that the collaboration does not cause confounding effects, only one subject is part of the 'collaborative' group while the other two group members are researchers. Importantly, in the 'collaborative' group only the EEG of the actual subject is measured. Moreover, the experiment is designed so that the two researchers start intensive interaction in the collaboration task so that the actual subject is likely to fall in a state of mind wandering. To operationalize the individual and collaborative tasks, we use Google Docs (as instance for computer-supported collaborative work) which allows both individual and synchronous work in collaboration. An example of the collaborative task with three collaborators is shown in Figure 13.2.

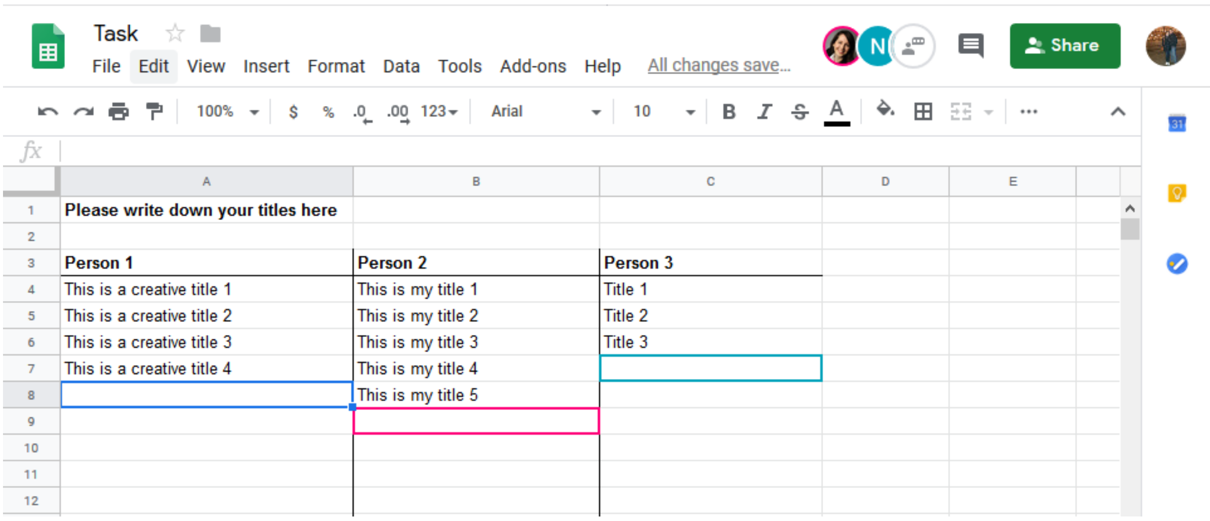

Figure 13.2. Experimental Task (Collaboration)

After completing the task, the participants are asked to fill out a short questionnaire assessing their general creativity and their self-reported degree of mind wandering, along with demographic questions. Finally, they are thanked, debriefed, and given the compensation for participation.

13.5 Outlook

Based on our proposed research model, we expect important contributions for IS research and NeuroIS alike. For IS research, this is one of the first studies that investigates how a class of systems, i.e., group collaboration systems, can influence mind wandering. In addition, it highlights that computer-supported collaborative work has the potential to enhance creativity, a process which is eventually mediated by mind wandering (see Fig. 1). If follows that the insight derived by our study is predominantly relevant for jobs that require a high degree of creativity (i.e., knowledge work), our results can inform workplace design for creative jobs. With regards to NeuroIS, this study provides new insights into the neural (EEG) correlates of a cognition-related construct, namely mind wandering [15]. Ultimately, our research could have significant potential to inform future studies on EEG-based correlates in mind wandering and consequently to conduct studies that seek to develop neuroadaptive systems [14, 15, 53]. We envision a system which can, based on the user's current state, influence his or her mind wandering state to affect important outcome variables, particularly creativity.

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14. Paper 8: Creativity Loading – Please Wait!

Title	**Creativity Loading – Please Wait! Investigating the Relationship between Interruption, Mind Wandering and Creativity**
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Table 46. Fact Sheet Publication

Creativity Loading – Please Wait! Investigating the Relationship between Interruption, Mind Wandering and Creativity

Abstract. *With the advancement of information technologies,routine tasks are increasingly supported by information systems, which is why ideation and creativity is becoming more and more important. We know from many anecdotes that creative ideas emergewhen our mind is wandering instead of being focused on the task at hand. Yet, most information systems thatare used for work-related purposes offer only little opportunities for task-unrelated thoughts. In contrast,current literature shows that most information technology is designed to keep our attention. To better understand the value of mind wandering, we propose an experimental design that incorporates interruptions that vary in their length with the objective to stimulate episodes of mind wandering andthus positively impact creativity. We provide initial insights on how the experiment should designed and discuss implications for future research.*

14.1 Introduction

To foster their creativity, scientists like Albert Einstein and Isaac Newton reported that by having task-unrelated thoughts, they were better able to solve problems [10]. Mind wandering is an attentional shift away from primarily tasks toward internal notions [59] that demonstrably helps create ideas by relieving the working memory [18]. Creativity on the other hand, is the ability to create an output which is novel and somehow useful or appropriate at the same time [62]. Literature repeatedly demonstrated the relationship between mind wandering and creativity as well as mind wandering and divergent thinking [10, 18, 36]. Whereby divergent thinking describes the combination of different information in novel ways as a result from creative idea generation [29, 40]. When the aimless and effortless train of thoughts leads to unexpected ideas, people oftentimes experience “Aha!” or “Eureka!” moments which can yield in creative ideas [58].

Research suggests a high rate of mind wandering during everyday activities, which reaches up to 50 percent of our waking time [58]. While mentally shifting from topic to topic, individuals mostly process autobiographical information [63] regarding future or past events [11]. During mind-wandering episodes, we find a deviation of external information towards internal notions, which triggers divergent thinking and thus creativity [36].

While previous literature provides evidence on the importance of both mind wandering and creativity, little is known about the relationship of these two phenomena while using technology. Research about the characteristics of an information systems and its impact on the interplay between mind wandering and creativity is in its infancy. This gap is critical because jobs increasingly require divergent thinking. In specific, creative thinking is considered as a basic prerequisite for successful practice in many domains dependent on innovation and novelty including product development and industrial design. Consequently, research that outlines managerial and design-relevant implications on fostering creativity can be considered a step towards designing future workplaces.

To shed further light on the role of mind wandering, we draw from interruption literature in Information Systems (IS) research. In specific, we refer to the goal-activation model [6], which suggests that the length of interruption has an impact on whether a goal is maintained or not. Based on this idea, we suggest that a specific amount of interruption time influences the ability to focus on a primary task and thus, individual goal persuasion. We suggest that individuals, who are interrupted for a considerable amount of time, are more likely to let their mind wander, compared to very short interruptions, which in turn leads to more divergent thinking and creativity. Our contribution to IS research is valuable from a theoretical and practical perspective. On the one hand, we want to explain the connection between mind wandering and creativity with a technological focus, operationalized by means of different types of interruptions in an online environment. On the other hand, we seek to provide an impulse for design and seek to promote creativity through the design of the technology itself.

To address our goal, this paper is structured as follows. First, we examine current literature to give a brief overview of mind wandering as well as creativity both in IS research and related domains. Second, we propose a research model that allows us to explore the relationship between design, mind wandering, and creativity more thoroughly. Third, we describe an experimental study for investigating our hypotheses and add preliminary results. We conclude with a discussion of our results.

14.2 Theoretical Background

Mind Wandering While Using Technology

Mind wandering is a ubiquitous cognitive process [58]. It is described as “a shift in the contents of thoughts away from ongoing tasks and/or from events in the external environment to self-generated thoughts and feelings” (p. 488) [58], which arises from the naturally and aimlessly [55]. The train of thoughts is detached from the direct external environment and directed towards internal notions and ideas [63]. Also known as task-unrelated thought or daydreaming [57], mind wandering is described as an unguided state of disconnectedness from the environment [52], in which the way of thinking is barely controlled or focused, and thus free from constraints or boundaries [14, 15, 23]. Furthermore, mind-wandering thoughts are self- generated and mostly based on autobiographical experiences [20, 58].

The rate of mind wandering can be influenced by the commitment to a task. Smallwood et al. describe that the higher the level of engagement in a task, the lower the probability of a drift of thoughts [55]. Also, the general attitude to the task itself reveals different levels of a wandering mind. If the task is perceived as pleasant (42.5%), the tendency for task-unrelated thoughts is much higher than for an unpleasant topic (26.5%) [34].

To get into the state of mind wandering, sometime must pass, after interacting with the current surroundings. Risko et al. show that students during a lecture tend to task-unrelated thoughts mostly in the second half class [49], which indicates that the duration of time can trigger mind wandering. This effect can be enhanced by the individual level of motivation and interest in the topic [43], which is a significant indicator for being in a state of a wandering mind. Additionally, it is more likely to mind wander while resting, in non-demanding circumstances and during task-free activities [13, 46, 61].

As mind wandering is an inattentive, task- unrelated train of thoughts, negative effects such as poor performance and high error rates occur [58]. Three areas have already been intensively studied: reading, learning and driving. First, studies on reading comprehension [45] show that interest and difficulty of the given text decrease mind wandering [21, 26]. Once the mind wanders, the understanding suffers [56] and the duration of reading increases [21]. Second, mind wandering interrupts learning processes. If thoughts are migrating, the external information from the current surrounding have no influence and can neither be learned nor interpreted [55]. Mind wandering during learning mostly occurs due to a lack of interaction, whereby an active cooperation between students yields the lowest rate of mind wandering [43]. Third, research on driving shows that mind-wandering drivers are at risk of being adversely affected by negligence. When the thoughts are wandering, the reaction time to braking is longer, the velocity higher and the distance to vehicle in the front is shorter compared to attentive drivers [71].

Despite its shortcoming, an increasing body of literature acknowledged that mind wandering also leads to various positive aspects such as (self-) reflection, future planning, and creative thinking. Creativity is important for generating new ideas [24]. To be innovative, it is crucial to look at things from various perspectives and to build something

unique [24]. Literature shows that mind wandering increases creativity, especially when dealing with complex problems [10]. In this context, results reveal that the deliberate sub-type of mind wandering, which happens with intention and metacognition, positively supports creative performance. In contrast, spontaneous mind wandering, which happens without intention or recognition, is rather negatively related to a creative outcome [4]. Thus, some authors that do not differentiate the sub-types conclude that mind wandering is mostly counterproductive [31] leading to the fact that empirical findings are mixed.
Given its ubiquity and complexity, the interest in mind wandering has increased in the IS domain in recent years [46, 63, 67]. Oschinsky et al. show that using hedonic systems (e.g., writing an email) yields in a higher occurrence of mind wandering than using utilitarian systems (e.g., using Facebook) [46]. In addition, Wati et al. refer to mind wandering as prerequisite for the outcome of performance in case of accuracy and efficiency adding different IS task complexities. They figured out that the relation to efficiency is significant, while the relation to accuracy is only significant under high task complexity [67]. Based on their results, Sullivan et al. defined technology-related mind wandering as "task-unrelated thoughts which occur spontaneously, and the content is related to the aspects of computer systems" [63]. The authors identified a positive moderating effect between technology-related mind wandering and perceived creativity [63]. Yet, the inconsistent results from the psychological literature of have not yet been discussed in the IS domain.

Creativity and Technology Use

Creativity is a process of creating innovative solutions and novelties [36]. To describe creativity, two essential elements are commonly used. Originality and usefulness [50] or novelty and quality respectively [36]. Novelty is described as the innovation part, to create something new and original. Quality in turn stands for the features of novelty and aims for being good and useful [36]. Therefore, creativity outlines something new with an improved benefit compared to the old solution.
Regarding the process of thoughts, creativity is divided into two different types of thinking. On the one hand, creativity is characterized by divergent thinking, which is a bridge to mind wandering due to the fact of interrupting current on-task thinking with unconstrained thoughts to generate different ideas. On the other hand, it consists of convergent thinking as process of choosing the "best" option of all appearing ideas [29, 69]. Thus, creativity denoted the trial of thinking about ideas and choosing the one solution, which fits best to the requirements of a given problem. Due to its relevance for innovation

and design, IS research on creativity has much potential. For example, Minas and Dennis use the priming effect to perform an idea generation task with creative support systems (CSS), which results in an increased creative output [44]. Moreover, Althuizen and Reichel show that technology enhances the production of novel ideas for problem solving, whereby IT-enabled stimuli providers have a greater effect on creativity than process guides and mind mappers. These stimuli were designed to provide relevant information about the current task by using clues in form of images, sounds, sentences, or words and thus increase creativity [5]. In addition, Lee and Choi indicate that organizational creativity is critical to improve organizational performance [38]. They study the relation between knowledge creation, organizational creativity, and organizational performance. The authors seek to both help firms to strengthen their performance and managers to find the right worker for knowledge creation and thus improve knowledge management.

Through the connectivity of individuals, social interaction and idea sharing become possible in technological environments and in a location- and time-independent way. Consequently, creativity is highly relevant during collaborative tasks as individual knowledge and the sharing of it helps improve team creativity [65]. For example, novelty and the quality of creative output were researched with the aid of technology in form of online brainstorming [12, 16, 25, 42] in collaborative work in connection with cognitive stimulation. Bhagwatwar et al. show that priming within a three-dimensional virtual environment increase the quality of ideas regarding to a greater breadth and depth [12]. This phenomenon is also shown by Dennis et al. who indicate that achievement priming allows people to generate more creative unique ideas compared to neutral priming [16].

While previous literature has spent considerable efforts to understand mind wandering and creativity isolated, there is only little research that investigates this relationship in detail. Since an increasing number of jobs require a significant amount of creativity, a better understanding of this relationship is both promising for literature and relevant for practice. Against this background, we seek to shed further light into this phenomenon by raising the following research question (RQ):

> ***RQ:*** *Does a lengthy interruption while using technology fosters more mind wandering and thus more creativity compared to a shortinterruption?*

14.3 Research Model

To address our research question, we propose a research model that hypothesizes the relationship between technology use, which we vary in terms of the length of the interruptions. Moreover, we include mind wandering as both a mediator and a moderator (c.f. Figure 14.1). On the one hand, mind wandering is triggered by interruption and has direct impact on the creative output. On the other hand, mind wandering influence the relation between the interruption impact and the creative output.

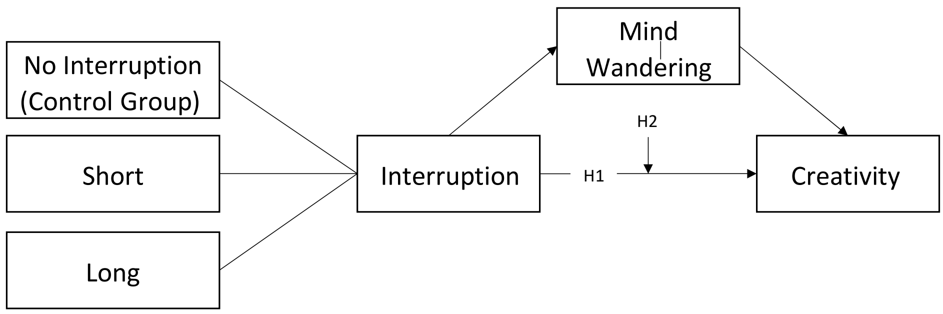

Figure 14.1. Research Model

Research suggests that ideation processes require non- demanding environments, in form of divergent thinking [29]. Whereby this "can significantly affect individuals' intrinsic motivation to engage in an activity, which in turn affects their creativity" (p. 257) [51]. Interruptions of a primary task serve as the basis for such a non-demanding environment. Consequently, we assume that interruptions influence the occurrence of mind wandering [37, 39], because the attention of the primary task can shift towards task- unrelated thoughts more easily as time passes [22]. This is also in line with Wang et al. who suggest that under certain circumstances creativity is enhanced through interruptions [66].

According to the goal-activation model [6], time is a critical component when it comes to new goals. For the different duration of both interruptions, we relate to literature, which also used a single interruption in experimental setting [27, 35]. Therefore, interruptions that occur for a short duration of time do not lead to the formulation of a new goal. In our context, we assume that short interruptions are not necessarily related to mind wandering episodes, because our working memory can still stick to the original goal (i.e., the primarily task). In contrast, in cases of longer interruptions, the individuals are much more likely to let the mind wander and even forget their initial task- related goals. Similar to this line of thought, Risko et al. demonstrate that with increasing time, the probability of mind wandering increases [49]. Also, Baird et al. indicate an encouraging effect on creativity after resting time [10]. Against this background, we propose our first hypothesis (H1):

H1a: *Interruptions lead to a higher degree ofcreativity compared to no interruption.*

H1b: *Long interruptions lead to a higher degree ofcreativity compared to short interruptions.*

Cognitive concepts such as mind wandering, mindfulness and cognitive absorption are commonly used as an accelerator between relationships (e.g., [17]). For that reason, previous research has included mind wandering as a moderator between technology use and performance [67]. In line with existing studies on the relationship between mind wandering and creativity, we propose an accelerating effect between task-interruption and creativity. In specific, we assume that the relationship between interruption and creativity is further strengthened through mind wandering. Consequently, we hypothesize that:

H2: *The relationship between interruptions andcreativity is accelerated by mind wandering.*

14.4 Methodology

Experimental Design

To test our hypothesis, we propose a within-design laboratory experiment with three conditions. A within- design is most suitable for this endeavor because episodes of mind wandering can vary within individuals over time [28]. Data will be collected from healthy students from middle-size universities. All participants get a financial compensation.

Experimental Task

At the beginning, the experimenter welcomes the participants and gives them an explanation of the process. Then a brief introduction to the program, which is used in the experiment, is given. We will use the web-based systems PsychoPy3 [47], that is designed for psychological experiments such as the proposed one. Afterwards, the participants are introduced to the task. We choose the title task because it has already been used in similar research settings [30]. The idea of the title task is to find a variety of alternative titles for well-known covers (e.g., for books or movies) [4]. Each participant has to do six tasks in a row. For that reason, we not only use book covers but also covers from well-known music titles. In specific, we select the popular covers from current movies (i.e., "Star Wars: The Rise of Skywalker" and "Avengers: Endgame") that are similar in genre to allow a comparison. For books, we choose "The Lord of the Rings: The Return of the King" and "Harry Potter and the Order of the Phoenix", which are also from the same genre. Finally, we chose two music covers, namely "AC/DC: Highway to Hell" and "Bon Jovi: It's my life". Within the experimental task, participants are asked to create as many alternatives as possible and write them down after they see the original title. This procedure of creative brainstorming and solution identification is explored in previous literature on creativity in IS research [5, 16, 25, 42]. For each task, the participant has 5 minutes to write down alternative titles. To strengthen the validation of the creative task, two researchers will evaluate the results independently. In specific, we will score the creative output (usefulness and originality) separately on a 5- point Likert scale ranging from "not at all original" to "highly original" [4, 50, 53, 70] and from "not at all useful" to "highly useful" [36, 50]. A combination of both dimensions is used to measure the overall creativity of the participant.

Manipulation

Previous literature indicates a range from 30 sec to 165 sec [27] for a single interruption during an experiment setting. Consequently, we include an interruption about 30 seconds and a longer interruption with 120 seconds. We assume that a longer duration of task interruption triggers more mind wandering than a short one. For visualization of these interruptions and to make it understandable for the participants, we include a visual loading screen when the interruption occurs (Figure 14.2). To indicate that the interruption an immediate part of the experiment and not an error message within the software, an instruction "Please wait." above the loading bar is implemented. The exact period in which the loading bar is completed is not known by participants and can only be estimated by the pace of completion. After this, both groups can continue with their ideas within the remaining time. Immediately after the processing time, participants are instructed to complete a final questionnaire. It measures mind wandering and perceived creativity as well as the demographics. It takes about 7 minutes. Finally, the instructor thanks the participants and hands over their compensation.

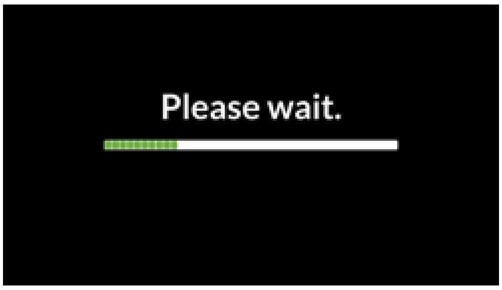

Figure 14.2. Example of the Interruption

Measurement Instruments

To identify the occurrence of mind wandering in the experiment, a self-report measurement is obtained by means of a questionnaire,which represents standard in the previous literature [68]. For the measurement of mind wandering, we combine two established item collections [46, 67], which were slightly adjusted to the given circumstances. The selected items (Table 47) are all concerned with divergent thinking and denote task- unrelated thoughts. Additionally, it is to note that all items are related to the state of mind wandering and donot describe mind wandering as a trait. This is due to the fact, that the experiment investigates the situation-dependent influence on creative output and not the general attitude concerning wandering thoughts.

	When using the technology to brainstorm forideas creation …
MW1	…, I thought about something, which was not related to the booking process.
MW2	…, I found myself distracted by other things.
MW3	…, I had so many things in mind.
MW4	…, I got easily distracted by unnecessary information.
MW5	…, my mind wandered.
MW6	…, I was daydreaming.
MW7	…, I did not concentrate on the creationprocess.

Table 47. Mind Wandering Items

In addition to the evaluation of the title task, creativity is determined by means of a self-report questionnaire. The measurement items refer to the generation of novel and innovative ideas and are also taken from established previous literature [33]. A complete overview of the remaining items is provided in Table 48 (Appendix A).

Preliminary results

Due to the ambivalence of the relationship between mind wandering and creativity [4, 60], we analyzed survey data that relate to our research model. In specific, we seek to provide initial evidence on the usefulness of our intended manipulation and its effect on creativity. For that purpose, we used established measurement scales for related constructs, namely perceived control [3], temporal disassociation [3], and perceived creativity [33].

We used data from 81 individuals, on average aged 30 ($M = 30.0$, $SD = 11.0$), with 42 percent female and 58 percent male respondents, with an average working experience of 8 years ($M = 8.44$, $SD = 10.7$). To understand whether the planned manipulation works as intended, we investigate the relationship between perceived control and temporal disassociation on mind wandering, because participants have no way to influence the interruption and therefore have a lack of control and are likely to lose their sense of time. While both variables do not measure interruption directly, we argue that it is a good first indicator that provides further information on our proposed hypothesis.

The results of analysis suggest a significant model fit between control and mind wandering $F(1,79) = 8.43$, $p = 0.00$, with a significant path coefficient ($b = -.34$, $p = 0.00$). Similarly, the relationship between temporal disassociation and mind wandering suggests a significant model fit $F(1,79) = 4.32$, $p = 0.04$, with a significant path coefficient ($b = 0.21$, $p = 0.04$).

These significant relationships can be considered an indicator that the temporal aspect and individual control take a central role in relation to mind wandering. Also, it demonstrates that the point of entry into task-unrelated thoughts is connected to a certain time interval in which the individual drifts away from the current environment to a mental state of inner thoughts, which cannot be controlled by herself/himself. In summary, the results of the regression analysis provide initial evidence related to the first hypothesis (H1a, H1b).

To preliminarily investigate whether mind wandering has an impact on creativity, we use the self- reported measures of mind wandering and creativity [4]. The results of a regression analysis suggests a non- significant model fit $F(1,79) = 0.02$, $p = 0.89$ and a non-significant relationship between mind wandering and perceived creativity ($b = 0.02$, $p = 0.89$). According to these results, mind wandering has no direct influence on the degree of creativity. A drift of thoughts and thus divergent thinking from the current situation neither positively nor negatively influenced the possible resulting creativity. However, empirical findings in the literature are mixed and need a more thorough investigation.

14.5 Discussion

Despite the importance of mind wandering as a fundamental cognitive process, there is a significant gap in IS literature in terms of a solid understanding of its role mind wandering in IS-related phenomena. We address this gap by proposing a research model that integrates mind wandering as a moderator and a mediation between the interruption and creativity. The length of the interruptions is a critical concern here because the length can have a significant impact on the primary task. Long interruptions are assumed to make it difficult to return to the primary task. Previous literature has suggested that this resumption lag [7] varies between 1 and 24 minutes [1]. Consequently, an effective interruption leads to a considerable amount of time to bring the user's attention back. This research, which includes a variation of interruption length, can therefore informs future research its impact on specific outcome variables such as mind wandering.

Previous literature also stressed the importance of intuition and intuitive action. For example, Eling et al. demonstrate that an intuitive analysis yield in quicker decisions [19]. In case of our proposed experiment, mind wandering can similarly stimulate this kind of intuitive action when participants generate titles quicker. Therefore, this research has also the potential to contribute to a better understanding of intuition.

Based on our results, we can derive several implications for research and practice. For theory, our study contributes to a better understanding of mind wandering while using technology. Moreover, while research in the domain of psychology has shown that there is a positive relationship between mind wandering and creativity [4, 10], IS literature lacks empirical evidence on this relationship in terms of technology use. Consequently, we contribute to IS literature that has primarily concentrated on on-task task performance [63, 67] by focusing on task creativity and innovative output induced by off-task thoughts.

An interruption while using technology is commonly considered as a negative as well as stressful aspect, which reduces task-performance [2, 8]. In line with other authors, who already shifted their attention towards positive outcomes of interruptions [2], we propose another perspective on the value of interruptions at work. While others have argued that interruptions are disruptive [9, 27], we suggest that interruptions can lead to mind wandering activities which in turn lead to the positive outcome of creating new ideas. This distinguishes it from other creative processes because mind wandering is task-unrelated and unguided and has gained only little attention so far. Therefore, we seek to contribute to existing literature on interruptions and its consequences from a new perspective.

This research is also promising for the development and design of IS. Interruptions as suggested here can be integrated in any class of system. We argue that based on its effects on mind wandering, interruptions are most likely beneficial in systems that are used in creative work. In contrast, systems that are designed for routine work and tasks that requires a high degree of attention should avoid any kind of distraction.

Since we focus on a cognitive process, this research can also inform IS design when it comes to neuroadaptive systems [48, 64]. Therefore, systems that use neurophysiological data to detect mind wandering episodes can maintain (or avoid) interruptions to either foster mind wandering or reduce it. This topic travels well with the rising interest in NeuroIS research and can also learn from integrating objective neuroimaging measures to further elaborate on the validity of measuring cognitive concepts such as mind wandering and creativity.

This research also has important implications for practice. Above all, we argue that mind wandering episodes can be valuable at work. Since creativity is a pivotal human asset, this research can inform practice on how to design workplaces and workplace IT. While technology is mostly designed to keep our attention (see for instance [54]), research shows that is time to think about alternatives. Particularly, organizations that depend on creative thinking should take concepts like mind wandering and daydreaming into consideration when designing future-oriented jobs.

14.6 Limitations and Outlook

As every research, this study comes with some limitations that should be addressed in future research. First, we used survey data to get preliminary insights on the usability of our research model. Future research should go one step further by carrying out an experimental study with an experimental task to get further insights. This is also relevant in terms of the manipulation. More empirical insights are required to justify the length of the interruption. Like other studies that focus on cognitive processes, self-reported measures can be biased. This can be particularly relevant in terms of mind wandering because participants are not always aware that their mind is wandering or can recall their train of thoughts. This relates to the fact that mind wandering is considered the standard process in nearly every daily activity [34]. Thus, the triangulation of certain measurement methods may become more important in future research. Finally, this research is primarily motivated with previous insights from cognitive sciences and mind wandering in specific. Consequently, more insights can be generated by extend this perspective by integration other theories from the creativity literature. For example, the theory of inventive problem solving (TRIZ) [41] and concept-knowledge theory (C-K theory) [32]) are promising candidates to justify potential outcomes better. This is particularly relevant when it comes to the distinction between divergent and convergent thinking [29, 69], which contribute a substantial part to the idea creation process. Since creative processes are highly important for many knowledge workers, this research is most promising in a field setting with a strong external validity.

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14.8 **Appendix A**

Creativity [33]	During the brainstorming session …
CREA1	…, I seek new ideas and ways to solve problems.
CREA2	…, I generate ideas revolutionary to the field.
CREA3	…, I think it is a good role model forinnovation/creativity.
CREA4	…, I try new ideas and approaches to aproblem.
Temporal Dissociation [3]	Please put yourself back in the given situation. In the experienced situation …
TD1	…, I lose track of time.
TD2	…, time flies.
TD3	…, I spend more time than I hadintended.
Control [3]	Please put yourself back in the given situation. In the experienced situation …
CO1	…, I feel in control.
CO2	…, I feel that I have no control.

CO3	…, I control my interactions.

Table 48. Measurement Items

15. Paper 9: Further Investigating the Impact of Mind-Wandering on Creativity

Title	**Investigating the Impact on Creativity in a Supportive Technology-Driven Environment: An Experimental Approach**
Authors	Thorben Lukas Baumgart[1] Frederike Marie Oschinsky[1] Björn Niehaves[1] [1] University of Siegen, Siegen, Germany.
Publication Type	Conference Paper
Status	Published
Full Citation	Baumgart, T. L., Oschinsky, F. M., Niehaves, B. (2021). Investigating the Impact on Creativity in a Supportive Technology-Driven Environment: An Experimental Approach. 27th Americas Conference on Information Systems (AMCIS 2021), Montreal, Canada.

Table 49. Fact Sheet Publication

Investigating the Impact on Creativity in a Supportive Technology-Driven Environment: An Experimental Approach

Abstract. *Fast-moving products and the urge for newness require constant innovation. Creativity has become an important asset for modern workers to meet this demand. However, today's work environments are highly technology-driven, which often hampers creative thinking. Particularly, external interruptions and internal absent-mindedness (i.e., mind wandering) can impair performance. Although research offers different links between the single constructs (i.e., creativity, mind wandering, interruptions), an integrative view is missing so far. Based on cognitive demand theory, we propose an experimental design to examine the mediating effect of mind wandering between technology-induced interruptions and their influence on creative output. With our work, we aim to open the door for a vivid discussion on regaining focus in the digital age.*

Keywords: *Creativity, mind wandering, interruptions, cognitive demand, experiment.*

15.1 Introduction

Creativity is an essential need for today's work. As the "ability to produce ideas that are both novel […] and useful […]" (Christoff et al. 2016, p. 722), it enables workers "to escape the present, reconstruct the past, and fantasize about the future" (Gabora 2013, p. 1548). In times of digital change, workers increasingly rely on the use of information and communication technology (ICT). Although creative support systems can foster ideation and aim to enhance "boundary-breaking, insightful thought during problem solving" (Massetti 1996, p. 83), technology use can also result in interruptions that impair work performance. Thus, ICT may create a potential threat for creative thinking processes.

Interruptions are "events that break continuity of cognitive focus on a primary task" (Coraggio 1990, p. 19). They can count up to more than a third of every workday (Spira and Feintuch 2015), and need considerable cognitive resources (Wang et al. 2014). Pop-ups (Tams et al. 2018) and e-mails (Addas and Pinsonneault 2018) are well-known technology-induced interruptions that disturb users at least four times per hour (Iqbal and Horvitz 2007). Thus, working in a technology-driven environment with constant "beep, buzz, and blink" (Tams et al. 2018, p. 858) does often not allow an efficient task performance (Coraggio 1990).

Another hindrance of performance is mind wandering (MW) with an occurrence up to 50% of waking time (Smallwood et al. 2007). The "state of decoupled attention" (Smallwood et al. 2007, p. 230) represents unguided internally-directed thoughts and "a fundamental breakdown in the individuals' ability to attend (and therefore integrate) information from the external environment" (Smallwood et al. 2007, p. 230). Despite its disadvantages, current studies highlighted that creativity could benefit from it (Baird et al. 2012; Wang et al. 2014). In specific, as the frequency of MW increases during tasks of low cognitive demand (Baird et al. 2012), creativity is enhanced (Wang et al. 2014).

Against this background, we contribute to existing research by proposing an experimental setting including MW as mediator in the creative thinking processes. We conduct our study in a technology-driven environment to answer the following research question (RQ):

> ***RQ:*** *Does MW mediate the relation between the cognitive demand of interruptions and creative performance?*

The structure of our work is as follows: First, we provide a brief overview of the theoretical background and describe the main constructs. Second, we describe a research model and derive a promising hypothesis. Third, we propose an experimental setting and discuss its strengths and limitations. We conclude by providing promising avenues for future research.

15.2 Theoretical Background

Creativity describes the ability to generate output that is new and innovative. For creative thinking, previous research indicates two elements. On the one hand, originality as the innovative part, which results in novelty. On the other hand, effectiveness as the evaluation of the outcome's quality, usefulness, and benefit (Runco and Jaeger 2012). Additionally, creativity includes two different ways of thinking. First, divergent thinking means to generate a multitude of possible problem solutions, to reflect from various perspectives, and to be spontaneous and free. Second, convergent thinking focuses on identifying the "best" solution within a certain category, to dig deeper and to really get to the bottom of a current problem. Both processes are required for a workable creative outcome. While divergent thinking is responsible for ideas generation, convergent thinking is responsible for transforming the ideas into practical ones. However, divergent thinking occurs with a spontaneous and free manner and is the first step of idea generation for creativity (Khatri and Dutta 2018). To support divergent-thinking episodes, information systems aim to help users remain focused during problem-solving (Massetti 1996) and provide task-specific stimuli. For instance, in technology-related settings, brainstorming is a recognized technique (Kalargiros and Manning 2015).

Interruptions are performance cuts in a task. They describe discrete, random events that shift the cognitive focus from a primary task to a secondary one (Coraggio 1990). Since interruptions cause a task switching between a primary task and a secondary one, performance is influenced by interruption and resumption lags (Addas and Pinsonneault 2018). For task resumption, resources from the working memory (WM) are needed. As "temporary storage [...] that holds the information necessary to complete an active task" (Tams et al. 2018, p. 862), the working memory capacity (WMC) is limited. As a result, the longer the interruption, the more it affects performance due to an increased resumption lag (Addas and Pinsonneault 2018).

Depending on the required cognitive demand, interruptions have either a positive or negative impact on creativity (Wang et al. 2014). For the positive impact, looking at MW episodes is worthwhile (Smallwood and Schooler 2015). MW interrupt "current on-task thinking with unconstraint thought to generate different ideas" (Baumgart et al. 2020, p. 302), whereas its origin can be internal as well as external. While spontaneous MW is task-unrelated that triggers an uncontrolled shift from the task and is indicated as negative, deliberate MW is described as an intentional shift from the task, which has a positive effect (Agnoli et al. 2018). With its complexity, MW impairs comprehension (Feng et al. 2013) or learning (Risko et al. 2012), but shows positive effects on creativity (Baird et al. 2012). In technology-related settings, research demonstrated higher performance accuracy for users who reported MW, but lower task performance when task complexity is high whereby moreover, a negative effect on performance efficiency was found (Wati et al. 2014). However, it is also shown that MW has a positive moderating effect between creativity and technology-related on-task thoughts (Sullivan et al. 2015). These multifaceted findings highlight that it will be worthwhile to further investigate the relationship between interruptions and creativity in technology-related situations. In addition, research has shown that there is an interconnectedness between the single constructs (i.e., creativity, MW, interruptions) (e.g., Baird et al. 2021; Wang et al.2014; Sullivan et al.2015), but that a coherent view is missing so far.

15.3 Research Model and Methodology

Previous research indicates that there are single relations between the three constructs, but a combined perspective is missing. To answer our RQ, we propose a research model (c.f. Figure 15.1), which serves a basis for hypotheses development. On the one hand, MW is supposed to mediate the relation between interruptions and creative performance (solid arrows): An interruption triggers MW and thus strengthens the creative performance of the technology user, since its divergent thinking foster the idea generation. On the other hand, interruptions might directly influence the user's creative performance (dotted arrow), refuting the necessity of including cognitive processes.

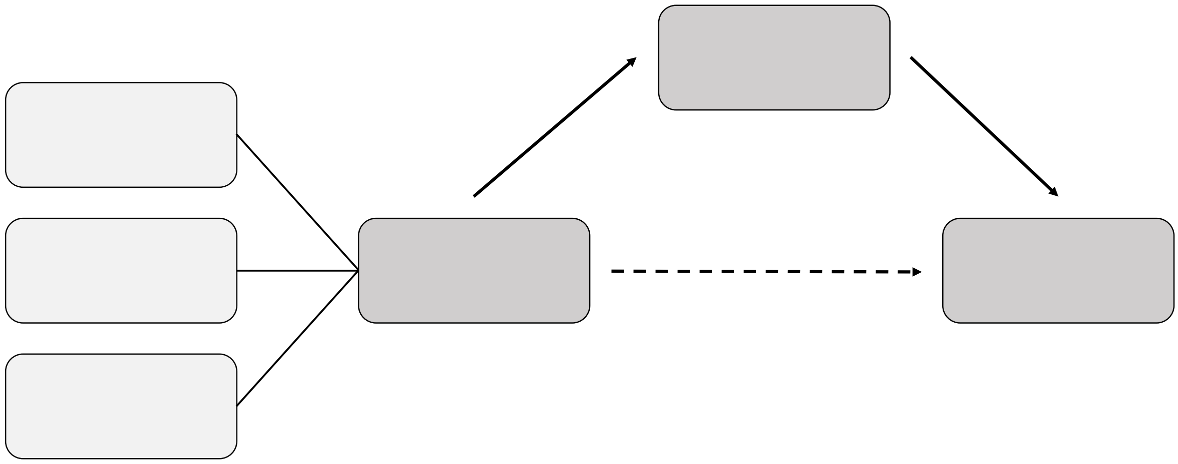

Figure 15.1. Research Model

Interruptions recess a primary task and lead to an interaction with a secondary one (Coraggio 1990). The secondary task result in MW (Wang et al. 2014) and self-generated thought (Smallwood and Schooler 2015) in technology-related settings. The higher the level of task engagement of the user (i.e., cognitive demand), the lower the likelihood of MW (Smallwood et al. 2007), which impairs creativity (Wati et al. 2014). Consequently, the lower the level of task engagement, the higher the likelihood of MW (Wang et al. 2014), which leads to higher creative performance. The cognitive demand of the user is displayed by the WMC. If the WMC is low, MW tends to be more frequent (Unsworth and McMillan 2013), and if the WMC is high, MW tends to be less frequent (Levinson et al. 2012). For manipulation check, we refer to previous research, which demonstrated that technology use affects MW frequency, and that attention could be affected by the insertion of external interruptions (Baumgart et al. 2020), Against this background, we hypothesize, first, that a low-demanding technology-induced interruption leads to more MW and thus fosters more creative performance compared high-demanding technology-induced interruptions. Second, a technology-induced interruption is expected to lead to more creativity compared to no technology-induced interruption.

To test our hypotheses, we propose an experimental setting (20 min). Data will be collected from healthy students from German middle-sized universities, who will get a financial compensation. The participants will be randomly assigned to one of three conditions: no interruption (control group), a low-demanding technology-induced interruption, and high-demanding technology-induced interruption, in a between-subject design. As writing is considered as a highly creative task involving divergent thinking (e.g., Dietrich and Kanso (2010)), a remote writing task will be set. Since all participants will receive the same task, its engagement level is not considered. Participants will be introduced to a scenario, where they will have to identify as a marketing employee in a role of frequently coming up with new ideas for design, sales, advertisement, etc. In contrast to previous research (Wang et al. 2014), context-related interruptions will be provided to maintain the marketing context. Before the experiment starts, the participants will be instructed and sign informed consent. The experiment starts with receiving an e-mail from the head of the department with instructions to write a new product description for a multimedia tablet. The e-mail shows pictures and technical details. The participants are instructed to be as creative as possible and to give free rein to their imagination. To trigger MW, after 10 min, a within-task manipulation is implemented. For the low demand, a second e-mail arrives as a company newsletter and provides a meeting appointment. For the high demand, the e-mail consists of an urgent mathematical task (i.e., total benefit calculation). After completing the e-mails' task, the primary task resumes. After completing the experiment, all groups fill out a questionnaire and provide their demographics.

To test the hypothesis, different measurements are used. For creativity, the results of the product descriptions are independently evaluated and scored for originality and effectiveness (Runco and Jaeger 2012) by three researchers based on a 5-point Likert scale (Agnoli et al. 2018). Subsequently, dimensions are combined to indicate the overall performance. MW is determined by self-report measurement. Items from established literature (Oschinsky et al. 2019; Sullivan et al. 2015; Wati et al. 2014) are combined and adapted and are measured on a 7-point Likert scale. For instance: "During the writing task, my mind wandered.", "During the writing task, I thought about something, which was not related to the situation." To examine whether creativity is affected and MW act as a mediator, we use a group-wise comparison between the interruption conditions. For this, the overall performance of creativity and MW are compared to be able of determining the influence of the cognitive demand and a link between the constructs.

15.4 Discussion and Outlook

This paper explores the role of interruptions and MW episodes on creative performance in technology-related settings. Since creativity is the ability to create something new and useful, IS research is increasingly interested in the influences of technology-induced interruptions (Wang et al. 2014) and MW episodes (Sullivan et al. 2015). An experimental setting was proposed to investigate the relation of interruptions and creativity as well as a mediating effect of MW between both concepts. As creativity is an important asset for idea generation, the ubiquity of ICT results in external disruptions and internal absent-mindedness. With the high occurrence of interruptions (Spira and Feintuch 2015) and MW (Smallwood et al. 2007) in technology-driven environments and the primarily negative impact on performance, the constructs are valuable to study in the IS domain. Although research has already demonstrated relationships between individual constructs, there is no cohesive consideration. By considering all constructs collectively, we contribute to understand its relations and the role of MW as an emerging area for IS. We intend to initiate a discussion on the relations and provide an initial indication for further investigation. Additionally, results could be used to improve the design of information systems, while including task's cognitive demand.

Instead of classic creative tasks, we propose a remote writing task. As previous research (Ritter et al. 2018) mentioned, the adapted alternative uses task or alternative uses task for divergent thinking or the remote associated test or word construction tasks for convergent thinking, both do not fit with the appropriate case. In terms of the manipulation, a single interruption is proposed. Since the number of ideas is higher after a single interruption than after frequent interruptions (Eliav and Miron-Spektor 2015) because idea generation is not interrupted again, this seems a fitting approach. In contrast to previous research (Wang et al. 2014), context-related interruptions and commonly used communication channels were provided.

Including additional measurements could provide further insights. By extending the questionnaire with additional items regarding creativity, interruptions, or MW, insights could be expanded, and further relations could be shown. Furthermore, MW is only included as a state. Considering MW as a trait in future work could indicate a general occurrence on a wandering mind (Seli et al. 2016). Additionally, in an experimental setting, interviews, survey, and neuropsychology (e.g., electroencephalography) approaches could be used to further investigate the constructs and its effect on each other.

As every research, this paper comes with some limitations. First, we only propose an experimental setting, which should provide a first indication to investigate an effect of MW between interruptions and creativity. Second, MW is only considered as a mediator. As previous literature (Sullivan et al. 2015) also showed a moderating effect, future studies can focus on the role of cognitive demand and as prerequisite for creativity. Third, no selective theories from cognitive psychology were addressed so far. For instance, including the Executive Control Theory (Randall et al. 2014) would provide more insights about the processes behind the constructs but would also explain possible relationships in between. Therefore, further steps of our research will include addressing the limitations, adding additional concepts (e.g., cognitive load, time pressure) to investigate further effects of interruptions, testing the research model and verifying the hypothesis.

15.5 References

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16. Paper 10: Restorative Effects in a Virtual Reality

Title	**Restorative Effects of Virtual Reality Nature Simulations at the Workplace. An Experimental Approach**
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Table 50. Fact Sheet Publication

Restorative effects of virtual reality nature simulations at the workplace. An experimental approach

Abstract. *Understanding information technology (IT) use at work is vital for addressing the ongoing transformation of the labor market. In recent years, personal well-being and employee satisfaction became increasingly acknowledged, leading to an increasing installation of naturalistic elements in today's offices. However, prior research has not explained how to stimulate such naturalistic elements in a virtual reality, leaving its huge potential for remote work unused. To address this gap, our short paper presents design principles on how to simulate nature using virtual reality during breaks. This study can contribute to stress literature and help office workers identify the working environment they need for restauration. Based on insights from psychology and neuroscience, our experimental approach will be outlined, leading to a discussion of fruitful avenues for future research.*

Keywords: *Simulation nature environments, restorative effects, virtual reality, workplace.*

16.1 Introduction

Work is a central area of life for many people. However, in the age of digitalization, working life can be characterized by massive information overload and constant interruptions that deplete mental and emotional resources (Schneider 2018; Schmidt und Cohen 2013). New strategies are needed to keep the workforce productive, healthy, and satisfied. In this regard, the physical environment is known for its positive impact on our well-being (Vischer 2007). Nature is widely considered as a potential place of restoration (Kaplan und Kaplan 1989; Kellert 1993; Ulrich et al. 1991). Kellert and Wilson (1993) illustrate why humans are evolutionarily attracted to nature in their biophilia hypothesis (Kellert 1993). Thereupon, the authors derive the Attention Restoration Theory (ART) (Kaplan and Kaplan 1989) as well as the Stress Reduction Theory (SRT) (Ulrich et al. 1991). These theories state that spending time in a natural environment can lead to cognitive, affective, and physiological restoration. Numerous studies support their claims by showing people evidently benefitting from natural settings that provide effective restoration and return to a task in a cognitively refreshed way (Felsten 2009). In specific, attention breaks such as mind-wandering can be important (Trougakos et al. 2008) because even small breaks of a few seconds while looking at green roof surfaces can have a significant effect

(Felsten 2009). Thus, nature elements seem to be an essential yet underrated element of a digital workplace (Bloom et al. 2017).

However, access to nature is becoming difficult for many people due to rapid urbanization. According to the United Nations (2018), up to 68% of the world's population is expected to live in urban environments by 2050 (United Nations 2018). A considerable amount of money is spent on nature and natural urban areas but planting flowers and shrubs did not come close to providing a natural environment. On top of that, a lot of people try to beautify their life with plants on the balcony or in the office, but this also cannot replace the walk-in nature an actual forest. In day-to-day work, the influence of nature is even more challenging to achieve (Felsten 2009). This again shows that new approaches are necessary. A possible solution for those who wish to experience nature at work are virtual reality (VR) technologies that simulate natural environments (Berto 2014). Here, people can go on safari, climb a mountain, or spend their time hiking in a forest. The idea of using computer-based environments to offset negative attitudes in the real world has gained prominence in mental health (Bohil et al. 2011). Nevertheless, the use of VR nature simulations in the workplace represents an underexplored area of research. To fill this gap, we base our work on current literature and expect that office workers could restore attentional resources during breaks in a natural scene. We aim to replicate the restorative effects of natural scenes in VR to study whether the use of this simulation in the workplace increases the restorative effects of office workers. To achieve our goal, we seek to answer the question "*Does the use of a VR nature simulation at work increase the extent of restoration?*". Our manuscript includes a theoretical background that explores the restorative effects of nature and nature simulations. Based on this, we propose an experimental approach in which subjects engage in a virtual nature simulation during the lunch break. To assess the attentional restoration, we measure cognitive, affective, and physiological aspects of restoration. Finally, we discuss our research approach in terms of Limitation, Future research and relate it to our research question.

16.2 Theoretical Background

Restorative effects of nature

Attention Restoration Theory (ART) (Kaplan und Kaplan 1989) and Stress Recovery Theory (SRT) (Ulrich et al. 1991) are two widely used theories that address the restorative influences of a natural environment on humans. The former discusses an individual's cognitive restoration (Kaplan und Kaplan 1989). A distinction is made between directed attention and undirected attention. Directed attention is used consciously by focusing on a specific stimulus while suppressing distracting stimuli. If this is used over an extended period, mental fatigue can occur, leading to concentration difficulties or a higher error rate (Krueger 1989).

According to Kaplan, an environment is characterized as particularly restorative if it meets the following four criteria: (1) being away, (2) fascination, (3) coherence, and (4) compatibility. Being away (1) is letting go of cognitive brain structures that are fatigued by overuse. As the name implies, it is created by the feeling of being far away from everyday life. Fascination (2) is an effortless mode of participation with involuntary attention. Coherence (3) is sufficient latitude to sustain interaction over time without boredom. It refers to the environment with enough content and a coherent, cohesive structure to replace the real world. Compatibility (4) is an adjustment to a person's inclinations and goals to avoid the use of mental effort. It occurs when the needs and intentions of individuals match the environment. A stay in a natural environment promotes the recovery of directed attention. This is replaced by a more effortless form of attention, the so-called undirected attention (Kaplan 1995).

The Stress Recovery Theory points to an affective and physiological restoration during contact with nature (Ulrich et al. 1991). This phenomenon occurs in the form of increased positive emotions and decreased physiological stress (Bratman 2012). Nature's restorative influences lead to a more positive emotional state, changes in physiological activity levels, and sustained attention. Natural environments with visible horizons, proximity to water, and vegetation are shown to be highly restorative (Bratman 2012).

Virtual reality nature simulations

Since not everyone has immediate access to nature, many scientists questioned whether a simulated nature could trigger restoration as well. Several studies used elements such as images or videos to simulate nature and examined them for restorative effects. Spending time in actual nature and watching slideshows with nature images indicated physiological stress reduction without any significant differences (Kjellgren und Buhrkall 2010). Cognitive and affective restoration was demonstrated in subjects who spent time in real nature. Moreover, Pilotti et al. (2015) found an improvement in the attentional capacity and long-term memory in subjects who watched nature videos at the end of their workday. For example, a forest environment was projected with CAVE Technologies on the walls and the floor (Annerstedt et al. 2013), or multiple technical devices such as a television, desktop computer with a keyboard, and headphones were used for this purpose (Baños et al. 2013). The studies revealed an increased physiological restoration in cortisol and heart rate (Annerstedt et al. 2013) and an increased positive affect when nature sounds were included (Baños et al. 2013).

An even more realistic simulation of nature can be produced by immersive VR technologies (Bohil et al. 2011). VR applications place the user in a simulated 3D environment. Head-mounted displays (HMDs) or VR goggles (e.g., Oculus Rift, HTC Vive) are used for this purpose. They use an integrated screen to show videos and images in 3D format. The image sections adapt to the user's eye and head movements and enable the user to explore 3D worlds in combination with motion sensors. The optional use of controllers allows them to deliberately interact with objects in this virtual environment (Anthes et al. 2016).

Furthermore, VR technologies offer the advantage of virtually interacting with one's own body and increase immersion (Slater und Sanchez-Vives 2016). A technology is considered particularly immersive if it isolates the user from the real world as much as possible (Slater 2003), stimulates as many senses as possible, provides a wide field of view and a vivid display with color rendering (Slater und Wilbur 1997). Furthermore, a technology's allowance for presence describes the perception of feeling located in the virtual environment (Slater und Wilbur 1997). Initial studies indicate that VR can change the users' emotional, cognitive, and behavioral responses (Ferrer-Garcia et al. 2019; Ferrer-Garcia et al. 2015; Riva et al. 2007). Li et al. (2020) also provide evidence of a VR-HMD-based intervention generating enhanced attentional engagement.

In recent years, researchers started to use VR simulations (e.g., forests) to trigger restorative effects. In this context, Mattila et al. (2020) showed that a VR simulated forest can lead to a similar level of restoration as a natural forest. Lähtevänoja et al. (2019) as well as Yu et al. (2018) illustrate VR's potential to increase positive emotions (Lähtevänoja et al. 2019; Yu et al. 2018). Anderson et al. (2017) demonstrate that a VR simulating nature can have a stress-reducing effect. Scene preference significantly influenced mood and the perception of the scene's quality. These few examples already acknowledge that naturalistic VR can relate to restoration, especially if it is adapted to personal preferences.

The emergent studies indicate that the use of VR nature simulations can lead to the user's restoration. In this study, we define restoration as cognitive, affective as well as physiological restoration. So far, the use of VR nature simulations during work breaks is not yet sufficiently researched. Furthermore, only forests have been used as a VR environment so far, although other natural environments can trigger restorative effects. We seek to address these shortcomings as we simulate a variety of natural environments. The overall goal of this manuscript is to fill this research gap. Its research question (RQ) is:

***RQ:** Does the use of a VR nature simulation at work increase the extent of restoration?*

On top of that, and to the best of our knowledge, hardly any research examined the impact of individual preference and demonstrated the most effective restoration for subjectively preferred nature scenes regarding VR nature simulations (Anderson et al. 2017; Gao et al. 2019). Even away from VR, there is little literature that provides a coherent guide to the selection of nature scenes in therapy. But they suggest that more tremendous therapeutic potential may be expected when people can choose which of the locations they would prefer to view (Thake et al. 2017). Based on this, we propose the following hypothesis H1:

***H1:** The VR nature simulation preferred by a user achieves the highest extent of restoration.*

Literature also lacks to acknowledge the long-term effects of using VR nature simulations. However, Korpela et al. (2008) found a positive correlation between the frequency of visits to favorite places and restoration. Here, Korpela showed that participants voluntarily visited their favorite places repeatedly over the year. The higher the temporal frequency, the greater the positive effect on restoration. From this, we derive H2 for our second hypothesis under investigation:

***H2:** The more frequent a user uses a VR nature simulation during their daily work routine, the greater the extent of restoration.*

16.3 Methodology

We propose an experimental design. Numerical data will be collected through standardized surveys and experiments in the laboratory. The experiment will follow a between-subjects design, where 120 participants are divided into three groups, each with a manipulated experimental condition. The analysis is intended to explain the causal relationship between variables.

Variables

The independent variable is the VR nature simulation, which is varied and examined for its effects on the dependent variables. The dependent variable is the extent of restoration, which is divided into cognitive, affective, and physiological restoration.

Cognitive restoration is measured by the "Stroop Color Task" (Stroop 1935). In this task, 70 colored words are shown within a short time frame, which either correspond to the paint color or not. Its goal is to name the colors of the shown words. The higher the number of correct answers, the greater the extent of cognitive restoration. Its result provides information about the subject's attentional ability.

Affective restoration is measured with the Positive and Negative Affect Schedule (PANAS) (Watson et al. 1988). The questionnaire includes 20 affects divided into ten positive (PA) and ten negative affects (NA). The subjects are asked to answer questions on a 7-point Likert-type scale ranging from 1 (not at all) to 7 (extremely). The scores for PA and NA are first calculated independently and their respective mean values determined. The higher the PA score and lower the NA score, the greater the extent of affective restoration. Positive Affect and Negative Affect are not considered opposite, but as discriminable dimensions of the same construct.

Electroencephalography (EEG) is used to measure physiological restoration. EEG is suitable as a non- invasive measurement method. Studies that examined physiological restoration in the context of nature concluded that increased alpha wave activity could be interpreted as a critical indicator of restoration (Grassini et al. 2019; Chang und Chen 2005; Ulrich 1984). The greatest advantage of EEG is its speed, which allows the detection of stimuli and the recording of complex patterns of neuronal activity in a matter of seconds. However, EEG offers lower spatial resolution compared to MRI and PET. Since EEG procedure is non-invasive and painless, it is the appropriate method to measure the expected cognitive processes for perception, memory, and attention (Teplan 2002).

Moderator variables are personal preferences regarding natural landscapes and the frequency of using a VR nature simulation. According to the hypotheses, these variables will be examined for their potential reinforcing effect on the dependent variable. Personal preference will be determined using a small survey based on a 7-point Likert-type scale.

The questionnaire includes the control variables of age, gender, origin, occupation, work experience, health status, medication and drug use, VR experience, attitude toward nature, and VR use habit. These variables are either eliminated by randomization in assignment and selection of the participants or factored in data analysis.

All in all, the model includes an independent variable, several control variables, and a dependent variable. Multivariate analysis of covariance (MANCOVA) is particularly appropriate for this construct. Since MANCOVA does not consider the interaction terms of the covariates and independent variables, a moderator analysis in the form of a t-test is performed afterward. The differences in the results will be compared and evaluated.

Virtual reality design

The literature identified the most favored nature environments that participants perceived as restorative (Korpela et al. 2001): forests, beaches, and mountains. Several designs are created for these three categories. We will consider elements according to ART (Kaplan und Kaplan 1989) and SRT (Ulrich et al. 1991). These include Kaplan's (1995) four criteria of (1) being away, (2) fascination, (3) coherence, and (4) compatibility. The contrast triggers the effect that participants work in an urbanized location but are allowed to immerse themselves in a natural environment that does not exist in close proximity with VR (Tyrväinen et al. 2014). In the context of recreation, it is the natural environments that meet this condition. This can be done by designing the environment as detailed as possible and we will follow Lähtevänoja et al. (2019). According to Ulrich, water sources, visible horizons, and vegetation are included in the modeling for restorative effect (Bratman 2012). Flying butterflies (Marselle et al. 2016), blue skies (White et al. 2010), and warm color temperatures (Stone 2003) are said to be appropriate examples of fascination. Furthermore, trees and bushes can evoke a sense of psychological distance that promotes both being away and being expansive (Nordh et al. 2009). Auditory VR content for the natural environment is partially composed of birdsong (Ratcliffe et al. 2013) and pleasant wind noise (Aletta et al. 2018), which can trigger soft fascination. The participants will hear other natural sounds, such as ocean noise.

For the control group, indoor environments such as office spaces, classrooms, or libraries are modeled that do not contain plants and animals. Background sounds will have no relation to nature.

Experiment preparation

First, a pretest is conducted to evaluate the planned data collection and to optimize processes. For this purpose, nine employees are consulted who are not actively involved in the experiment (three per group). They are not allowed to participate in the main experiment after the pretest. The persons are asked to look at the natural environment and to evaluate the experimental setting. For hardware We will use non-see- through HMDs with headphones and special sensors to register the user's head and eye movements. As software, the VR nature simulation is modeled by 3D creation software. For EEG measurement, wearable and wireless EEG devices transfer the collected data in real-time to a host computer. Through the pretest, we also want to validate our hypotheses. Through the first experiences of the design, we want to learn and ensure the validity of our hypotheses and, if necessary, sharpen them.

In the main experiment, we first want to recruit 120 persons recruited first calculated with G-Power (0.25 effect size, 0.5 correlation, and 0.8 power) (Faul et al. 2007). To recruit enough participants, we want to use the university, local companies, and the city government, as we have a good network and the way and effort for the test persons to the laboratory are manageable. Conditions for recruitment of persons are besides work in office without natural influences also circumstances of physiological conditions of person (for example no drugs). The participants are randomly divided into three groups. The target group is office workers who live in an urbanized environment. Group 1 receives a randomly selected VR nature simulation, Group 2 receives a VR nature simulation based on their personal preference, and Group 3 is the control group. To verify H1, personal nature preferences are determined in Group 2. The group participants will be asked in advance via email to fill out the corresponding survey for this purpose.

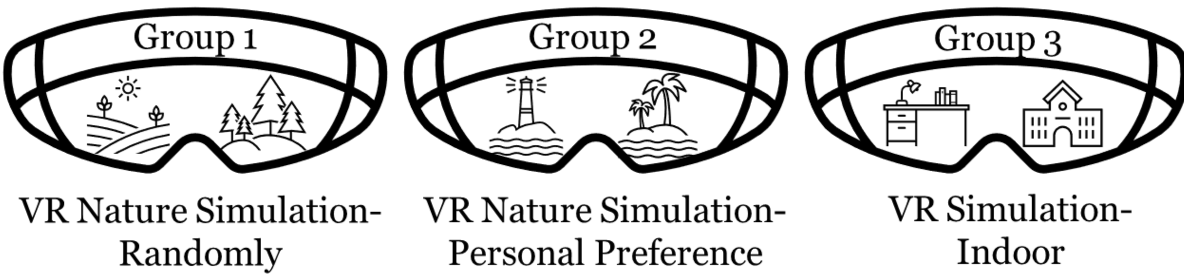

Figure 16.1. Experimental Setup

Outline for conducting the experiment

The experiment is scheduled for two weeks. The participants are asked to come to the laboratory every day. The Participants go to the VR simulations at the same time each day (e.g., during their lunch break). Regular attendance is required to put "outlier" days into perspective, as cognitive load and task difficulty may vary depending on the day. It is optimal if they have worked for four hours beforehand to have accumulated a certain stress level. Restricting the time of day should eliminate possible confounding effects of the circadian rhythm on the dependent variable.

The experiment's procedure is explained to the participants, but the overall intentions of the investigation are not explained to avoid bias. Instead, the participants will be debriefed at the end of the study. During the experiment itself, they are required to sign an informed consent form and complete the questionnaire that captures control variables. Age, gender, origin, occupation, work, and VR experiences are asked only once, at the beginning of the study, as they usually do not change during the experiment. Health status, medication and drug use, attitude toward nature, and VR use will be collected at each session.

Both for practical reasons (time and personal resources) and the expected small changes in EEG values from one day to the next, daily checks of the EEG are not foreseen. The experiment with EEG is performed three times: at the beginning, after one week, and at the end of the study. At the beginning of the experiment, EEG electrodes will be attached to the heads of the participants. EEG data will be collected continuously until the end of the investigation. After the activation of the EEG, the Stroop Color Task is performed, followed by PANAS. Then, the VR equipment is put on the participants and the intervention phase takes place. During the experiment, the participants sit on a chair. Nevertheless, they can move freely in the VR nature simulation via (head) movements or the controller. The duration of VR use follows previous studies (Yu et al. 2018; Anderson et al. 2017) and is set to 15 minutes. The simulation switches off automatically when the time has elapsed. After VR use, the VR equipment will be removed from the participants, and they will again undergo the Stroop Color Task and PANAS. Upon completion of these tests, the EEG electrodes will be removed. During the last day, the personal preferences of the participants of group 1 are asked. This is done at the end to avoid confusion regarding their assigned VR settings.

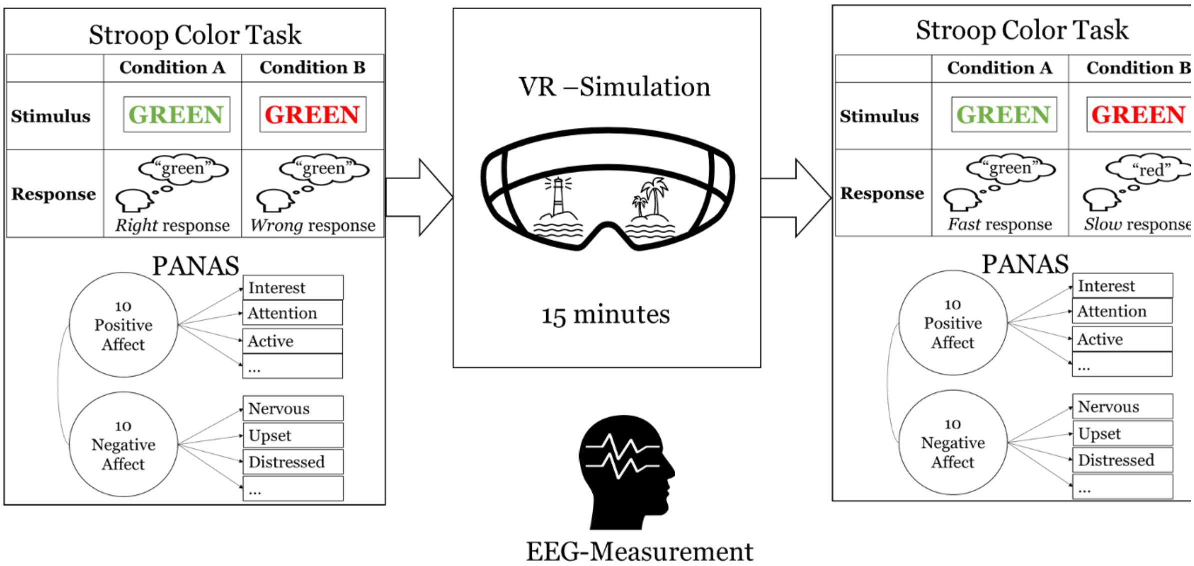

Figure 16.2. Overall Experimental Procedure

16.4 Discussion and Outlook

The present experiment fulfills essential quality criteria of conducting quantitative research. To ensure objectivity, the variables were clearly defined to avoid false interpretations regarding the research question and hypotheses. Reliability refers to the reproducibility of the experiment. This is maintained by the standardized measurement methods and the unambiguous wording of the questions in the questionnaires. Validity means that the measurement captures precisely what it claims to measure. Stroop Color Task, PANAS, and EEG are standard methods used in restorative research and investigated for their reliability.

A limitation in the methodology may be the repetition of the tests. Frequent processing of the Stroop Color Task may lead to learning and fatigue effects for participants. These possible effects must be considered in the data analysis to prevent bias in the results. Because only office workers are considered, generalizability to the entire population or other workgroups cannot be inferred. Also, other physiological measurement methods, such as pulse measurement, electrodermal activity or cortisol measurement could be use in the future but are not included in this study. In this study, the EEG has been integrated, because the body should be free to move and no gender-specific interference should occur. In addition, the simulation disease "cybersickness" was not considered (Bohil et al. 2011). Frequent and prolonged use of immersive VR technology can cause nausea in users. This happens when the technology is not advanced enough, and the user's vision does not match their movements. The effects of cybersickness can skew the results or lead to dropout in individual trial participants. Precautions to prevent this are the seated position and the manageable daily time of 15 minutes. To better demonstrate the long-term effect, it is also being considered to provide the test persons with a VR-Nature environment at their workplace. For this purpose, the test persons would have to use this VR environment regularly and repeat the measurements one year later.

Ideas for further research are, on the one hand, the stimulation of other human senses such as olfactory senses, e.g., lavender scent for calming. So far, only visual and auditory senses have been considered in VR. An example of a higher immersive experience is the study by Anderson et al. (2017). When visiting a VR beach, participants were able to sit on a beach lounger, and warmth was generated by a heat lamp Furthermore, VR users could vary their position between sitting, standing, or lying down. On the other hand, applied research can use immersive environments in the daily work life, for instance during meetings or virtual teamwork (Zeuge et al. 2020) with nature backgrounds. Playful interaction with virtual nature offers great potential for improving sustained attention and self-reported recovery (Patil et al. 2019). Gamification can be an interesting workaround for breakout sessions in VR nature simulations.

If the results of the data analysis confirm our hypothesis, VR nature simulation can be considered as a restorative product. It can be assumed that the use of VR nature simulations during work breaks can lead to being more attentive and working more purposefully. Confirming H1 would highlight the potential of modifying VR content. More natural environments can then be designed according to one's personal preferences to enhance the restorative experience. This can be done by immersion and presence. The result of H2 could provide information about VR's long-term effects. The planned study can show that the regular use of VR nature simulations can lead to better performance and attention also in a short-time effect. All in all, conducting this experiment can make an important contribution to restorative research and the future of work.

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17. Paper 11: Freedom of Technology Choice

Title	**Freedom of Technology Choice: An Experimental Evaluation**
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Table 51. Fact Sheet Publication

Freedom of Technology Choice: An Experimental Evaluation

Abstract. *With a growing number of information technology (IT) devices such as smartphones andtablets, individuals can choose a preferred device to fulfill private or organizational tasks. Since existing literature on technology acceptance and adoption mainly focuses on one specific technology, the availability of alternative technologies from which individuals can choose is still poorly understood. Addressing this gap, we investigate the concept of freedom of choice. We distinguish it from related concepts; empirically, we present the results of a laboratory experiment providing evidence that freedom of choice has a positive impact on users' cognitions, emotions, andperformance in completing a task. We contribute to existing literature on technology acceptance by highlighting the role of freedom of choice in early stages of use behavior and provide empirical insights that justify the implementation of policies (e.g., Bring- Your-Own-Device policies).*

Keywords: *Freedom of Choice, Experimental Study, Bring-Your-Own-Device.*

17.1 Introduction

In today's digital age, users have a multiplicity of technological alternatives to choose from to perform tasks. For example, when checking email or playing a mobile game, we can choose from several tablet devices, including the Apple iPad, the Samsung Galaxy Note, or the Microsoft Surface. While users commonly choose from those options to perform tasks in their personal lives, the degree to which organizations grant users the freedom to choose from alternative technologies is often limited. Some organizations orientate themselves toward higher degrees of freedom of technology choice and allow their employees to bring along their own personal devices or apps. In doing so, they define bring-your-own-device (BYOD) policies (Gregory et al. 2018). However, there are also many organizations that mandate the use of specific technologies (Wu and Lederer 2009). This mandate can also be a subject of explicit policies. Nevertheless, it is oftentimes only implicit.

The implications of restricting users' freedom of technology choice are well recognized in research on shadow information technology (IT). Studies show that more than 80% of users who are restricted in their technology choice by organizational policies start to ignore those restrictions and select and use their preferred technology at work (Haag and Eckhardt 2017; Microsoft 2019). While employees may have the chance to use technologies that are better aligned with their idiosyncratic preferences (Baskerville 2011; Klesel et al. 2017), which reduces their levels of frustration, the outcome may also risk organizational digital assets, including sensitive data (Haag and Eckhardt 2017). Therefore, limiting employees' freedom to choose their preferred technologies minimizes the likelihood that individuals can use the technologies they feel confident with, and increases the risk of shadow IT use in organizations. With the millennial generation entering the workforce, the trend toward a technologically advanced workplace accelerates (Gewald et al. 2017). For this group, individually chosen technologies are very important and have a great influence on their choice of employer. This underpins the relevance of properly managing users' freedom of technology choice, or the lack thereof, in organizational contexts.

While prior information systems (IS) literature has extensively studied technology acceptance and the use of one specific technology (e.g., the use of e-learning systems; Yung-Ming Cheng 2011), only little attention has been paid to the availability of multiple technological options from which users can choose (Jung and Lyytinen 2014; Schwarz and Schwarz 2014; Sedera et al. 2016). These few studies investigate the factors influencing users' preference and choice of one technology above another and how users, who are granted the freedom of technology choice, select and use technology in the post-adoption context (ibid). The impact of the freedom of technology choice on relevant usage outcomes, however, has barely been studied (Gaß et al. 2015, p. 79). At the same time, the increasing number and relevance of studies on mobile technologies (Sørensen and Landau 2015), IT consumerization, and BYOD emphasize the growing digital technology options available for organizational users (Gregory et al. 2018; Murdoch 2010; Schwarz and Schwarz 2014). That is why Schwarz and Schwarz (2014) call for more research on "*the phenomenon of choice when users are confronted with multiple options that are available to accomplish the same task*" (p.6) "*to understand the relationship between task, choice, and performance in a more meaningful way*" (p.15).

Against this background, the objective of this research is to better understand the role of freedom of technology choice, or the lack thereof, as a contextual variable by investigating its causal effect on users' technology-related perceptions and behaviors. The results of a lab experiment provide initial evidence that freedom of technology choice has a significant influence on key IS variables. Participants' cognitions of the usefulness and ease of use of the technology, their emotions regarding the satisfaction with and enjoyment of the technology, and their task performance are substantially lower when their freedom of technology choice is constrained.

Our study contributes to theory and practice. From a theoretical perspective, we seek to extend current literature that focuses on single technologies and/or alternative interfaces (e.g., Murray and Häubl 2011) by investigating users' lack of freedom of choice when alternative technologies are available. In doing so, we investigate a phenomenon that is gaining relevance in light of individual information systems (Baskerville 2011) and the consumerization of IT (Gregory et al. 2018; Niehaves et al. 2012). Moreover, we provide initial evidence that a lack of freedom of technology choice does not only refer to users' cognitions and performance, but also users' emotions regarding the satisfaction with and enjoyment of using the technology while performing a task. From a practical perspective, this study seeks to inform organizations about the benefits of granting contextual freedom of technology choice.

This paper is structured as follows: In section two, we describe the concept of freedom of technology choice and how it can be distinguished from existing related concepts. In section three, we hypothesize several effects of freedom of technology choice on users' cognitions, emotions, and behaviors. Section four describes the experimental setting of this study. Thereafter, we present the results of the lab experiment (section five). We discuss our findings in section six and conclude with promising avenues for future research.

17.2 Freedom of Technology Choice and Related Work

Following established literature on freedom of choice in general (Pattanaik and Xu 2000) and technology choice in IS research (e.g., Schwarz and Schwarz 2014), we define freedom of technology choice as: *whether or not the environment provides substantial discretion to the individual in determining which technology to use in a particular IT-supported task/the technologies to be used in carrying out IT-supported tasks*.

Our definition thus assumes that multiple technologies are available for completing a specific task. This assumption is in contrast with most studies on technology acceptance and use that investigate users' cognitions, emotions, and behaviors regarding a specific technology (Schwarz and Schwarz 2014). For instance, Murray and Häubl (2011) analyze the impact of the freedom to choose among alternative design features of a specific technology based on the theory of psychological reactance. The results of their experimental study suggest that when users feel constrained when choosing an interface, it reduces their perceived ease of use and preference to use this interface once an attractive alternative interface becomes available. We identified a limited number of previous studies that focus on technology choice and acknowledge the availability of multiple technologies. Schwarz and Schwarz (2014) conceptualize technology choice based on the choice concept in the marketing literature. They analyzed 173 MBA students' intention to choose from one of two spreadsheet applications that they were willing to use to continue their IT-supported work tasks. They found that ease of use and the relative advantage of the technology substantially influenced users' technology choice. Likewise, Sedera et al. (2016) analyzed the acceptance process of users when they were presented with a choice of technologies to complete the same task. The study drew from dual process theory and identified the importance of rational, emotional, and compliance facets as important factors determining users' technology choice. They further described technology choice as an iterative non-linear process in which users evaluate and re-evaluate the technological options. Jung and Lyytinen (2014) took an affordance perspective to analyze the dynamics underlying the choice process of selecting different communication technologies. They proposed multiple patterns that emerge when users explore their environment for the media affordances offered by an available set of technologies to accomplish their goals. In sum, those previous studies investigated which factors determined users' preference and choice of one technology above another as well as what the selection and usage processes look like when users are granted the freedom of technology choice.

While we follow those previous studies regarding the assumption that users have multiple technologies available to choose from, we focus on the freedom of technology choice, or its lack thereof, as an environmental/contextual variable and especially its role for users' cognitions, emotions, and behaviors. The reason for this is that the wide adoption of digital technologies in everyday life changes users' practices and expectations and, in turn, influences the IT-related activities of employees and managers in organizations, as studies on IT consumerization emphasize (e.g., Gregory et al. 2018). Today, users have multiple alternative technologies available to perform their tasks. However, the degree to which the organizational context grants users the freedom to choose which technology to use to complete their tasks varies. Still, many organizations mandate the use of a specific technology (Wu and Lederer 2009). Others allow users to choose from a set of given technologies (Jung and Lyytinen 2014) or to bring their own personal devices or apps by defining BYOD policies (Gregory et al. 2018; Klesel et al. 2019). In the case of a lack of freedom, users may even take the freedom of choosing the technology by using shadow technologies that the organization does not approve (Haag and Eckhardt 2017). Studies investigating the freedom of technology choice, or the lack thereof, as a contextual variable and its role for users' cognitions, emotions, and behaviors can thus help organizations select and implement a more effective and valuable approach.

Exemplary findings of studies on related concepts provide preliminary insights on the importance of freedom of technology choice on key organizational and individual outcomes. For instance, prior studies on job autonomy, and on work method autonomy, describe the degree of choice people have over the general procedures to perform tasks (i.e., without specific focus on technology-related freedom). These studies show significant effects on users' job performance (Ozer and Vogel 2015), job satisfaction (e.g., Morris and Venkatesh 2010; Tripp et al. 2016), and innovation quantity (Ye and Kankanhalli 2018). Compared to freedom of choice based on the environment, Junglas et al. (2019) focus on freedom based on users' personalities and perceptions. They find that users' IT self-determination describing users' psychological state of perceiving significant freedom in choosing which IT to use for their job, is one important dimension of users' IT empowerment, which in turn drives IT consumerization and innovative work behavior.

In summary, these concepts emphasize the importance of freedom in work-related settings while they differ in their conceptual domain. Table 52 shows how the concept of freedom of technology choice differentiates from related concepts discussed in prior work. The structure is built on whether the related concept refers to specific or multiple technologies (cf. Schwarz and Schwarz 2014) and whether the involved freedom is based on the user (i.e., perception-dependent freedom) or on the environment (cf. Wu and Lederer 2009).

	Concept	**Definition**	**Distinction from freedom of technology choice**
Focus on a specific technology	*Freedom based on the user*		
	User self-determination	An individual's sense of having choices to make own decisions about system usage (Kim and Gupta 2014)	Self-determination in user empowerment represents a perception-dependent freedom in choosing how to use a technology for work tasks,while freedom of technology choice is the environment-based freedom to choose which technologies to use for work tasks.
	Freedom based on the environment		
	Voluntariness	The degree of free will included in the adoption of an information technology (Wu and Lederer 2009)	Voluntariness is whether the environment provides freedom in adopting a technology, while freedom of technology choice is whether there is freedom in selecting from multiple technologies for a task.

	Initial freedom of choice	Whether or not users have the freedom to choose the interface that they use to complete a given task from a given set of design alternatives (Murray and Häubl 2011)	Freedom of choice focuses on users who are free to choose from various design features of a specific technology, while we focus on the freedom to choose one technology above another from a given set of technology alternatives with different risk and opportunity and thus, outcome profiles.
Focus on multiple technologies	*Freedom based on the user*		
	IT self-determination	A psychological state of an individual's control relation on how IT-supported work is executed (Junglas et al. 2019)	IT self-determination is to measure an individual's psychological reaction to the work environment, while freedom of technologychoice is to measure the objective role of the IT- related environment.
	Freedom based on the environment		
	Work method autonomy	The degree of choice that individuals have over procedures or methods they use to perform tasks (e.g., Ye and Kankanhalli 2018)	Work method autonomy is about an individual's freedom of choosing the procedures for performing tasks in their job, while freedom of technology choice is about the freedom of specifically choosing the technology for performing IT-supported tasks.
	Bring yourown device(BYOD)	A policy that allows employees to access selected corporate IT systems and data, such as email, on their personal devices (Gregory et al. 2018)	BYOD specifies the degree of freedom to which the environment grants employees to use their personal devices for work tasks, while freedom oftechnology choice refers to users' freedom to choose between multiple (personal as well as corporate) technologies to perform tasks.
	Shadow IT use	Users' own discretion to introduce and/or use technologies for IT-supported tasks without the organizational environment providing substantial freedom to do so (Haag and Eckhardt 2017)	Shadow IT is IT used without (explicit or implicit) organizational approval, while freedom of technology choice is the explicit organizational approval of users to freely choose between selected technologies to perform IT-supported work tasks.

Table 52. Conceptual Delimination from Previous Related Concepts

17.3 Research Hypotheses

Theory of Psychological Reactance

One of the most influential theories regarding freedom of choice, and in particular the lack of it, is the theory of psychological reactance (Brehm 1956, 1966, 1989; Brehm and Brehm 1981, 2013). According to this theory, people respond negatively when their freedom to choose how to behave is constrained (Brehm 1966; Brehm and Brehm 1981). The free behavior can be any conceivable realistic and possible act, including individuals' beliefs that they should be free to choose between alternatives (Brehm 1966). If such a free behavior is restricted or threatened to be restricted, such as being constrained to using a specific alternative, psychological reactance can arise (ibid.). The strength of reactance is dependent on the importance one ascribes to the free behavior being constrained as well as on the extent of constraints on the free behavior (Brehm and Brehm 1981).

The theory of psychological reactance was extensively evaluated by its founders in different psychological experiments (e.g., Brehm 1956, 1966, 1989; Brehm and Brehm 1981, 2013) and has been used as the basis to explain outcomes of freedom of choice, and the lack thereof, in various other disciplines including consumer research (Lessne and Venkatesan 1989), organizational behavior (Greenberger et al. 1989), and IS research (Lowry et al. 2015; Lowry and Moody 2015; Murray and Häubl 2011). This research has clearly demonstrated that when individuals are constrained to one alternative, they perceive that alternative as less attractive than it would have been had it been freely chosen. Besides attractiveness, reactance can also influence individuals' perceptions of the process of interacting with alternatives (Murray and Häubl 2011, p. 959) as well as on the outcomes of this interaction (e.g., Glass et al. 1969; Greenberger et al. 1989).

We propose that psychological reactance is likewise set in motion by the lack of freedom of technology choice. With the increase in digital technologies in personal lives and the resulting IT consumerization (e.g., the use of e-learning systems), users increasingly believe that they should be free to choose their preferred technology to perform IT-supported tasks. In their study on IT consumerization, Harris et al. (2012) found that 45% of all respondents were convinced that the hardware devices and software applications that they personally used were more useful to them than those provided by their company without any freedom of technology choice. The increasing emergence of shadow IT in organizations further shows that employees who are limited in their freedom to choose their preferred technology react negatively by employing unapproved technologies from outside of the organizational IT infrastructure (Haag et al. 2015; Zimmermann and Rentrop 2014).

By integrating prior literature on freedom of choice, psychological reactance, as well as technology acceptance and choice (as outlined in the related work section above), we expect that freedom of technology choice has effects on users' cognitions, emotions, and behaviors. Accordingly, our hypothesis includes widely-used concepts in utilitarian and hedonic systems. Consequently, we assume effects on 1) users' *perceived usefulness* (PU) and *perceived ease of use* (PEOU) of the (freely or prescribed) employed technology as the most significant and widely used cognitions of technology acceptance research (Venkatesh et al. 2003); 2) on users' *satisfaction with technology* (SWT) and *enjoyment of technology* (EOT) as technology-related emotions are found to be of increasing importance in the IT consumerization and private usage context (Harris et al. 2012; van der Heijden 2004), especially when a choice between multiple technologies exists (Sedera et al. 2016); and 3) on users' *task performance* (PERF) as the key outcome variable of individual technology use (Burton-Jones and Straub 2006; DeLone and McLean 1992). We believe that this study is a first step to meeting our objective to better understand how the impact of freedom of technology choice granted to users, or the lack thereof, influences their cognitions and emotions regarding that technology as well as their outcomes for using the technology.

Hypothesis Development

We expect that freedom of technology choice affects individual cognitions regarding the perceived usefulness, which is defined as "*the degree to which a person believes that using a particular system would enhance his or her job performance*" (Davis 1989, p. 320), and the perceived ease of use, which is defined as "*the degree to which a person believes that using a particular system would be free of effort,*" (ibid.) of the technology employed for performing. Past work on psychological reactance theory shows that limiting one's freedom of choice between alternatives stimulates reactance which in turn negatively affects individuals' perceptions of the process and thus their cognitions of interacting with limited alternatives (e.g., Carver 1977, Edwards et al. 2002, Murray and Häubl 2011). In the IS field, Murray and Häubl (2011) found that individuals who freely chose the interface they preferred to interact with in an experimental task perceived that the interface was easier to use than those who were restricted to use a specific interface in the task.

We therefore assume that constraining people, who know about alternative technologies, to using a specific technology for a task will give rise to reactance. Reactance will in turn make those people perceive the technology as less useful and more difficult to use than if they could have chosen among a set of alternative technologies. Additional support for this argument comes from research on IT consumerization (Niehaves et al. 2012). For example, a recent study found that 45% of employees perceived their personal technologies that they could freely choose more useful than those provided and usually mandated to use at work (Harris et al. 2012). Thus, we hypothesize the following:

***H1:** Individuals who are constrained to using a specific technology to perform a task will show a lower level of perceived usefulness (PU) with respect to that technology than those individuals who are free to choose a technology.*

***H2:** Individuals who are constrained to using a specific technology to perform a task will show a lower level of perceived ease of use (PEOU) with respect to that technology than those individuals who are free to choose a technology.*

Sedera et al. (2016) showed that in the presence of choice, emotional aspects will outweigh rational factors influencing users' technology acceptance processes. One variable in this regard is satisfaction with technology, which is defined as an "*individual's emotional state following IT usage experiences*" (Bhattacherjee and Premkumar 2004, p. 237). IT satisfaction is widely used in technology acceptance research (Bhattacherjee and Premkumar 2004; van der Heijden 2004) and in relation to mobile devices (Klesel et al. 2018). Previous literature in the context of consumer research shows that reactance has a negative influence on satisfaction (Fitzsimons 2000). Vice versa, Markus and Schwartz (2010) assumed that freedom of choice positively influences satisfaction and well-being. Greenberger et al. (1989) found higher levels of satisfaction among people who believe they have greater decisional control.

In the IT consumerization context, descriptive findings indicate higher levels of satisfaction with devices that are associated with higher levels of freedom of technology choice (Harris et al. 2012). Based on these previous results, we hypothesize the following:

***H3:** Individuals who are constrained to using a specific technology to perform a task will show a lower level of satisfaction (SWT) with respect to that technology than those individuals who are free tochoose a technology.*

Besides satisfaction with IT, research has also acknowledged enjoyment as an important hedonic factor that is relevant in the domain of technology acceptance research (van der Heijden 2004; Lowry et al. 2015). Enjoyment of a technology describes "*the extent to which the activity of using the computer is perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated*" (Davis et al. 1992, p. 1113). Studies in the context of consumerization and individualization of IS have found that users report higher degrees of enjoyment working with digital technologies (e.g., tablets), which were primarily designed for the private market compared to working with traditional enterprise IT (Lowry and Moody 2015). Although we do not yet know whether or not this may be attributed to the higher degree of technology choice in private usage contexts, prior research on reactance suggests that reactance succeeding the lack of freedom of choice raises negative emotions regarding the attractiveness of the restricted alternative (e.g., Brehm 1966, 1981). We extrapolate from that research and expect that reactance arises for people who are constrained to using a specific technology for a task, which in turn decreases their enjoyment of interacting with that technology. Thus, we hypothesize the following:

> ***H4:*** *Individuals who are constrained to using a specific technology to perform a task will show a lower level of enjoyment (EOT) with respect to that technology than those individuals who are free to choose a technology.*

Finally, a critical outcome variable in the technology acceptance and use literature is individual task performance assessing individual task outcomes in terms of its efficiency (e.g., Bala and Venkatesh 2016; Burton-Jones and Straub 2006). In other fields on related concepts, Greenberger et al. (1989) found that task performance is enhanced when people believe they have greater decisional control. Similarly, Glass et al. (1969) found that individuals who were constrained in their environment-based decisions displayed less persistence on tasks and made more errors than individuals in the free condition. Ozer and Vogel (2015) showed that software developers who had the freedom to adapt their software development procedures to feedback/new knowledge performed better. Extrapolating from this prior work in other fields and on related concepts, we expect that individuals whose freedom to choose their preferred technology is constrained will be affected by psychological reactance eliciting feelings of helplessness. Thus, we hypothesize that the following:

> ***H5:*** *Individuals who are constrained to using a specific technology to perform a task will perform worse than those individuals who are free to choose a technology.*

17.4 Methodology

Experimental Setting

We tested the hypotheses using a laboratory experiment employing a two-group between-subjects design where participants had to solve a data input task by means of using a tablet. Since there are many tablets available on the market from which customers can choose from, we deemed them well suited to investigate freedom of choice. Following Murray and Häubl (2011), we manipulated technology choice by designing a constrained condition and a free condition. Participants were randomly assigned to either one of the two groups. In the constrained condition, the participants were assigned to a specific tablet, while participants from the free condition could freely choose among three available tablets (the Apple iPad, the Samsung Galaxy Note, or the Microsoft Surface). The three tablet types were similar in terms of functionality (e.g., similar speed and display size) to eliminate biases due to device type. All participants did the experiment one-by-one in the same room under equal conditions guided by the same experimenter. The experiment procedure followed a four-step approach.

Step 1: After a short introduction to the general task procedure of solving a data-inputting task by means of a tablet, participants completed a pre-experimental questionnaire relating to their personal background, demographics, and previous experiences with tablets. The purpose of this was to capture control variables. We also asked participants to determine their preferred tablet to record their tablet preference.

Step 2: Subjects in the free condition could pick one of three tablets to fulfill the task. Subjects in the constrained condition were randomly assigned to one of the two tablets they did not select as their preferred tablet to constrain their freedom of technology choice and thus stimulate psychological reactance that was set in motion by the lack of freedom of choice (Brehm 1966; Brehm and Brehm 1981). During the experiment, the participants were not aware of the true intent of it—namely the exploration of reactance. To limit biases due to initial unfamiliarity with the tablets, participants were granted some time to become familiar with the tablet and to ask questions. In addition, the experimenter gave a short introduction into the applications needed to fulfill the task.

Step 3: Participants had to solve several tasks that were received by email. In total, seven emails were sent to the participants. Six of those required participants to respond in different ways. The emails were designed to resemble typical email communication that occurs in workplace settings. An overview of the email contents and the required actions are summarized in Table 52.

Step 4: We collected participants' task- and tablet-specific perceptions in a post-experimental survey.

Measures

To ensure the content validity of our variables, we used previously validated scales from existing IS literature. We measured *perceived usefulness* and *perceived ease of use* as proposed by Venkatesh and Davis (1996). The items for enjoyment of device were adapted from Davis et al. (1992). For our construct satisfaction with the device, we utilized the *satisfaction* scale of Bhattacherjee and Premkumar (2004). Furthermore, we included the control variable tablet *self-efficacy*, which was adapted from the self-efficacy scale of Venkatesh et al. (2003) to be able to control for effects due to experience rather than freedom of technology choice. The post-treatment questionnaire also included a manipulation check by measuring the degree of freedom of technology choice that participants perceived in order to perform the task. Table 55 (Appendix) presents all items used in our study. Based on Cronbach's alpha, a sufficient internal consistency of all constructs is given (α_{PEOU} = .85, α_{PU} = .95, α_{EOD} = .94, α_{SWT} = .89, α_{TSE} = .94). Performance was measured using the completion time (Murray and Häubl 2011).

Content of the email	**Required action(s)**
"Can we meet tomorrow at 3:30pm for 2 hours to discuss our project? If not, please make other proposals for an appointment (at least three)."	• Look in the calendar app • Notice that there is another appointment atthe requested time • Respond with three proposals according tothe free time in the calendar app
"I'm missing information from our previous meeting. Can you please take a picture of the whiteboard in your office and send it to me?"	• Use the camera app to take a picture • Send that picture via email
"As discussed, you can find the project plan enclosed."	• No response required, but in another emailthe project plan is requested

"I'm on my way to the office. Can you please text me where I can find [name of a rural supermarket]? Just look at Maps. I need the street name and number."	• Look in the Maps app for a rural supermarket • Alternatively, use Google web search • Transcribe/copy and paste the street nameand number into the response email
"I need the revenue numbers of the company Autonomy Corp from the previous 3 years. You have the document on your tablet. Please have a look and send the numbers to me. Please do not send the entire document, but only the revenue numbers."	• Look for a specific document[3] • Transcribe the revenue numbers into theresponse email
"Have you received the project plan from Mr. Dreher already? If so, please forward the email to me."	• Forward the email
"Did you finish working on the returns? Can you please let me know which articles have been returned (the article name is sufficient)?"	• Transcribe the article names from the return sheets (see return task) into the response email.

Table 53. Task Description

17.5 Data Analysis

Participants and Design

The laboratory experiment was conducted with a total of 54 participants (35 male, 19 female) from a major university in Europe. The participants had diverse backgrounds including business, information systems, law, psychology, and social sciences as well as diverse degrees ranging from bachelor's degrees to Ph.Ds. Freedom of technology choice was selected as the between-subject factor (freedom of tablet choice (choice, N = 24) vs. constrained freedom of tablet choice (constrained, N = 30)). The number of participants in this sample is sufficient to exceed the recommended minimum numbers of 20 observations for each group (Hair 2010). The participants had an average age of 23 (M = 23.30, SD = 2.78) and indicated a high level of self- efficacy (M = 5.56, SD = 1.49). Thirty-two of the participants were tablet owners (59%) while twenty-two did not privately own such a device (41%). Participants received monetary compensation for their efforts. Psychology students could also receive course credit. Subjects were randomly assigned to

[3] The experimenter showed the participants where to find the document at the beginning of the experiment.

the treatment groups. There was no significant difference regarding gender ($t(47) = -.87$, $p = .388$) or age ($t(41) = -.17$, $p = .859$).

Manipulation Check and Confounding Factors

We first checked whether our manipulation with respect to the contextual freedom of technology choice versus the constrained condition are aligned with users' perceptions of freedom of technology choice. The t-test revealed a significant difference in perceived freedom of technology choice for the autonomous ($M = 6.08$, $SD = 1.17$) and the constrained ($M = 1.93$, $SD = 1.31$) conditions ($t(51) = -12.287$, $p < .001$). Thus, it can be assumed that the manipulation worked as intended and participants in the unconstrained group perceived a higher level of freedom of technology choice.

To investigate the effects of possible confounding factors, an Analyses of Variance (ANOVA) was computed with age, gender, experience with tablets, and tablet usage as the experimental factors. None of the considered variables had a significant effect on freedom of choice ($ps > .38$). Moreover, we carried out several ANOVAs to test if there is a significant effect of demographic variables (i.e., age, gender), tablet ownership and tablet usage on any dependent variables. While tablet ownership and tablet self-efficacy have significant effects on perceived usefulness ($p = 0.06$ and $p = 0.06$), the remaining variables were not significant ($ps > .14$). Consequently, we excluded them from the subsequent analysis.

Effects of Freedom of Choice

Figure 17.1 shows the group-wise means and standard deviations. Before applying a Multivariate Analysis of Variance (MANOVA) on all five dependent variables, Mardia's test was applied which suggests multivariate normality. Box's M was conducted to investigate homogeneity of the covariance matrices ($p = 0.002$). Since the Box's M is significant, we use the Pillai's trace test, which is more robust against violations of homogeneity of the covariance matrices. Pillai's trace test reveals a significant main effect of choice ($p < .001$). We then used follow-up ANOVAs to test the effects of freedom on all dependent variables separately. ANOVA results on perceived usefulness showed that there was a significant effect of freedom of choice ($F(1, 52) = 7.12$, $p = .010$, $\eta^2 = .12$). Similarly, the results showed a significant effect of freedom of choice on PEOU ($F(1, 52) = 6.67$, $p = .013$, $\eta^2 = .11$), on SWT ($F(1,52) = 12.05$, $p = .001$, $\eta^2 = .19$), EOD ($F(1,52) = 21.17$, $p < .001$, $\eta^2 = .29$), and PERF ($F(1,52) = 6.43$, $p < .014$, $\eta^2 = .11$). To account for multiple-comparison issues, we adjusted the p values as suggested by Holm (1979). By so doing, all path coefficients remained significant. We conducted a post-hoc power analysis to determine the effect size using G*Power (Faul et al. 2009). Based on a sensitivity analysis with α = 0.05, power = 0.8, total sample size = 54, and 2 groups, the effect size is 0.388.

Source	Sum of Squares	df	Mean Square	F	p	adj. p	partial η^2	partial η^2 90% CI [LL, UL]
PU	19.07	1	19.07	7.12	.010	.030	.12	[.02, .26]
PEOU	6.30	1	6.30	6.67	.013	.030	.11	[.01, .25]
SWT	7.25	1	7.25	12.05	.001	.004	.19	[.05, .33]
EOD	25.82	1	25.82	21.17	.000	.000	.29	[.12, .43]
PERF	465071.00	1	465071.00	6.43	.014	.030	.11	[.01, .25]
Note. LL and UL represent the lower limit and upper limit of the partial η^2 confidence interval, respectively. The adjusted p values are reported as suggested by Holm (1979).								

Table 54. ANOVA Test

17.6 Discussion

With this study, we seek to advance our understanding of the importance of freedom of technology choice in today's digital age, in which on the one hand, the variety of digital technological options for performing the same tasks is constantly growing, but on the other hand, many organizations react by constraining those options for users. We show the negative effects that the lack of technology choice can have on users' cognitions, emotions, and performance. We find that a lack of freedom of technology choice does not only negatively affect users' cognitions and performance, but also users' emotions regarding the satisfaction with and enjoyment of using the technology while performing a task. Most notably, freedom of technology choice has a highly significant effect on users' enjoyment of and satisfaction with using the technology.

Contribution to Theory

While our results are in line with our theoretical assumptions and previous studies on reactance theory, when it comes to performance, they differ from the results presented by

Figure 17.1. Descriptive Statistics

Murray and Häubl (2011), which show that "*the users in the free condition never have an advantage in task completion times over those in the constrained condition*" (p. 970). By contrast, our study suggests that users in the free condition are significantly more performant (i.e., they have shorter task completion times) compared to participants in the constrained group. While this difference is significant, our study cannot show that being constrained always leads to reduced completion times.

This research contributes to a better understanding of choice-related concepts. We distinguished established constructs that have specific assumptions in terms of the number of available technologies (single technology vs. multiple alternative technologies) and with regards to the origin of freedom (based on the environment or based on the user). Even though the freedom of choice has long been present in scientific discourses (for an overview, see for instance Sen 1988, 1990), our review further emphasizes the role of technologies and accounts for the fact that the availability of alternative technologies has only gained little attention so far (Schwarz and Schwarz 2014). The existence of instrumental relevance (i.e., the value of the freedom of technology choice as means to other ends) and intrinsic importance (i.e., the value of the freedom of technology choice on its own right) can be adopted from previous work to specific technology-related settings. One subsequent approach for future research is to see freedom of technology choice as either 'positive,' concentrating on what a person can chose from, or 'negative,' focusing on how the absence of it constrains a person. We hope that our distinction between related concepts guides future research in carefully selecting the most appropriate concept for research questions.

Our results indicate that freedom of choice is an important predecessor to technology-related variables, which is in line with previous studies which have suggested that individuals with a high degree choice self- efficacy perceive a higher degree of usefulness and ease of use and are ultimately more satisfied with their IT (Klesel et al. 2018). Therefore, the study complements and enriches existing literature on technology acceptance and adoption (Venkatesh et al. 2016). For theorizing technology adoption behavior, including freedom of choice, it can be fruitful to shed further light on use behavior. For instance, being free to choose might also lead to more effective use of that technology. Thus, our work can be extended by integrating it into models on effective use (Burton-Jones and Grange 2013) or enhanced use of technology (Bagayogo et al. 2014).

Finally, our study contributes to research on hedonic motives in IS research (van der Heijden 2004; Lowry et al. 2013). Freedom of choice can be considered an important predecessor to enjoyment and satisfaction, and thus be useful for work-related aspects. This is in line with early works on hedonic motives (Huizinga 1949) and more recent literature that emphasizes hedonic motives in IS literature (Lowry et al. 2013).

Implications for Practice

Our results assist organizations to select and implement a more effective and valuable approach to handle the increasing multiplicity of digital technologies available today. Since the context of our study (i.e., the availability of alternative technologies) can be found in organizational practice today (e.g., as part of BYOD programs), this study can inform organizations about the role of freedom of technology choice. Our results suggest that freedom of technology choice may positively influence an individual's attitude toward a technology. Most importantly, allowing freedom of choice can increase an employee's performance, which is a key job outcome for organizations (Bala and Venkatesh 2016). Therefore, governance forms including BYOD can be considered promising approaches to foster acceptance and use of technologies. In this context, our study shows that there is a significant difference with only little choice opportunities (i.e., three different devices). By providing slight variety of technologies that can be used for business-related purposes, the proposed effects can be achieved. Accordingly, the results indicate that to foster acceptance and increase satisfaction with technologies, a "choose your own device" strategy may be superior compared to the traditional "here is your device" strategy as pursued by many enterprises. To grant knowledge workers substantial freedom of choice, organizations can use our insights to enhance their effectiveness, creativity, and productivity. This is in line with existing studies, which already demonstrate that knowledge workers can use the deep understanding of their personal devices and workspaces to develop new strategies to accomplish task objectives and to quickly retrieve information (Kohlegger et al. 2013). Although they invested work time into constructing and maintaining this freely chosen workspace, their overall task performance and focus was enhanced by their perceived enjoyment of work. The positive relation with satisfaction at work again positively strengthens their acceptance of technology (van der Heijden 2004). Increasing the number of technologies also comes with challenges for organizations including security issues.

Consequently, they are advised to find a middle way between considering a great number of alternatives for the users and limit excessive security risks.

Limitations and Outlook

This study has limitations which in turns opens the door for future research. Based on our research design including a laboratory setting, external validity is limited. For example, the amount of time given to users to familiarize with the technology could be enlarged. In addition, the results could be further evaluated with another sample. In doing so, our results that differ from previous studies could be explained.

We further acknowledge that other variables could play a role in addition to the selected ones. Since this is one of the first studies seeking to analyze the phenomenon of freedom of technology choice on technology- related attitudes, we deliberately selected factors highly relevant for technology acceptance research. Similarly, previous literature suggests that the used variables might have interrelationships (e.g., van der Heijden 2004; Venkatesh et al. 2016). Future research could focus on developing an integrated model that also includes the relationships among the variables.

Moreover, the experimental task was conducted with tablets. Additional research may expand the current context by considering further technologies of similar and different characteristics used for work-related tasks (e.g., smartphones). Finally, this research was conducted in a context where participants have to solve one given task. Thus, the focus was on a short period of technology use. When individuals use a technology for a longer period, the results may be different. For instance, perceived enjoyment of a device may be reduced when using the chosen technology becomes habitual or routine. Similarly, perceived ease of use or usefulness may change as the user becomes accustomed with the technology. Thus, research may further examine the long-term effects of autonomy and freedom of technology choice in the post-adoption phase.

17.7 References

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17.8 Appendix

Construct	ID	Item	Source
Perceived Usefulness (α = **.95**)	PU1	Using the tablet improved my performance in the experiment.	(Davis 1989; Venkatesh etal. 2003; Venkatesh and Davis 1996)
	PU2	Using the tablet in this experiment increased my productivity.	
	PU3	Using the tablet enhanced my effectiveness in this experiment.	
	PU4	I found the tablet useful in this experiment.	
Perceived Ease of use (α = **.85**)	PEOU1	My interaction with the tablet was clear and understandable.	(Davis 1989; Venkatesh etal. 2003)
	PEOU2	Interacting with the tablet did not require a lot of mental effort.	
	PEOU3	I found the tablet was easy to use.	
	PEOU4	I found it easy to get the tablet to do what I wanted it todo.	
Enjoyment of	EOD1	I found using the tablet to be enjoyable.	(Davis et al.

Technology (α = .94)	EOD2	The actual process of using the tablet was pleasant.	1992)
	EOD3	I had fun using the tablet.	
Satisfaction with Technology (α = .89)	All things considered; I am______with my use of the tablet.		(Bhattacherjee and Premkumar 2004)
	SWT1	1 Extremely displeased------------------------7 Extremely pleased	
	SWT2	1 Extremely frustrated------------------------7 Extremely content	
	SWT3	1 Extremely terrible-------------------------7 Extremely delighted	
	SWT4	1 Extremely dissatisfied----------------------7 Extremely satisfied	
Technology Self-Efficacy(α = .94)	TSE1	I feel comfortable using a tablet on my own.	(Davis 1989; Venkatesh etal. 2003)
	TSE2	If I wanted to, I could easily operate a tablet on my own.	
	TSE3	I can use a tablet even if no one is around to help me.	
Perceived Freedom of Technology Choice	PDA1	I was able to use my favorite tablet for the task in the experiment.	Self-developed manipulation check
	PDA2	I was free to choose which device to use for the tasks.	

Table 55. Measurement Instrument

18. Paper 12: How Autonomy is Used in Information Systems Research

Title	**How Autonomy is Used in Information Systems Research: Status Quo and Prospective Opportunities**
Authors	Sebastian Weber[1] Michael Klesel[1,2] Frederike Marie Oschinsky[1] Björn Niehaves[1] [1] University of Siegen, Siegen, Germany. [2] University of Twente, Enschede, The Netherlands.
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Status	Published
Full Citation	Weber, S., Klesel, M., Oschinsky, F. M., Niehaves, B. (2020). How Autonomy is Used in Information Systems Research: Status Quo and Prospective Opportunities. 53nd Hawaii International Conference on System Sciences (HICSS-53), Hawaii, USA.

Table 56. Fact Sheet Publication

How Autonomy is Used in Information Systems Research: Status Quo and Prospective Opportunities

Abstract. *Autonomy is a pivotal concept that allows researchers to investigate important aspects such as job-related outcomes in Information Systems (IS) research. With the increase of mobile technologies, autonomy is increasingly gaining importance. Given the growing body of research in this area, this research presents the results of a systematic literature review. Our results show in detail how autonomy has been used and identifies fruitful avenues for future research. Specifically, we suggest that future research should contextualize autonomy to give it a central theoretical significance for IS research. Moreover, future research should also acknowledge the multi-dimensional facets of autonomy to enhance its explanatory power.*

18.1 Introduction

Autonomy has been used for at least three decades (e.g., [52]) to investigate important phenomena that are related to Information Systems (IS) research. A major reason for the great interest in autonomy relates to the fact that having freedom is a fundamental human need. Moreover, arguments have been made that Information Technology (IT) has a significant impact on how individuals perceive autonomy [39] and vice versa, how perceived autonomy influences IT use [2]. Consequently, numerous scholars have conceptualized autonomy to explore IS-related phenomena. To that end, autonomy has been applied to the individual, group, and organizational level. Moreover, it has been used to describe individual characteristics, job characteristics, or design aspects. Therefore, the concept of autonomy can be considered a pivotal construct for IS research. Figure 18.1 also highlights that autonomy, based on our review, enjoys continued and growing attention.

Due to the high interest in autonomy, there is a wide range of how the concept is used. While some scholars use it as an overall job characteristic [2], others use it to conceptualize specific dimensions such as decision-making autonomy [3]. Similarly, autonomy has been used as a unidimensional construct as well as a multidimensional construct [30]. Consequently, there is a broad spectrum of perspectives to study autonomy.

While the great interest in autonomy has significantly contributed to extend the current body of knowledge, it also led to an ambiguity in terms of the way the concept can be used. In specific, it remains unclear which domains to conceptualize autonomy exist and what the existing are may lacking to provide a better representation and explanation in the future. Since this is a potential threat for theory development, our research objective is to provide a systematic overview of how autonomy has been used in IS research so far.

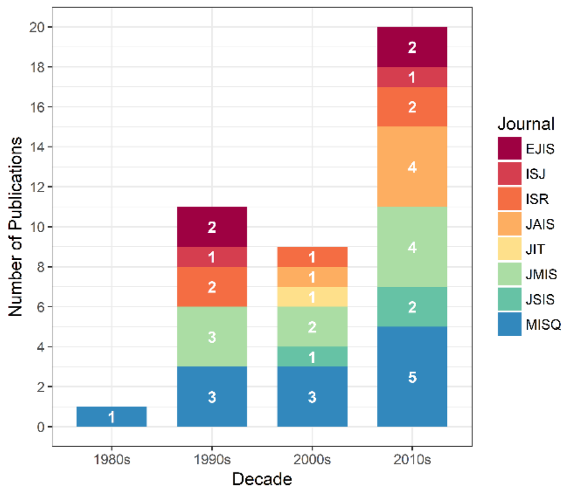

Figure 18.1. Autonomy-related Research in the "Basket of Eight" per Decade

By addressing our objective, our contribution is twofold: First, we aim to provide a systematic overview of the used autonomy conceptualizations. To do this, we analyze the concept in terms of what it captures (i.e., the unit of analysis, the dimensionality, the operationalization, and the technology-relationship). Second, we want to identify prospective opportunities on how to study autonomy in IS. Considering the multitude of used operationalizations, we want to emphasize the fact that autonomy is not only relevant to conceptualize job characteristics but can also be adopted for technology-related issues. In specific, we highlight the occasion to consider technology-autonomy as a fruitful concept (i.e., a concept that recognizes technology specific choices) for future research.

To address our objectives, the remainder is structured as follows: In section two, we briefly review the role of autonomy in general and in IS research. After that, we present our methodological approach in detail. In section four, we present our results. We reflect and discuss our findings in section five. We conclude by highlighting the limitations of our study and by providing some avenues for future research.

18.2 The Role of Autonomy in IS Research

Etymologically, the concept of autonomy originates from the ancient Greek terms "autos" (self) and "nomos" (rule or law), which refers to the idea that citizens can make their own rules [16]. Based on its generic nature, the concept of autonomy has been studied at various levels in several disciplines, including philosophy (e.g., [12,16]), psychology (e.g., [14,20,27,53]), organizational sciences (e.g., [39,54]), and information systems (IS) research (e.g., [1,2,23,42]). Manifold conceptualizations, operationalization, and outcomes emerged. In psychology, autonomy is a well-known construct since it is a fundamental aspect of influential theories such as the job characteristics model (JCM) [20] and the self-determination theory (SDT) [14]. The JCM links several job design characteristics, such as job autonomy to explain job responses (e.g., satisfaction, turnover) [19]. Hackman and Oldham define job autonomy as "the degree to which the job provides substantial freedom, independence, and discretion to the employee in scheduling the work and in determining the procedures to be used in carrying it out" [19]. In particular, results of a JCM meta-analysis provide evidence that a work design which features job autonomy yields positive employee attitudinal outcomes [18]. In the case of SDT, which is a theory of human motivation, autonomy is one of three innate psychological needs that foster self-motivation [51]. Within this theory, autonomy refers to "not to being independent, detached, or selfish but rather to the feeling of volition that can accompany any act, whether dependent or independent, collectivist or individualist" [51]. Conditions which support this feeling of autonomy promote higher intrinsic motivation and improved personal well-being [51].

In contrast to these positive findings, other studies also highlight critical issues related to autonomy. Most notably, studies from organizational sciences report an autonomy paradox [39,54]. The autonomy paradox reflects that the introduction of mobile email devices in the work context first increases the perceived autonomy of an individual. However, over time, when the device use is collectively adapted, this sense of autonomy decreases, due to the pressure of always being available [39].

Previous IS literature examined autonomy in various research streams. Literature often uses the JCM (e.g., [43,55]) and SDT (e.g., [26,28]) in an IS-specific context. They often integrate the autonomy construct of these theories in new theories, such as work exhaustion theory [42], social exchange theory [61], theory of effective use [34], field theory [17] as well as task closure theory [46]. In most cases, these studies integrate the construct of autonomy of the JCM. Hence, autonomy is often used as a job characteristic to explain important IS job-related outcomes, including innovation behavior [2], job-satisfaction [43,55], or turnover [1,42]. Apart from explicit conceptualizations of autonomy, IS research also uses several concepts relating to autonomy. For instance, they utilize the concept of task authority [52], perceived locus of causality [37], outcome control [38,45], or centralization [29].

Based on the prevalence of autonomy in IS research, various perspectives have been taken to investigate autonomy. Nevertheless, a systematic synthesis of how autonomy can be used, e.g., what entities have been analyzed, or what the pivotal focus of autonomy(-related) concepts is, has not been conducted so far. Against this background, we address this shortcoming and provide a structured literature analysis of autonomy in IS research.

18.3 Methodology

Method selection and data collection

In order to examine how the concept of autonomy has been used in IS research, we conducted a structured literature review [5,57,58,60] and followed a proposed five-step procedure as suggested by vom Brocke et al. [57]:

1) *definition of review scope*: In the first step, we used the taxonomy of Cooper [13] to define our review scope. According to this taxonomy, we focus on how the concept of autonomy is operationalized. The goal of our review is synthesizing and integrating findings of prior work on autonomy to purvey a status quo and to give advice on how scholars can further extend the current body of knowledge. Since we are interested in analyzing the construct of autonomy in this review, we organize it methodologically and conceptually (i.e., synthesizing by similar measurement approaches and same abstract ideas). To achieve this goal, we espouse a neutral perspective to inform general and specialized scholars in the field of autonomy-related IS research. Furthermore, our review aims to cover pivotal autonomy-related research for the IS discipline by including the Association for Information Systems (AIS) senior scholars' basket of journals (known as the 'basket of eight') [4]. We focused on these impactful outlets because we believe that they cover a substantial body of knowledge within the IS field.

2) *conceptualization of topic:* In the second step, it is suggested to give a broad conception of the topic and to identify potential research areas. Therefore, we give a brief overview of autonomy in general as well as in IS research in specific in the previous chapter. We identified a gap which we want to address with this review.

3) *literature search*: Step three involves the literature search. As aforementioned, we focused our search on the 'basket of eight' and therefore used the databases Web of Science, ScienceDirect, and EBSCOhost, which provided us access to these journals. To find relevant papers, we chose the search term 'autonomy' because it incorporates several variations (e.g., job autonomy, task autonomy) and searched within the title, abstract and in the

keywords/subject without limitations regarding the publication date. The literature search was conducted in November 2018 and yielded 48 papers.

Papers with a scope not related to our research were excluded. Hence, all abstracts, titles, and keywords were first scrutinized to check their suitability. The examination yielded the exclusion of two papers as they did not mention autonomy or related terms [35,47]. This led to a sample of 46 papers for a complete reading. After reading each paper thoroughly, further papers that mentioned autonomy only on a surface, but not as a focal concept in their research, were also excluded [21,41,48,50,59].

In summary, we identified and investigated 41 papers in more detail. The search, exclusion, and further investigation were performed by at least two of the authors. If differences arose, they were discussed in the group and solved together. Table 57 provides an overview of the identified papers. Since the primary objective of this paper is the investigation of autonomy and its operationalization, we only consider quantitative studies and their measurements in the subsequent steps 4) literature analysis and synthesis and 5) research agenda. Thus, we included 27 papers for our detailed analysis.

Outlet	Identified papers					
	qualitative	%	quantitative	%	Σ	%
EJIS	4	10	0	0	4	10
ISJ	0	0	2	5	2	5
ISR	3	7	2	5	5	12
JAIS	3	7	2	5	5	12
JIT	1	2	0	0	1	2
JMIS	0	0	9	22	9	22
JSIS	1	2	2	5	3	8
MISQ	2	5	10	24	12	29
Total	14	34	27	66	41	100

Table 57. Distribution of Considered Papers per Outlet

Data analysis

For a systematic analysis of the literature on autonomy [60], we develop a framework that covers the fundamental properties of a construct. Drawing from MacKenzie et al. [36], we include four different aspects that are explained in the following[4]:

[4] Note that MacKenzie et al. [36] also highlight other aspects. Since our data is mostly cross-sectional, we are not able to investigate, e.g., "stability over time" thoroughly. Thus, we limit this review on four crucial aspects of a construct.

Entity: reflects the unit of analysis that is used to investigate autonomy. The entity can be either the individual level, the group level, or the organizational level. We classified each study based on the underlying measurement items. For instance, items like "I control the content of my job." [2] indicate that autonomy is investigated on an individual level. In contrast, authors who indicate that organizational-level constructs were measured (e.g., [49]) are classified accordingly.

Dimensionality: indicates whether a construct is measured in a unidimensional manner or by means of multiple dimensions. To evaluate the dimensionality, we look at the constructs and items. Most of the analyzed research measures autonomy with one scale and without any sub-dimensions [1,42,43]. Those studies are classified as unidimensional. In contrast, authors who included multiple dimensions of autonomy (e.g., scheduling autonomy, work-method autonomy, decision-making autonomy as proposed by Ye and Kankanhalli [62]) are classified accordingly.

Construct: refers to the operationalization of a construct. Previous literature often adopts the concept of autonomy for a specific context. Thus, they slightly differ from the general notion of autonomy. For instance, Durcikova et al. [15] use "climate for autonomy" instead of job autonomy to examine if employees perceive the organizational climate as autonomous. However, since the measurement items are aligned with the general notion of (job-)autonomy (i.e., "I schedule my own work activities.") [15], they are categorized in the general section. In contrast, Karahanna et al. [26] measure autonomy as an innate psychological need, originating from the SDT, which operationalizes autonomy with another focal point than (job-)autonomy. While the general notion reflects autonomy regarding work-tasks, the satisfaction of the need of autonomy describes a "subjective experience of psychological freedom and choice during activity engagement" (e.g., one can also feel satisfaction of the need of autonomy when he is dependent on others) [10]. Thus, we distinguish constructs that differ in their meaning as well as operationalization and clustered similar ones.

Technology-relationship: reflects how autonomy is used in order to make it relevant for the IS discipline. For that purpose, we distinguish a direct and indirect relationship towards IT. A direct relationship is given when the construct itself is adapted for an IS-specific context. For instance, data resource management (DRM)-related autonomy [24] is considered a direct relationship. This becomes most evident in terms of the measurement items, which are likewise adopted for the IS context (e.g., a free selection of hardware) [24]. In contrast, an indirect relationship exists when the IS-context is given via the structural model (e.g., [43]) or via the study sample (e.g., IS professional as shown in [42]).

18.4 Results

The results of our analysis are summarized in Table 58 and Table 59. They highlight that the primary entity of analysis is the individual level (74%), whereas research on the group- (15%) and organizational level (11%) has been of less interest. 73% are classified as autonomy in general, whereas 27% are contextualized constructs. Regarding the dimensionality, the majority recognizes autonomy as a unidimensional construct (78%). Only 22% consider autonomy as a multidimensional construct. A direct technology-relationship was given in 15% of the autonomy constructs, while the other research does this indirectly via an IS context (52% indirect via the structural model and 33% indirect via the sample).

Property	Classification	%
Entity	Individual	74
	Group	15
	Organizational	11
Construct	Autonomy	73
	Contextualized construct	27
Dimensionality	Unidimensional	78
	Multidimensional	22
Technology-relationship	Direct	15
	Indirect via theory	52
	Indirect via sample	33

Table 58. Quantitative Results

Studies using autonomy on the individual level are mainly concerned with job-related aspects. For instance, previous studies investigated job satisfaction [22,23,43,55], job performance [46] and turnover intention [1,42] of IS employees. This has also been done in an IT context, e.g., through the investigation during the implementation of an Enterprise Resource Planning System [43]. However, none of the unidimensional autonomy constructs had a direct relationship towards IT. In contrast, the two papers, that recognize autonomy as a multidimensional construct, measure autonomy with a focus on technology.

For instance, Ye and Kankanhalli [62] show the impact of design autonomy on the user's innovation quantity. To this end, they measure design autonomy as a three-faceted construct, whereby each of the dimensions (i.e., scheduling autonomy, work-method autonomy, decision-making autonomy) is centered on free technology-specific choices (e.g., choosing the time to develop an application, freedom to choose a method to design applications, choosing the application one would like to develop). Their results reveal that work-method autonomy and decision-making autonomy positively support the quantity of newly developed [62].

Research on the group level used multidimensional autonomy constructs more often compared to unidimensional constructs. The constructs mostly aim to measure team autonomy. However, only the unidimensional construct measures team-autonomy with a focus on technology. In specific, the authors show that agile software development teams are more efficient in responding to users' requirement changes when they have more autonomy in terms of technology (e.g., choosing the technology and tools to develop) [33]. Besides the positive effects, there are also seem to be adverse effects that reduce the degree of response extensiveness (i.e., they responded less to user requirements [33]. The multidimensional team autonomy constructs with two facets measure autonomy with an indirect technology-relationship, as they study IS employees. Both research results indicate that providing teams with autonomy yields positive outcomes in the form of better software project quality [38] and improved quality of work life and performance [25]. The other multidimensional construct, which takes into account a technology-relationship, has a focus on DRM-related autonomy [24]. The authors' analysis reveals that this technology-specific autonomy should be adjusted to the organizational settings (i.e., a high need of centralization requires a limited autonomy of local units, while a need for decentralization requires a high degree of autonomy) to achieve high DRM success [24]. On the organizational level, the term autonomy generally expresses how much power the organization has in relation to its environment. The majority measures autonomy unidimensionally. However, none of the research papers measured autonomy with a focal point on technology. For instance, the results of Roberts et al. [49] suggest that organizations that grant autonomy to IS managers, take more benefit of innovative IS use, because these managers can create more diverse ideas and thus also improve economic gain.

Entity	Dimensionality	Construct	Technology-relationship	References
Individual	Uni	(Job-) Autonomy	Indirect via structural model (e.g., part of TAM)	[2,15,17,34,43,52,56,61]
			Indirect via sample (e.g., IT consultants)	[1,22,23,42,46,55]
		Satisfaction of Needs for Autonomy	Indirect via structural model	[26,28]
		Perceived Locus of Causality	Indirect via structural model	[37]
		Decision-Making Autonomy	Indirect via structural model	[3]
	Multi	Design Autonomy	Direct via construct	[62]
		Autonomy for Strategic Systems Planning	Direct via construct	[40]
Group	Uni	Team Autonomy	Direct via construct	[33]
	Multi	Team Autonomy	Indirect via sample (software development teams)	[25,38]
		DRM-Related Autonomy	Direct via construct	[24]
Organization	Uni	Centralization	Indirect via structural model	[29]
		Organizational Autonomy	Indirect via structural model	[49]
	Multi	Outcome Control / Decentralization	Indirect via sample (software firms)	[45]

Table 59. Overview of the Results

18.5 Discussion

Our results show that the concept of autonomy is frequently operationalized as a unidimensional concept. In the domain of job-related research, it commonly reflects an overall job autonomy. While this approach contributes to a better understanding of previously unknown relationships, it is also limited due to the disregard of other dimensions. For example, it prevents the identification of the individual influences of the different autonomy facets. This in turn leads to the fact that no concrete actions that are important for practice can be derived. The large number of studies at this level also show that employees value autonomy as it is linked to several important outcomes such as organizational commitment [1] or job satisfaction [22]. Furthermore, with regard to IS-specific outcomes it is linked to innovation behavior [2,15] or IT satisfaction [31]. Since IS employees and innovative IS behavior are crucial resources for business success, we argue that it is beneficial to take a closer look at the different facets of autonomy. Several studies by Breaugh [6–9] also continuously support the multi-dimensionality of autonomy. Therefore, it is promising to conceptualize autonomy not as a single-dimensional construct but as a multi-dimensional one to increase the explanatory power of future theories. Current studies already including multiple dimensions (e.g., [62]) show that the inclusion of different dimensions is vital for a better understanding of IS-related phenomena. Hence, we suggest acknowledging autonomy as a multi-dimensional facet in future research.

Autonomy in the proper sense is often not IS-specific. Still, it is not surprising that the concept itself has widely been used to extend IS theories [24,33,40,62]. However, in light of the rich concept of technology use [11], there are several undeveloped opportunities to contextualize autonomy for the IS discipline. For instance, based on the increasing dissemination of mobile technologies, autonomy can be adapted to reflect the freedom to choose or the freedom to use a specific technology. Initial efforts in this direction have already been made. For example, Murray and Häubl [44] show the impact of freedom of choice in cases of alternative interfaces. Thus, this approach is promising in terms of an IS-specific conceptualization of autonomy (i.e., technology autonomy). The results offer a starting point as they examine how autonomy has been used in prior research.

Our review demonstrates that the concept of autonomy is well suited to be used for different units of analysis. In specific, there is sufficient literature that uses autonomy on an individual, group, and organizational level. Despite this fact, most research uses autonomy on an individual level. Acknowledging the strong influence of occupational theories, including the JDC [19] and the SDT [14] this is not surprising. However, we argue that IS research still leaves great potential out of sight. Specifically, with a high degree of autonomy on the individual level [39], it is reasonable to assume an impact on the group and the organizational level [32]. Consequently, we suggest using autonomy on the group and organizational level as well as taking a cross-level perspective.

18.6 Limitations and Outlook

This research has several important limitations. First, for this review, we limited our scope on a few very impactful outlets. To make this review more comprehensive, future research should include more outlets (e.g., conferences). Second, we identified several promising avenues for future research that have not been investigated in detail so far. Hence, further empirical insights are required to support or reject our findings. In specific, future research should develop a construct to measure IS-specific autonomy and investigate the effects of it on outcome variables such as job satisfaction or IT satisfaction. Third, it is also important to report that this study has primarily been investigated on a measurement level. Whereas this can be most useful for quantitative research, it is limited regarding qualitative research. Consequently, future research could also investigate and synthesize the results of research that have been conducted qualitatively. Alternatively, future research could investigate the effects of autonomy utilizing a meta-analysis to show the most important effects. Finally, we suggest that future research should conceptualize and evaluate a multi-dimensional measurement instrument that includes commonly used dimensions of autonomy as well as new dimensions such as instrument autonomy to make it more relevant for IS research.

18.7 References

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19. Paper 13: How Employees Stay Satisfied in Times of Digital Change

Title	**Do Employees Stay Satisfied in Times of Digital Change? On How Motivation Aware Systems Might Mitigate Motivational Deficits**
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Table 60. Fact Sheet Publication

Do Employees Stay Satisfied in Times of Digital Change? On How Motivation Aware Systems Might Mitigate Motivational Deficits

Abstract. *Fostering motivation seems a crucial parameter at the time of the global pandemic and far beyond. It helps master the challenge that employees spend up to half of their working time in an unproductive manner – especially when using technology. Against this background, Information Systems (IS) research started to design systems capable of supporting employees in enhancing their productivity and focus at work: attention aware systems. We follow up on the regarding design implications in current literature and similarly propose the development of motivation aware system to enhance employee motivation. We suggest following a mixed-method approach to study whether the development of these systems could be seen as a promising avenue. Also, we outline how to design such systems and point at possibilities for future research.*

Keywords: *Employee Motivation, Performance, Satisfaction, Attention Aware Systems, Motivation Aware Systems.*

19.1 Introduction

Employees spend up to half of their working time in an unproductive manner – oftentimes using information technologies (IT) (Bennett & Naumann, 2005). Studies show that, since an increasing number of them works remotely, employees are diminishingly controlled by their colleagues and executives, and prevalently use their privately owned devices for professional purposes (Klesel et al., 2017). The Bring Your Own Device (BYOD) movement already led to the implementation of various organizational guidelines intended to regulate how employees use their private equipment. Nowadays, the ongoing global pandemic resulted in an even more urgent demand for strategies on how to use privately-owned devices when working outside the office. Because the companies' IT departments have only limited control over applications and downloads these days, it seems strikingly important to find ways to ensure the employees' productivity when using private IT.

Fostering motivation seems a crucial parameter to master this challenge. At the individual level, being motivated increases performance, well-being and creativity, while it minimizes misconduct and absenteeism (e.g., Baard et al., 2004; Zhang & Bartol, 2010). At the organizational level, a high level of motivation increases overall productivity and profitability, growth and competitiveness as well as customer satisfaction and retention (e.g., Noe et al., 2017). Thus, the interest in motivation principles is well-established and yet steadily increasing.

Doing research about motivational obstacles and drivers is fruitful since it is imperative for organizations to create a motivating working environment so that employees remain willing to exploit their full potential and productivity. Against this background, Information Systems (IS) research already set focus and started to design systems capable of supporting employees in doing so: attention aware systems. These systems are able to detect a user's current attentional state, evaluate alternative attentional states and employ focus switch or maintenance (Roda & Thomas, 2006). Consequently, we see great potential for the development of specific systems capable of supporting motivational mechanisms: motivation aware systems. Technologies, in addition to allowing fast access to information and people, should be designed to mitigate against motivational deficits. Based on current literature and latest empirical evidence, we derive three research questions (RQs):

***RQ1:** Which factors influence the motivation of employees in the working environment?*

***RQ2:** Can the development of motivation aware systems be seen as a promising avenue to enhance employee motivation?*

***RQ3:** How can a motivation aware system be designed?*

To answer these questions, we seek to compile the current state of research and to shed light on the most important influences on employee motivation. With this research-in-progress paper, we will describe the theoretical foundation of such a system. Our work thereby merges existing knowledge of the fields of business administration, management, psychology and IS research (Chapter 2) to derive implications for design (Chapter 3). After concluding remarks about the benefit and limitation of our approach, possible ways of future research are shown (Chapter 4).

19.2 Theoretical Background

Motivation is defined as the direction, intensity, and persistence of a will to execute a behavior towards or away from goals (Kanfer et al., 2008). Motivation is thus not an actual behavior, but the willingness to undertake it. It is substantial among the various antecedents of human behavior, which can be divided into four groups: Besides motivation, behavior is mostly affected by individual abilities, an enabling context and the social environment (Rosenstiel, 2007, p. 57). There are interactions between the antecedents of human behavior as they all depend on individual experience and subjective perception. However, we will focus only on motivation.

Maslow's Pyramid

Maslow's Need Pyramid (1954) is as an early example of motivation theories. Instead of motif he uses the term need because scientists in those years frequently talked about needs, drivers, and even instincts interchangeably. The author assumes that underlying needs drive behavior and states a hierarchical structure: At the lowest level, there are basic physiological needs (such as hunger). If these are satisfied, security needs (such as stability) are activated at the next level. They are followed by social needs (such as belonging) and needs for self-realization (i.e., self-esteem via respect and self-actualization via the pursue of inner talent) at the top. The assumption of levels and hierarchy implies that only when a lower need is satisfied, the upper one is activated. By properly identifying needs, Maslow presumes, people can be effectively motivated.

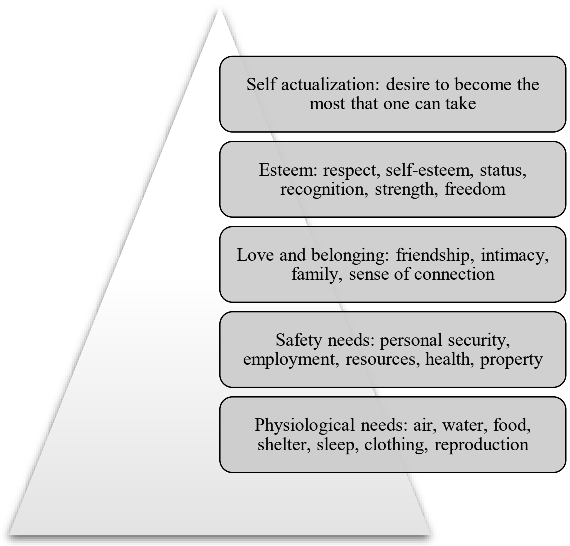

Figure 19.1. Maslow's Hierarchy of Needs

Maslow's assumptions have successfully spread in theory and practice as a kind of motivation checklist. For instance, they explain why it is not purposeful to allow an employee to choose where to work (i.e., self-realization), if the social need for contact is not satisfied. However, empirical data rises doubt: Observations show people who trade their security for status or who risk their health for self-fulfillment. In addition, the importance of the needs can vary greatly depending on age and the stage of life (Gebert & von Rosenstiel, 2002). Maslow's theory lacks essential motifs such as power and does not include differences in culture (e.g., Stajkovic & Luthans, 1998; Winter, 2001; Steel, 2007). It does not show what motivational leadership, or a motivational work environment should look like, how to design tasks or how to formulate organizational goals. Thus, we aim at finding a more promising approach.

Lewin's External Influences and Internal Influences on Motivation

Lewin considers external and internal influences on human motivation more systematically (1936). He describes behavior as a function of person and environment. External influences on employees' motivation are the design of a task (e.g., Bakker & Demerouti, 2007) or a company's incentive system (e.g., Stajkovic & Luthans, 2003). Other important factors are teamwork, leadership and the organization itself in that it shapes the above aspects with its corporate culture. Internal influences on employees' motivation are the personality of the individual (e.g., Judge et al., 2007) and their ability to regenerate from work and stress (e.g., Sonnentag, 2003; Sonnentag et al., 2010). Other essential factors are self-efficacy, individual habits, optimism, and self-regulation. Employee motivation arises from the interplay of environmental influences and characteristics and the traits and states of individuals.

Herzberg's Two-Factor Theory of Motivation

To find out whether the development of motivation aware systems can be seen as a promising avenue to enhance employee motivation, we consider the vast psychological literature. For instance, Herzberg and his colleagues were interested in the external influences of why someone is motivated at work (1959). They moved away from studying general motives towards concrete aspects in the environment of employees. In their studies, they asked numerous employees from different branches and hierarchical levels about typical situations at work. Based on frequency lists, the researchers discovered an interesting pattern: They distinguished two factors a) dissatisfying 'hygiene factors', and b) satisfying 'motivators' (Herzberg, 1972). Against this background, they deduced that dissatisfaction and satisfaction represent two different dimensions, and not simply opposite poles of a single dimension.

The dimension of hygiene factors describes the work environment (e.g., the quality of relationships). Exemplary hygiene factors are leadership, working conditions, administration, or payment. If the hygiene factors are favorable, there is no dissatisfaction – but they do not determine whether employees are motivated or not. The dimension of motivators focuses on the work itself (e.g., performance experience). Exemplary motivators are responsibility, recognition, the content of the task and perception of growth. This dimension determines whether there is dissatisfaction as it produces motivation – but only if hygiene factors have been optimized. According to Herzberg (1972), the opposite of dissatisfaction is thus not contentment but only the absence of dissatisfaction.

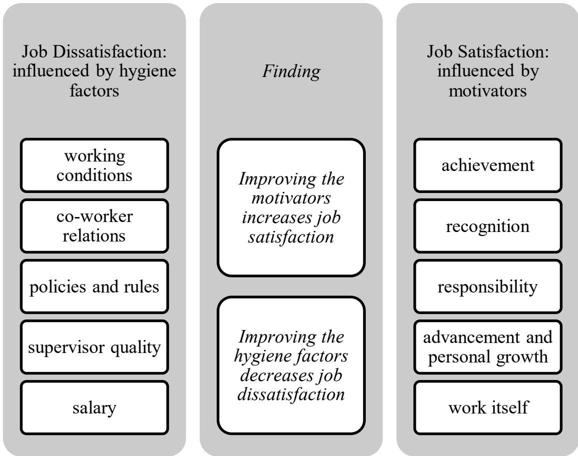

Figure 19.2. Herzberg's Two-Factor Theory of Motivation

When we compare Maslow's Hierarchy of Need with Herzberg's Two-Factor Theory, we see that they overlap at some points. The basic psychological needs for safety and security as well as for belonging and love fit well with hygiene factors. Interpersonal relations, supervision, company policies and administration, salary, and working conditions are addressed. The needs on a higher hierarchy (i.e., esteem and self-actualization) are accompanied by Herzberg's motivators. They illustrate achievement, recognition, responsibility, advancement, and work as a value for itself. Bearing this insight in mind, four states can be discriminated from each other. Transitions are fluent, but the states pinpoint the central idea that in the case of dissatisfaction, motivation goes nowhere.

The condition of the hygiene factors is bad; motivators are low.

The employees are dissatisfied and there is nothing that could motivate them in the short term. This likely results in high turnover, low attendance, and low performance.

The condition of the hygiene factors is bad; motivators are high.

Although the employees like their job, a bad working environment suffocates the joy of work. Inefficient administration and bureaucracy, a bad relationship with the leader or team constantly demotivate.

The condition of the hygiene factors is good; motivators are low.

The employees are in a great environment, with a great boss, nice colleagues, and well-organized processes. Unfortunately, the task offers no fun at all.

The condition of the hygiene factors is good; motivators are high.

The employees find themselves in an optimal environment, are satisfied and have a dreamlike job, which motivates. This stage is where sustainable motivation comes about.

The empirical investigation in a concrete context for a specific target group (i.e., employees) provides meaningful categories. Therefore, the two-factor theory has also been applied in IS research. For instance, Cenfetelli (2004) found out that the rejection to use IT is best predicted by inhibitors (i.e., hygiene factors) that discourage usage when present, but do not necessarily favor usage when absent (see also Bhattacherjee & Hikmet, 2007; Hsieh et al., 2014). Next, the results are much more manageable and useful for practical purposes than, amongst others, Maslow's Pyramid. With Herzberg's change of perspective, companies and executives were given more concrete advice to promote employee motivation. Moreover, looking at the four states, we see that the lower the motivators, the higher the potential of applying motivation aware systems.

19.3 Towards Designing Motivation Aware Systems

Understanding how our brain works gives us important clues about how to increase employee motivation. For designing motivation aware system, we again dive into psychological literature as it reveals that human affect optimization is associated with the release of substances in the brain (e.g., endorphins for positive feelings and cortisol for negative feelings) and that specific physical reactions are linked to their release (e.g., an increase in heartbeat) (see also Kuhl, 2001). Events in the environment or in one's own body are registered by the limbic system, which in turn activates behavior-controlling centers. Thus, the measurement of specific brain substances, limbic system activity and physical reaction make it possible to draw conclusions on a person's state of affect quite reliably (Roth, 2017). This insight is very valuable when it comes to designing a motivation aware system. Again, we are aware that research stemming from neuroscience, psychology, and medicine already address bodily responses of humans, whose insights open a promising avenue for future studies. On top of that, in our own follow-up studies, we will put this work in the perspective of the design science process, so that our next steps become prominent. In addition, this will help understand our work's relation to the current body of knowledge and empirical evidence.

One important clue is that rewards at work must have some degree of uncertainty. They must be an exception, which can be implemented as a feature in a motivation aware system. Another important clue is that habits carry reward in themselves. It is fun to do things quickly, accurately, and effectively. The more tasks are practiced and established; the less emotional effort is required to carry out an activity. To hold on to the proven conveys the feeling of security and competence and reduces fear and skepticism. Motivation aware systems can detect the necessity to do automated things at work. This can greatly increase to feel comfortable work and thus, enhance employee motivation.

To answer our RQs, we suggest following a mixed-method approach: To elaborate on RQ1 and RQ2, we will send a survey to 350 small, medium-sized and large companies in (left out for review). If the results are promising, a second survey is planned abroad, considering cultural features. To elaborate on RQ3, we will do both a systematic literature review and expert interviews to get an idea of how the insights about attention aware systems can stimulate the design of motivation aware systems (e.g., Which measurement methods could be used to measure motivation?). In the end, we plan to do focus group interviews to discuss the preliminary findings and to draw conclusion on how to refine our study. Data analysis will be in line with data collection either in the form of quantitative (i.e., structural equation modeling) or qualitative analysis (i.e., content analysis). The results will be interpreted and discussed in an interdisciplinary team.

19.4 **Discussion**

At this point, we do not at all claim completeness or generalizability as we have only deduced our approach theoretically. Against this background, we want to address a few critical factors of our work so far and present ways for future research: First, literature shows that job satisfaction can be partly innate and not externally determined (Hahn et al., 2016). Moreover, the widely assumed positive linear relationship between job satisfaction and motivation seems not to exist (Bowling, 2007). For instance, job satisfaction can rise from achieving own goals without meeting organizational goals. Future research can offer a more differentiated perspective and consider important confounding factors such as openness to career moves (e.g., working one's way up with job shopping). It will be interesting to study whether motivational deficits really persuade employees to change jobs.

Being a research-in-progress paper, our work still lacks clarity and empirical insight. Against this background, future research is invited to come up with narrower research question to approach the broad research question mentioned in this manuscript. On top of that, they can acknowledge that working environments may differ greatly between different jobs and domains. The ongoing debate of establishing 'new work' in a post-pandemic world highlights the need for more focus and unerring conceptualization.

Furthermore, future studies can consider additional system design options when it comes to the question of how motivation aware systems can increase employee motivation. For example, the differentiation into hedonic and utilitarian systems could have explanatory power (van der Heijden, 2004). On top of that, future work can address the very close relationship between motivation and self-efficacy (Bandura & Wessels, 1997). Self-efficient employees tenaciously pursue their goals (persistence) and estimate what effort is worthwhile for which task (reality orientation). They feel quite satisfied and capable and make the important experience that the pursuit of self-determined goals is a reward in itself. In this respect, looking at the correlation of employee motivation and self-efficacy opens the door for interesting insights.

In addition, applying Herzberg's Two-Factor Theory of Motivation offers several pitfalls. First, the four states are still abstract. The author focused on essential aspects in the environment of employees, but still did not show what motivating leadership or motivating work tasks exactly look like. In addition, the distinct assignment as a hygiene factor or motivator is narrow. Among others, leadership is categorized as a hygiene factors, but has been shown to be a powerful motivator that can do much more than simply not demotivating employees (e.g., Aryee et al., 2012; Avolio, 2011; Bass & Riggio, 2006). On top of that, the generalization and validity of motivators and hygiene factors are vague. Depending on the situation, the meanings change. For example, salary can become more significant during an economic crisis. The meanings vary between subjects (e.g., Minton et al., 1980). Next, the motivators themselves are somehow delusive, since people are more likely to seek the reasons for success in themselves, but attribute the reasons for failure to external factors to protect their self-esteem (e.g., Mezulis et al., 2004) (e.g., Mezulis et al., 2004). Finally, we are aware that the mentioned theories are still basic and that researchers have built on them for many years. In particular, the technology adoption literature published technology-related findings such as the Motivational Technology Acceptance Model by Davis's lab.

However, in a constantly changing working environment, we see great potential in researching factors that are related to employee motivation, using the application of motivation aware systems as a contemporary example. Future research can show how to design such systems in more detail, study whether they really motivate to achieve higher performance and provide a deeper analysis of relevant related approaches. Based on these future insights, conclusions can be drawn on how employees can stay motivated during the global pandemic and in times of continuous change and digital transformation.

Acknowledgements

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20. Paper 14: Working in the Digital Age

Title	**Working in the Digital Age: Merging A Status Quo Bias Perspective and Reflective Practice**
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Table 61. Fact Sheet Publication

Working in the Digital Age: Merging a Status Quo Bias Perspective and Reflective Practice

Abstract. *The pillars of digital change (new role models, new competences, changed attitudes) are most visible in the everyday practice of staff. In the digital age of continuous transformations, we need a theoretical basis that can describe an individual's behavior in situations of uncertainty, instability, uniqueness, and value conflicts. We approach this theoretical gap by joining the vision of "Reflective Practice" (Schön, 1983) and the status quo bias perspective (Kim and Kankanhalli, 2009; Lee and Joshi, 2017). By proposing a three-step mixed-method study, we try to answer the question of how work can be designed in the digital age. Based on our insight, we seek to develop a guideline to help organizations frame the working conditions in a future-oriented and comprehensible way.*

Keywords: *Digitalization, Digital Work, Rational Choice, Reflective Practitioner, Cognitive Bias, Status Quo Bias Perspective.*

20.1 Introduction

Digitization is changing the way we work and organize. The use of information technologies (IT) makes it possible to fulfil tasks more effectively and to maintain or even increase the quality of service and data security. At the same time, IT use can save time, reduce errors, and streamline internal processes. Nevertheless, digital change is accompanied by new roles and modified needs for (IT) competence (e.g., Hill, 2014; Malsbender et al., 2014; Ogonek et al., 2018, 2016), as well as a changing attitude towards digital solutions (e.g., Ogonek et al., 2018). This triad has been intensively studied and provides the basis for our investigation. To explain decision-making of employees in the digital age, we consider the fundamental work in decision research. Nobel prize winner Herbert A. Simon (e.g., Simon, 1944, 1946, 1997; see also Sherwood, 1990) has stated that employees do not have access to all the necessary information and cannot process all facts correctly. Rationality is 'bounded'. His work is more prominent than ever in the digital age. Despite the high value of using technologies, many benefit from them only to a limited extent and encounter IT with skepticism or even fear. They insist on learned procedures and known solutions, although this perseverance objectively entails disadvantages (e.g., temporal, financial and emotional costs). This behavior is known as 'status quo bias' (Kim and Kankanhalli, 2009; Polites and Karahanna, 2012; Lee and Joshi, 2017; Li et al., 2016). Current acceptance models and their underlying theories (e.g., Davis,

1989) often neglect the explanatory power of the status quo bias. We rely on the work of "Reflective Practice" (Bousbaci, 2008; Habib, 2017; Schön, 1983) as it pioneered to include cognitive biases and heuristics to explain how people interpret their working life and shape their behaviour accordingly. For this reason, we propose to expand research on competence building in the digital age and to include the aspect of this cognitive bias to shape the education and training of staff. Our research question is: How can work in the digital age be designed? Based on our insight, we seek to develop a guideline to help organizations frame the working conditions in a future-oriented and comprehensible way. For addressing our objective, we briefly present the theoretical background and research framework and then discuss the structure of our three-step methodological approach. Finally, we give an outlook.

20.2 Related Work

In his seminal work "Reflective Practitioner – How Professionals Think in Action", Donald Schön (1983) develops the concept of practitioners, which goes far beyond *experts* using standard solutions (p.21). This concept is the basis for our further investigation. The concept consists of three parts (A) Knowing-in-Action (KiA), (B) Reflection-in-Action (RiA), and (C) Reflection-on-Action (RoA). The core of the concept is the phenomenon of RiA, which therefore builds the focal point of our framework.

KiA. Knowledge often is an unconscious and partly subconscious process. It forms the basis for action. Knowledge can be achieved through repetitions in a repertoire of expectations, representations, and techniques in the practice of the expert (ibid., p.60). The repetitions make knowledge more and more specialized.

RiA. In everyday life, practitioners apply knowledge tacitly and implicitly (e.g., implicit perceptions, judgements, and skills). Schön describes the phenomena with the phrases "thinking on your feet", "keeping your wits about you" or "learning by doing" (ibid., p.49-50; p.54). RiA is not a matter of conscious thinking, but of feeling and intuition. The practitioner acts and works on a task and – sometimes ad hoc – situations arise in which he automatically calls up his existing knowledge (ibid, p.50). One can understand this as 'rules of thumb', illustrating the proximity to heuristics and cognitive distortions (ibid, p.63). The knowledge of the practitioner (KiA) in a rationally bounded manner. RiA can be divided in three subcategories:

(1) Framing – F: First, the problem framework is defined. When a satisfying solution is found, the process stops. Every practitioner understands the task of finding a satisfactory solution as unique and has to define and frame the problem in the first step (ibid., p.129).

(2) Reframing – RF: Second, the problem frame might need to be reset and reframed due to the complexity of a problem. The focus of the practitioner will be shifted away from the problem at hand to a different perspective of the situation. This can open new design possibilities. A practitioner needs to solve the new problem with a kind of craftsmanship (ibid, p.130).

(3) Experiment – X: Third, the practitioner has to try whether the new solution is satisfactory. It is a kind of experiment. The new solutions will be examined with a new problem framework. The practitioner succeeds in spontaneously comparing, evaluation and finally favoring solutions (ibid., p.130).

RoA. The practitioner thoroughly thinks about the result of the situation or task. This reflection improves the practitioner's way of approaching the next task. This helps to improve the 'processing economics' (ibid., p.60) and possibly leads to 'overlearning' (ibid. p.60-61). Thus, it automatically influences KiA.

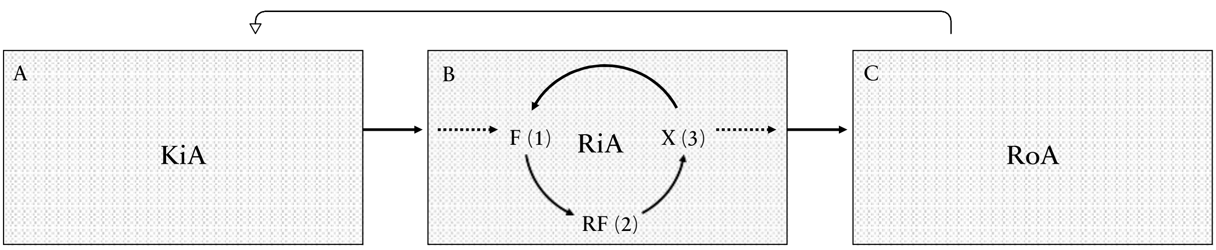

Figure 20.1. Reflection in Practice

Bounded rationality has its origins in the field of psychology (Tversky and Kahneman, 1974). Due to the explanatory power of the approach, it has been adopted in many other disciplines and serves to understand many previously puzzling phenomena. The approach follows the assumption that decisions are not always based on the weighing of costs and benefits. Instead, human judgment is influenced by heuristics and cognitive biases. Heuristics, or 'rules of thumb', help decision making in complex situations under uncertainty, and in situations that do not allow for long and reasoned reflection (Schön, 1983). However, cognitive biases, as systematic deviations from rationality, can lead to suboptimal and undesirable outcomes, for instance, because not all alternatives were considered or the effort of action wrongly estimated (Kahneman, 2003).

Undesirable outcomes are what we often observe when someone sticks only to a habitual decision making and behavior, even when better alternatives exist (e.g., the department head does not consider IT solutions, although workspaces require digital components (Fleischmann et al., 2014)). Samuelson & Zeckhauser (1988) were at the forefront to distinguish between three main constructs that influence the so called 'status quo bias': rational decision-making, cognitive misperception, and psychological commitment.

In IS research, Lee & Joshi (2017) supplement the perspective and offer the constructs. In particular, the authors adopted the categories and subdivided them even further. The dimensions are briefly summarized in the following.

Rational decision-making is not always possible under uncertainty. Uncertainty is the individuals' lack of information and/or expertise about the alternatives, which may impose search and analysis costs, and lead to decision paralysis (Samuelson and Zeckhauser, 1988). The concept was divided into anxiety costs as well as search and analysis costs (Lee and Joshi, 2017).

Cognitive misperception consists of loss aversion and anchoring effects addressing the perceived value. Loss aversion illustrates that individuals weigh losses heavier than gains in making decisions (e.g., Kahneman and Tversky, 1979; Kahneman, 2011). Anchoring effects refer to the individuals' propensity of setting a starting value and then assessing changes with reference to the initial state (Tversky & Kahneman, 1974).

Psychological commitment has three parts: sunk costs, regret avoidance and the effort to feel in control. Sunk costs in sequential decisions describe the continual selection of the same choice, where individuals' desire to justify previous commitments to a course of action by making subsequent commitments (Samuelson and Zeckhauser, 1988). Regret avoidance, which was later divided into the categories regret avoidance and social norms (Lee and Joshi, 2017) shows that individuals are likely to avoid consequences in which they could make the wrong choice, even if in advance the decision appeared correct given the information available at the time (Samuelson and Zeckhauser, 1988). Finally, the effort to feel in control, which was later added by the term 'self-efficacy' (Lee and Joshi, 2017), refers contexts where people have the freedom to make choices and thus perceive that they control the situation' (Samuelson and Zeckhauser, 1988).

20.3 Framework

In merging the status quo bias perspective and reflection in action, we focus on two important points:

"Problem-ignoring". Type I-III occur when the application of existing knowledge (e.g., executing a standard solution) happens without reflection, and is thus based on a bias. A suboptimal solution thus appears to be the 'best' answer to a task.

"Not getting out of the wheel". Type IV-VI occur when the evaluation of the variants is not done rationally but based on biases. Therefore, a rationally better solution is discarded.

After highlighting these two points, we identify two prominent cases where it is necessary to think rationally. Thus, the status quo bias has to be comprehensibly reduced. First, thorough RiA must be made possible. The practitioner has to recognize a situation as unique and new and thus frame a new problem in it, which involves reasoning and weighing of alternatives. Second, if the practitioner in the iterative process of RiA has to somehow recognize an outcome of his experiments as a satisfying solution. He has to formulate: "We stop experimenting. This is the solution, and we start with the implementation!" The two cases where it 2)is necessary to think rationally, will be acknowledged in our future studies.

20.4 Research Agenda and Concluding Remarks

Our aim is to develop an integrated model based on the status quo bias perspective and reflection in action. To obtain a holistic view of technology acceptance and the intended use of staff in the digital age among different organizations, we will conduct a preliminary mixed-method study in a municipality. The study will also be carried out in one small-sized and one medium-sized enterprise and a university of applied sciences. The three-stage mixed-methods study consists of a qualitative preliminary study, a pilot test, and a quantitative survey. A subsequent workshop, which can be attended analogously and digitally, aims to mirror the results in practice, draw conclusions about new job profiles and shape and strengthen leadership. The findings of the study will be summarized and made available to the public free of charge. The study is structured as follows:

Qualitative preliminary study. Focus group with public administration managers to develop an activity scenario that includes innovative technologies (e.g., artificial intelligence).

Moreover, we present the status quo bias perspective and the reflection in action approach. Thereupon, we identify missing variables.

Pilot test. The newly developed scenario is used as a priming tool for our questionnaire. The pilot test itself contains this scenario and the extended list of variables. To test the comprehensibility of our questions and the meaningfulness of the formulations, we perform a test with a small sample of employees (N = 5).

Survey. After revising the questionnaire, we carry out a large-scale online survey (N = 300). The aim is to develop our model in an explorative manner and to search for significant correlation and cause-effect relationships. After conscientious data cleansing and analysis, the results will be summarized. To present and discuss the project results, a workshop will be held, which can be attended in analogue and digital form. The aim is a future-oriented discourse on competence development and digital work.

To conclude, we seek to develop a guideline to help organizations frame the working conditions in a future-oriented and comprehensible way. By proposing a three-step mixed-method study, we try to answer the question of how work can be designed in the digital age. Because the pillars of digital change (new role models, new competences, changed attitudes) are most visible in the everyday practice of staff, we seek to test the newly developed theoretical basis (joining the status quo bias perspective and reflection in action). The findings can be applied and refined in various settings of digital work.

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II Decision Support

21. Paper 15: Biases in Information Systems Research

Title	**Cognitive Biases in IS Research: A Framework Based on a Systematic Literature Review**
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Table 62. Fact Sheet Publication

Cognitive Biases in IS Research: A Framework Based on a Systematic Literature Review

Abstract. *Cognitive biases are worth considering in Information Systems (IS) research because they explain non-rational usage behavior and extend scientific understanding. Since the first publication in 1994, many papers in major IS outlets have appeared. However, although IS researchers increasingly acknowledge several specific biases (e.g., framing), other biases remain largely neglected (e.g., reference point dependency). In this article, we compile existing literature to create an overview of the growing body of IS research on cognitive biases. On this basis, we propose a framework that focuses on distinct biases regarding the IS topic they affect. Our framework will allow for more systematic research and analysis of the non-rational behavior of developers, managers, and users of information technology. Thereupon, future research will close existing theoretical gaps, e.g., the systematic combination with technology acceptance models. Besides, we also highlight tangible implications for practitioners.*

Keywords: *Cognitive Biases, IS Research, Framework, Literature Review.*

21.1 Introduction

Cognitive biases are important to Information Systems research as the bounded rationality concept is essential in understanding human behavior (Lee and Joshi 2017; Simon 1955). Cognitive biases describe behavior where "individuals draw inferences or adopt beliefs where the evidence for doing so in a logically sound manner is either insufficient or absent." (Haselton et al. 2015, p. 2). Researchers have traditionally explained human behavior with models based on the rational choice assumption. Rational choice models hold a unique appeal, being clear and simple. They were introduced to our domain with the Technology Acceptance Model (TAM) with its variables perceived usefulness and perceived ease of use that builds on the theory of reasoned action by Ajzen and Fishbein (Ajzen and Fishbein 1980; Davis et al. 1989). But rational choice models do not explain various human behaviors that are not rational (Boudon 1998). Exploring non-rational behavior is therefore relevant to IS research on two levels: Firstly, considering both rational and non-rational elements helps to increase the explanatory power of models and explanation approaches (Lee and Joshi 2017). Secondly, as for the example, the conceptualization of the status quo bias – a non-rational preference for the current situation – together with technology acceptance constructs by Kim and Kankanhalli (2009) shows that we need a IS specific research approach for cognitive biases. Such an IS specific approach is relevant to establish common ways to measure a bias in IS, ensure a correct combination with existing concepts and guide future research.

The psychologists Tversky and Kahnemann (1973) introduced cognitive biases with three initial heuristics as a starting point for later researchers, who have since discovered many biases. They introduced the first heuristic in an experiment where they showed that participants falsely guessed the probability of an event because they relied on the "availability" of related information (availability heuristic). The representativeness heuristic describes an effect where participants of experiments assess the likelihood of a student belonging to a specific group not based on the overall statistical probability, but rather on how much the student's description represents a certain class (Tversky and Kahneman 1974). Tversky and Kahneman (1974) also demonstrated how unrelated numerical anchors heavily influence participants guessing a city's population (anchoring and adjustment heuristic). To date, there are numerous publications on cognitive biases, and a large number of biases have been identified by different disciplines, from management studies (Das and Teng 1999) to design science (Arnott 2006). For example, Arnott (2006) mentioned 37 biases, Burow (2010) found 19 biases, Browne and Parsons (2012) discuss ten biases. Efforts concentrated on bias collection and classification have found even more biases, e.g., Benson (2019) identified 188 biases. This large number of biases in research indicates that cognitive biases are indeed relevant to current research.

Cognitive bias research has reached a significant level in IS research, with more than 50 biases studied to date. The first IS publication targeting cognitive biases by Keil et al. appeared in 1994. It looked at sunk cost, self-justification, and irrational escalation in the context of technology project management (Keil et al. 1994). Since then, a continuous stream of research has looked at more than 50 different biases (e.g., framing, anchoring, reactance). This reflection of biases in IS research amounts to approximately 1/4 of biases identified in research in general. It shows the relevance of cognitive biases to explain, for example, non-rational aspects of technology use behavior as well as to broadening technology acceptance theory. They also improve existing acceptance models and theorizing on technology use across different sectors and are specified for IS research.

No current overview of the IS research field's present state exists, and to date, researchers could not establish an exhaustive framework. The first overview of this growing body of research was an initial scientometric analysis by Fleischmann et al. (2014), which offered an overview until 2012. They identified forty-six cognitive biases and clustered them into eight categories. On this basis, they identified research gaps and promising research questions for further research. This provided a valuable starting point for subsequent researchers in the IS domain to systematically assess additional phenomena and thereby extend the knowledge base. With the growing number of publications, the necessity for an overarching framework arises to facilitate the identification of related biases in the IS research and meta-research. Although several categorizations of biases have been put forth (Arnott 2006; Burow 2010; Browne and Parsons 2012; Fleischmann et al. 2014), and these have inspired further research (Mohanani et al. 2020) researchers could not yet establish a framework that allows to sort biases in a way not constructed from the biases in question and derive further research insights for all biases in IS on an aggregated level. Closing this gap is important as it allows us to systematically increase our scientific understanding of various IS phenomena, e.g., technology acceptance and thereby advancing the current knowledge and facilitating future research. To achieve this, we conducted an extensive literature review with the following research questions (RQ) and research objective (RO):

RQ1: *What is the current state of research on cognitive biases in IS research?*

RQ2: *Which research designs are researchers using to study cognitive biases in IS research?*

Based on these insights, we address our research objective (RO), as we needed an understanding of which and how IS researchers study biases to create a framework to guide future research:

RO: *Identify a framework for the cognitive biases relevant to IS research.*

In the following, we discuss the theoretical background on cognitive biases and explain the research method in more detail. Moreover, we present the findings and discuss our results in a final section, opening the door for future research.

21.2 **Cognitive Biases**

Tversky and Kahneman (1974) challenged the established rational choice assumption in research with their cognitive bias theory. The concept of a homo oeconomicus assumes that humans behave completely rationally and can assess their actions regarding merits and costs and constantly aim for utility and wealth. Economics researchers introduced the approach in the late 19th century. It allowed them to illustrate human behavior in parsimonious models with simple assumptions (Persky 1995). Only in the late 20th century, Tversky and Kahnemann challenged those assumptions and introduced cognitive biases as a systematic approach to study human behavioral inconsistencies. In the beginning, Tversky and

Kahnemann (1974) identified three types of biases: availability, representativeness, and anchoring and adjustment. In IS research, the first publication on cognitive biases appeared 20 years later, where Keil et al. (1994) looked at sunk cost, self-justification, and irrational escalation in the context of IT projects. Since then, researchers have studied a significant number of biases.

In 2014, Fleischman et al. provided the first comprehensive overview of cognitive bias research in IS with their scientometric analysis and their categorization of biases. This categorization of biases into the following eight categories was a major contribution of their research: Perception biases, pattern recognition biases, memory biases, decision biases, action-orientated biases, stability biases, social biases, interest biases. One can refer to Fleischmann et al. (2014) for a detailed description.

To date, several taxonomies of biases have been established in various contexts and from different perspectives. The available set of taxonomies ranges from those in the psychology literature like an individual differences perspective (Oreg and Bayazit 2009), over the categorization based on bias type introduced above (Fleischmann et al., 2014), their relevance for certain tasks (Dimara et al. 2015), different domains such as supply chain management (Carter et al. 2007), to specific types of information systems like decision support systems (Arnott 2006). The different categorizations established so far have in common that their underlying logic and number of categories depending on the considered number of biases. Therefore, each time a new bias is discovered or applied to the IS field, these have to be reconsidered and possibly appended or changed. A framework could help to ensure a systematic exploration of the topic and encourage meta-research.

21.3 Method

Scope of Literature Research

To create a wide-ranging overview of cognitive biases in IS research, we conducted a comprehensive literature search in key IS journals and established IS conferences. We concentrated on the senior scholars' basket of journals as a representative sample of IS research (Gogan et al. 2014; Sørensen and Landau 2015). To complement this, we considered the proceedings of the four AIS conferences (see Table 63) as well as the HICSS due to the significant number of publications on the topic. We also added two journals cited in prior literature due to relevant contributions to the cognitive bias studies in IS (see

Table 63). Such an approach yields the advantage that our findings are comparable with prior systematic literature reviews (Fleischmann et al. 2014).

Regarding the search terms used, we adapted prior literature results to develop the biases over time. In other words, we used the biases identified by Fleischmann et al. (2014) as search terms: Framing, negativity bias, halo effect, selection bias, representativeness bias, sequential bias, priming effect, recency effect, biased perception of partitioned prices, emotional bias, primacy effect, selective perception, confirmation bias, availability bias, reasoning by analogy, disconfirmation bias, reference point dependency, irrational escalation, reactance, illusion of control, cognitive dissonance, mental accounting, mere exposure effect, exponential forecast bias, ambiguity effect, zero-risk bias, input bias, base-rate fallacy, omission bias, overconfidence, optimism bias, anchoring, sunk cost bias, status-quo bias, loss aversion, endowment effect, herding, stereotype, value bias, attribution error, cultural bias, after-purchase rationalization, self-justification. Our aim was to show the development over time; therefore, we did not search for additional biases already researched in other disciplines. Nonetheless, when new biases appeared in the same publication with already established biases, we included these.

Search procedure

In a first step, we identified publications with the selected biases (search terms) mentioned in their title or abstract in the previous section's outlets and a publication date after 2012 (starting where Fleischmann et al. (2014) left of).

Outlet	< 2012	<= 2020	Total
International Conference on Information Systems (ICIS)	19	28	47
Decision Support Systems (DSS)	16	8	24
MIS Quarterly (MISQ)	11	12	23
Americas Conference on Information Systems (AMCIS)	13	20	33
Pacific Asia Conference on Information Systems (PACIS)	7	17	24
Hawaii International Conference on System Sciences (HICSS)	NA	21	21
Information Systems Research (ISR)	11	10	21
European Conference on Information Systems (ECIS)	4	15	19
Journal of Management Information Systems (JMIS)	7	10	17
Information Systems Journal (ISJ)	3	6	9
International Journal of Electronic Commerce (IJEC)	6	2	8
Journal of the Association for Information Systems (JAIS)	2	5	7

Journal of Strategic Information Systems (JSIS)	NA	6	6
European Journal of Information Systems (EJIS)	1	4	5
Journal of Information Technology (JIT)	NA	2	2
∑	100	166	266

Table 63. Distribution of Publications on Cognitive Biases in Selected IS Outlets

This search included the respective databases for the identified outlets: Science Direct, EbscoHost, SpringerLink, Web of Science, and AIS eLibrary. In a subsequent step, a forward and backward search ensured exhaustiveness of search, and a subsequent manual check identified relevant publications for the detailed analysis. Our initial search identified 210 publications. For the forward search, we used Google scholar. The backward and forward search combined identified 16 additional publications, among other things, due to insufficient classification of publications in the databases mentioned above.

Both steps combined resulted in 226 articles published after 2012. Three researchers scanned these identified papers manually for relevance and possible misclassification of outlet or publication type. For example, we excluded publications that only referred to a bias in their research method. On these grounds, 43 publications were excluded, which left 183 articles published after 2012 for further analysis. Combined with the 83 publications already identified by Fleischman et al. (2014), this allowed us to consider 266 publications altogether. We present the search results per outlet in Table 63. For some outlets, no results were available in the given period (marked with "NA").

Procedure of Analysis

We examined the 266 publications based on seven factors that answer three different questions:

- When and where are biases studied in the IS community? (1) year of publication, (2) outlet, and (3) industry contexts: We directly took the year of publication and outlet from the publications metadata. The industry context was coded following the NAICS 2012 1st level categories to ensure comparability with Fleischmann et al. (2014) and identify focus changes.
- What types of biases do IS researchers study? (4) biases studied, (5) bias categories as proposed by Fleischmann et al. (2014). We identified the bias based on the search terms derived from Fleischmann et al. (2014) and an explicit hint in the publication.

This identification allowed us to assign a bias category. We assigned new biases to a category based on descriptions by Fleischmann et al. (2014).

- How are biases studied in IS research? (6) examined research field and (7) applied research method. The examined research field was assigned based on the categories proposed by Fleischmann et al. (2014) to ensure continuity and comparability: research for business models of information and communication systems (ICT), software development, application systems, IS management, IS usage, the economic impact of IS, meta-research. We categorized the research method following Palvia et al. (2007)

Identification of the Framework

Based on the literature analysis results, we identified a framework for cognitive biases in line with Gregor's (2006) theory for analyzing. We defined acceptance criteria for a framework to sort cognitive biases. We then evaluated available frameworks from different literature streams in the context of cognition and biases for their possible fit with these criteria. Subsequently we adapted the framework we identified to the bias context and sorted the identified biases in IS research by its dimensions. We then assessed it against our initial acceptance criteria.

The study of cognitive biases in IS spans over 26 years (see Figure 21.1) and shows a positive trend. Nonetheless, it is no main topic in IS research yet. The analysis shows that the number of publications on the topic increases again in the last three years after a slump in 2013/2014. Interestingly, this happened directly after the initial scientometric analysis by Fleischmann et al. in 2012. Measured by the absolute number of publications in IS research, this is not yet one of this research field's main topics (Goyal et al. 2018).

More than 50 different biases have been studied in the IS context, even though names sometimes differ to date. From 2007 to 2012 appears most productive regarding introducing new biases to the IS research field (see Figure 21.2). Nonetheless, we have to take into account that biases are often not named consistently. For example, Yin et al. (2012) talk of loss avoidance while other authors talk of loss aversion (Davis and Ganeshan 2009; Gardiner and Kofi Andoh-Baidoo 2019; Zheng et al. 2017; Wang et al. 2019). Irrespective of this naming issue, all of them referred to the concept that most people tend to be risk-averse by placing more attention on avoiding losses than on a possible the opportunity of advantages (Yin et al. 2012).

21.4 Findings

Biases in IS Research

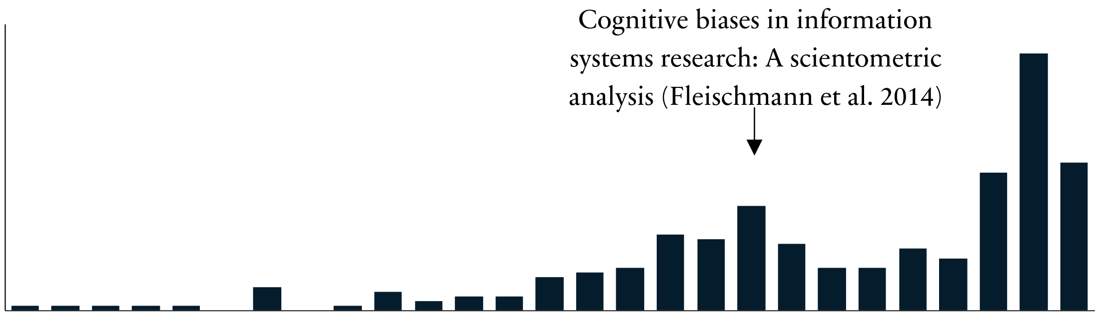

Figure 21.1. Number of Publications on Cognitive Biases in the IS Context per year

Our study tried to identify similar concepts referred to by different names based on content analysis to facilitate their consistent identification for future researchers. In case of doubt, we referred to the concepts as two distinct biases. For example, we consider post-adoption regret and post-purchase rationalization as separate biases. Both refer to internal evaluation processes after taking a decision. But while post-adoption regret focuses on the effect of possible feelings of regret for having foregone a different option (Zou et al. 2015), post-purchase rationalization describes the phenomenon of trying to find positive arguments for the choice taken and thereby rationalizing it (Turel et al. 2011).

Regarding the research gaps identified by previous literature, e.g., IS usage and memory biases, most of them remain open (see Table 64). To allow the reader a comparison with prior analyses, we structure biases based on bias category as identified by Fleischmann et al. (2014) and not on the single-bias level. The research focuses still on IS Usage and IS management. Especially in IS Usage, cognitive biases seem to explain different phenomena from user behavior on a crowdsourcing platform usage to employees' security behavior (Goel et al. 2017). This focus is unsurprising as the use of IS is one of the main focuses of the research field and, for example, prominently mentioned in editorial statements of key outlets (MIS Quarterly 2020).

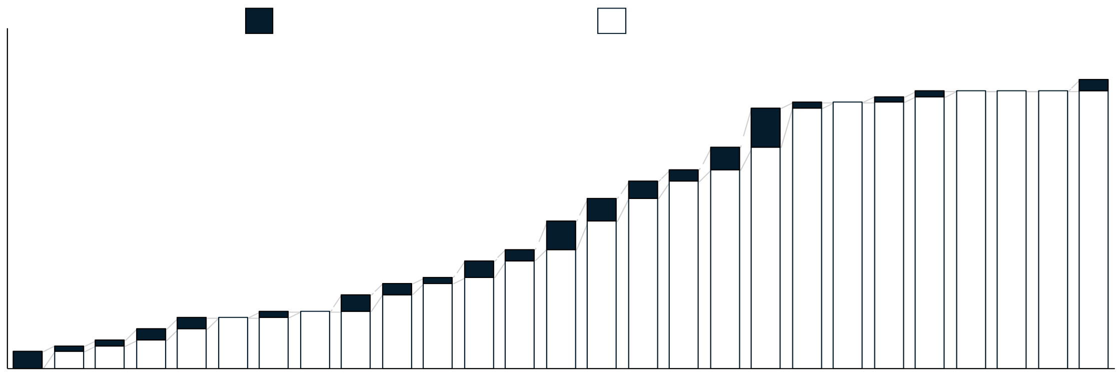

Figure 21.2. Number of Newly Introduced Cognitive Biases and the Cumulative Number of Total Cognitive Biases Studied in the IS Context

As industry context is often relevant for practitioners and researchers alike, we also analyzed industry contexts' frequency. Of the 266 publications reviewed, 65% mentioned a specific industry, classified following the NAICS 2012 main categories. The focus of publications was heavily on Information (61), Retail Trade (48), Finance and Insurance (26), Health Care and Social Assistance (13), and Public Administration (8), but researchers also looked at Educational Services (7), Transportation and Warehousing (7), Rental and Leasing (2), Accommodation and Food Services (1), Arts, Entertainment, and Recreation (1).

Bias Category	**Business Models of ICT-Firms**	**Soft-ware Develo pment**	**Applica tion System s**	**IS Manage ment**	**IS Usage**	**Econo-mic impact of IS**	**Meta-research**	**∑**
Perception biases	3	10	2	14	79	1	2	111
Pattern recognition biases	0	2	0	1	23	0	0	26
Memory biases	0	0	0	1	0	0	0	1
Decision biases	0	4	1	8	33	0	0	46
Action orientated biases	0	0	0	8	11	0	0	19
Stability Bias	0	8	2	5	43	0	1	59
Social biases	0	5	0	10	35	0	0	50
Interest biases	0	0	0	1	1	0	0	2
∑ (research field)	3	29	5	48	226	1	3	∑ =314

Table 64. Updated Coverage of Research Fields and Categories (Fleischmann et al. 2014)

As the bias categories by Fleischmann et al. (2014) are based on the biases identified future additions to the field might lead to additions or even revisions of these groups. We propose an analysis based on two dimensions of the bias relevance to an IS.

Bias dimension	Bias Category	Business Models of ICT-Firms	Soft-ware Develop ment	Applicat ion Systems	IS Manage ment	IS Usage	Econo-mic impact of IS	Meta-research	∑ (biases)
Specificity	General	3	16	5	15	114		2	155
	Specific		8		24	74	1	1	108
∑ (research field)		3	29	5	48	226	1	3	∑ =314
Dynamics	event-related	3	17	4	28	140	1	2	195
	not event-rel.		7	1	11	48		1	68
∑ (research field)		3	29	5	48	226	1	3	∑ =314

Table 65. Coverage of Bias Dimensions Constructed Based on Posner and McLeod (1982)

Based on Posner and McLeod's (1982) dimensions of mental processing, we propose two dimensions:

- The **Dynamics** dimension illustrates if a mental process is enduring like a learning style or transient like an emotion. For the IS context, we propose the terms non-event related and event related. If one looks at the practical implications of biases for IS they either focus on a specific context, e.g., managers who make an unsuitable job decision (irrational escalation), or a general context, e.g., the misjudgment about someone's performance due to prior positive information (halo effect).
- The **Specificity** dimension describes how specific the context is. It makes the distinction between general mental processes like traits and specific processes like structures. Regarding the second dimension, biases are either not event-related, e.g., the general misinterpretation of information, when only text appears in decision support systems (base-rate fallacy), e.g., not related to a certain process step, or event-related, e.g., the influence of message-framing – a concrete event – on app user privacy setting (framing).

It is important to note that these dimensions are not considered strict but rather serve as an orientation (Posner and McLeod 1982). Nonetheless, these dimensions allow us a different perspective: Apparently researchers have been much more interested in general context and event-related biases so far.

The Research Designs for Studying Cognitive Biases in IS

Regarding the research design (see Table 65), the most frequently used method is a laboratory experiment, which is in line with the psychological literature, from which most bias concepts stem. The second most frequent design is analyzing secondary data, especially online reviews and Peer to Peer (P2P) lending sites – and survey research.

Cognitive Biases (We present biases with >10 publications due to page limitations.)	Laboratory experiment	Secondary data	Survey	Conceptual models	Case study	Field experiment	Interviews	Mixed methods	Mathematical model	Multimethod	∑ (bias)
Framing	20	10	5	6	7	3	1	4			56
Anchoring	8	3	1	5	1	3	3	1		1	26
Herding	1	16	3	1	1	1	1		1		25
Stereotype	7	2	4	3	1	1	2				20
Cognitive dissonance	5	4	5	2	1		2				19
Confirmation bias	7	4	1	1		2					15
Negativity bias	2	9	1					1			13
Overconfidence	5	1	5	1		1					13
Status quo bias	1		4	3	2			1			11
Other biases	26	10	12	6	6	5	1	2	0	0	68
∑ (research method)	82	59	41	28	19	16	10	9	1	1	∑ =266

Table 66. Methods Used to Explore Cognitive Biases Classified after Palvia et al. (2007)

In general, the research does not seem to follow systematic patterns where researchers assess one bias systematically, but biases appear across different contexts and researchers. For example, the availability bias was examined in 1997, 2002, and 2011, while 56 publications examined the framing bias between 2000 and 2020. At the same time, some biases only appear in one publication.

Interestingly, for those biased studies, often, the main research design seems to emerge (shaded in dark grey). In the following, we will briefly present three examples of biases with more than ten publications and their most frequent research design: Framing refers to the effect the framing of a message can have on an individuals' perception (Cheng and Wu

2010). IS research mostly studies framing in laboratory experiments. The same method is also most frequent for anchoring, as we introduced above (see Introduction). Herding refers to the decisions of others influencing an individual (Lee and Lee 2012). An abundance of available data allows the most frequent research via secondary data analysis.

Delving deeper into the most prevalent method of laboratory research it appears that student subjects are still prevalent – like IS research in general. To make the connectedness of the biases and their research design more tangible, we will take a closer look at the most frequently studied cognitive bias in IS research, framing with 56 publications. Of these, 23 experimented, but only three of these were field experiments. The majority (11) conducted laboratory experiments in the university context. Three of them performed additional experiments with practitioners and thereby showed the validity of their results (Compeau et al. 2012). Three publications used online subject pools like Amazon Mechanical Turk. Another two publications recruited participants through organizations – one being community centers and the other local practitioners. Four works were research in progress without detailed method descriptions. The research on cognitive biases shows a prevalence of student subjects, which fits with the overall research focus on the individual level. Compeau et al. (2012) showed that nearly 3/4 of the research in ISR and MIS Quarterly was with students.

The lack of a common measuring approach with established variables for exploring the same phenomenon hampers meta-research – in the following, we present the variables used to explore sunk cost as an example for the maximal variance. The five studies in IS research that primarily focuses on sunk cost all use different independent and dependent variables depending on their exact research focus (see Table 67). Not considering the publications that considered sunk in the context of several other biases (Goh and Bockstedt 2013; Polites and Karahanna 2012).

A more consistent approach to variable selection could hold potential for meta-research in the future. For example, this would allow subsequent tests across researchers and solidify findings on the use of specific variables. We hope that this research effort is a first step in that direction by creating the necessary awareness and transparency.

Studies on sunk cost in IS research	**Independent variable**	**Dependent variable**
Sunk cost and target achievement biases in subsequent IS-outsourcing decisions (Vetter et al. 2010)	Hard- and software, training (→ sunk cost), target-achievement	Adherence to the course of action, risk tolerance

Understanding runaway information technology projects: results from an international research (Keil et al. 1994)	Sunk cost and presence or absence of alternative	Willingness to pursue prior course of action
A cross-cultural study on escalation of commitment behavior in software projects (Keil et al. 2000)	Risk propensity, level of sunk cost (→ risk perception)	Willingness to continue a project
The effect of an initial budget and schedule goal on software project escalation (Lee et al. 2012)	Difficulty of a budget/schedule goal, specificity of a budget/schedule goal, project completion, commitment to a budget/schedule goal	Willingness to continue a troubled software project
Understanding the role of gender in bloggers' switching behavior (Zhang et al. 2009)	Satisfaction, attractive alternatives, sunk costs, gender	Intention to switch

Table 67. Example of Non-consistency of Variables Used to Explore Sunk Costs

21.5 A Framework for Studying Cognitive Biases in Information Systems Research

The first step to identify a framework for studying cognitive biases in IS research was to define the relevant selection criteria and select a framework accordingly: 1. the framework has to allow the sorting or ordering of biases in a meaningful way; 2. the classification must be simple and understandable; 3. the classification has to be MECE (i.e., mutually exclusive, collectively exhaustive); 4. the classification must result in an added value for further research, i.e., knowledge gain; 5. the framework needs to have proximity to cognitive biases, which means it should come from either research in psychology or IS. Following these criteria, we propose to adopt the taxonomy of mental operations developed by Posner and McLeod (1982). The research identified their approach as ideal for sorting out current and future end-user computing research (Bostrom et al. 1990) and was cited to explain the mismatch between cognitive style research and MIS and DSS. In the wider context of cognitive biases, it only appears regarding general bias processes that affect decision making (Housel and Rodgers 1994).

We now propose a framework based on the two dimensions Specificity and Dynamics adapted from Posner and McLeod (1982) as introduced above to sort cognitive biases. Such a framework is relevant to IS research because it opens a new perspective for further research along its two dimensions both for identifying gaps and more systematically assessing possible similarities. In the following, we sorted the cognitive biases identified in the literature search into the framework (see Figure 21.3). Regarding the publications that look at more than one bias (40 of the 266 publications), most of them either consider one primary bias or multiple ones that fall in the same group. Nonetheless, researchers must conduct further studies for those 24 publications that looked at multiple biases from different quadrants in-depth.

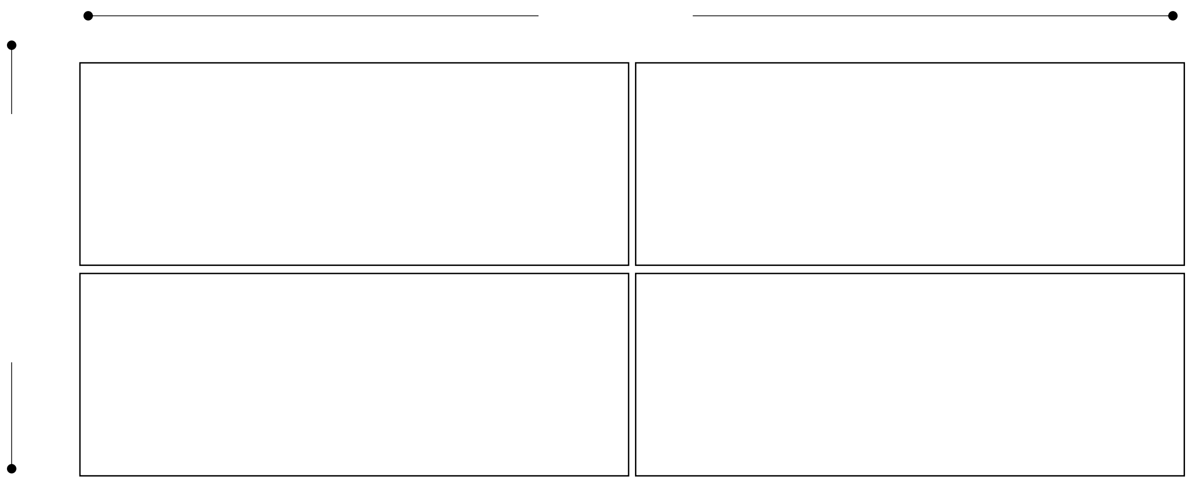

Figure 21.3. Cognitive Biases in IS Sorted into the Proposed Framework

Sorting the biases according to the two dimensions, Dynamics and Specificity, creates meaningful groups of biases that open up opportunities for further research:

- **Structure:** To differentiate between Structure and Strategy, Posner and McLeod (1982) build on a chess player's image whose strategy becomes an internalized structure with years of training. Following this notion, we placed biases under Structure that rely on an internal concept or experience, e.g., stereotypes that lead hosts not to accept Airbnb guests (Rhue and Daniel 2019).
- **Trait:** Posner and McLeod (1982) classify enduring influences on an individual's performance as traits. Quite common human traits are biases that cause individuals to falsely process statistical information, e.g., customers of online retailers showing a biased reaction to shipping costs (Frischmann et al. 2012).
- **Strategy:** A sequence of mental operations for a particular task represents a Strategy following Posner and McLeod (1982). Therefore, we group biases in this quadrant that lead to distorted information selection about certain topics, a group or the subject itself, e.g., when selecting only information that confirms an initial

statement or assumption and disregarding contradicting those presented by a search engine (Kayhan 2015).

- **State:** Posner and McLeod (1982) summarize more general influences that vary over time under State. External stimuli that affect the general population represent such influences. We, therefore, clustered biases in that quadrant that are triggered by some external stimulus, e.g., anchoring and adjustment when being provided a random number when guessing the size of a city (Tversky and Kahneman, 1974).

The framework, therefore, fulfills our initially identified acceptance criteria: It allows us to sort biases in a meaningful way. The classification is simple and understandable. The classification is MECE and results in an added value for further research due to the focus on bias characteristics in relation to IS. Finally, as it comes from psychology research, it has certain proximity to cognitive biases.

21.6 Discussion

Building on Fleischmann et al. (2014), we identified 51 cognitive biases in key IS research outlets. We analyzed the 266 publications that examined one or multiple cognitive biases regarding overall coverage of the research field and their research design. On this basis, we proposed a framework for sorting biases regarding their Dynamics and their Specificity in relation to the IS topic under question.

Practical and Theoretical Implications

Following the two initially introduced RQs and the RO, this paper contributes the following: First, we present the current research on cognitive biases in IS. Through the thorough literature search, we could provide an overview of the current research regarding biases and research contexts, i.e., industries. We were able to show that the cognitive bias perspective is gaining momentum in IS research and that cognitive bias theory has to be carefully combined with existing concepts (Kim and Kankanhalli 2009; Lee and Joshi 2017). An overview makes the wealth of knowledge on how to study cognitive biases in IS already assembled easily available. At the same time, this overview makes it easier to identify gaps and facilitates future research to build on related studies. It has broad theoretical implications as it allows a comparison of models or a combined approach of one established IS model like TAM one or several selected biases, as has been shown for specific biases already, e.g., Kim and Kankanhalli (2009). Our overview could be, for example, the starting point to identify relevant biases regarding technology acceptance or similar concepts. Second, an overview of the research designs used for studying cognitive biases in IS was derived. We assess the prominent research designs in the field. We show that distinct approaches for certain biases have evolved in the literature. It could serve as a starting point for assessments in the field. Moreover, analyzing the research methods helps standardization and facilitates meta-research. Third, we identified a framework for the cognitive biases relevant to IS research. The proposed framework is not simply a clustering of biases but offers fruitful avenues for further research. Studying biases based on their implication on the decision-making process indicated by the quadrant could help put biases in relation with one another or to test for multi-bias mitigation strategies

The overview of cognitive biases in IS, however, is also relevant to practitioners. Several of the identified biases have implications for the design of information systems and applications. This overview might be a starting point to explore relevant biases and adjust system design accordingly. The same applies to biases relevant in several other contexts, e.g., technology acceptance in the context of new system introduction. Here our overview of biases and methodological approaches to study them could help practitioners to test for relevant biases more rigorously and to develop countermeasures.

Limitations

Despite our utmost care in designing this research, there are some limitations regarding the scope and method of analysis as well as the proposed framework: Regarding the search scope there are two major limitations: The focus on major IS outlets neglects other IS-relevant publications in other outlets. We also focused on the development of biases identified by Fleischmann et al. (2014). Therefore, we did not search for all possible biases. Future research should add new search terms to reflect the newest findings from the psychology field. Regarding the analysis, we had to strike a balance between new developments and continuity. In the classification, the 2012 NAICS codes were therefore used – not the updated version from 2017. Regarding the proposed framework, one limitation is that Posner and McLeod (1982) did not develop their framework for this purpose. But as it fits the identified criteria, it is suggested as an adaptation for the context. We hope that further research will be able to improve the framework fit even further. One example is the challenge that cognitive biases from different parts of the framework can be complimentary and studied in the same publications. Due to the small number (24), we do not consider this effect to be significant but see room for further advances.

Further Research

We identify the following three calls for further research.

Broaden the scope of studied outlets and industries: This research effort focused on the core IS outlets. Future research should also look at key psychology outlets and related fields to identify new biases with possible explanatory power for phenomena researched in the IS context. Regarding the industry context, the research focus is clearly on Retail Trade and Information, Finance and Insurance, Healthcare and Social Assistance, and Public Administration. But even here, in some industries, only parts have been explored. For example, there is a lot on Healthcare, but future research should look at Social Assistance, as there are few known examples so far. Future research could also focus on sectors only scarcely researched, like Educational Services, Real Estate, and Rental and Leasing, Accommodation and Food Services, Arts, Entertainment, and Recreation, and Transportation Warehousing. Another possibility is the exploration of industries not yet researched - especially when in testing bias effects across industries.

Increase the number and depth of biases studied in IS: Along the biases studied, we have identified several biases that only one publication mentions, e.g., after-purchase rationalization, attribution error, and base-rate fallacy. Here, more evidence on their effects and the implications for IS would be helpful. On the other end of the spectrum, meta-research on the biases most frequently researched would help consolidate existing knowledge. Regarding Fleischmann et al.'s (2014) bias categories, the memory bias and the interest bias category still lack research efforts (see Table 64).

Extend existing knowledge: Regarding the examined research fields, the field business models of ICT-firms and the field economic impact of IS are those with the fewest publications and could be interesting for further research (see Table 64). Based on the analysis of the applied research method of the existing publications, a more diverse selection of research subjects would be helpful, e.g., favoring practitioners instead of students. Also, to reassess and expand existing knowledge, established IS models should be revisited and possibly appended by bias research. For example, models based on rational choice assumptions like TAM can be expanded and complemented in the light of cognitive bias research. This model expansion is already partly underway. Eleven publications in this analysis mention technology acceptance in the context of bias research, but so far, they assess specific biases and not the whole sum of biases possibly relevant. Researchers have also tested effective mitigation strategies for specific biases. They need to build standard approaches in research and practice to avoid the endowment effect's negative effects (Rafaeli and Raban 2003).

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22. Paper 16: To Resist, or not to Resist

Title	**To Resist, or not to Resist, that is the Question: On the Status Quo Bias of Public Sector Employees When Dealing with Technology**
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Status	Published
Full Citation	Oschinsky, F. M., Stelter, A., Kaping, C., Niehaves, B. (2020). To Resist, or not to Resist, that is the Question: On the Status Quo Bias of Public Sector Employees When Dealing with Technology. In: Radtke, J., Klesel, M., Niehaves, B. (Ed.), New Perspectives on Digitalization: Local Issues and Global Impact. Proceedings on Digitalization at the Institute for Advanced Study of the University of Siegen, Siegen, Germany.

Table 68. Fact Sheet Publication

To Resist, or not to Resist, that is the Question: On the Status Quo Bias of Public Sector Employees When Dealing with Technology

Abstract. *Technological innovations and new ways of working became the daily routine in German administrations at the municipal, the state and the federal level. Technology use among their employees is an essential aspect of mastering the digitaltransformation in the public sector. The employees' status quo bias, however, profoundly influences their perception and behaviour in technology-related settings.The critical role of cognitive biases is recognised in many disciplines, including sociology, psychology, and marketing. Against this background, the objective of ourwork is to expand existing acceptance models with the aspect of bounded rationalityand apply them to employees in the public sector. This allows us to gain theoreticalinsights concerning the resistance of using technology in this domain. As technologybecomes ever more ubiquitous in times of the coronavirus pandemic, and as the performance and well-being of public sector employees is more and more importantto the administrative board members, including the status quo bias perspective whendealing with technology use presents increasing theoretical and practical importance.*

Keywords: *Technology Acceptance, Status Quo Bias, Bounded Rationality, Public Administration, Cognition.*

22.1 Introduction

Demographic changes pressingly affect the public sector (Müller et al., 2011). In order to both fulfil legal requirements and growing expectations of citizens, to provide appropriate services and to have a productive and satisfied staff, public administrations are trying to use the advantages of digitization to make their routines more effective and efficient (Liu & Yuan, 2015; Räckers et al., 2017). Nevertheless, the implementation and the use of technologies need comprehensive change management on both a technical and organizational level (Ben Rehouma, 2018).

The employees' acceptance and motivation to use technologies is crucial in this regard. Their soft skills such as openness and willingness to learn become increasingly relevant for the success of the digital transformation in the public sector (Ogonek et al., 2016). However, many employees are skeptical or afraid to lose control and fear to be replaced due to not mastering the new tools. Their reluctance leads to the fact that the potential of available technologies is not fully used, which in turn results in many disadvantages such as time or financial costs (Kim & Kankanhalli, 2009). Facing limited resources, it is all the more necessary to understand how to reduce the staff's resistance and how to promote the skills needed for dealing with the ongoing changes.

Technology acceptance and the intention to use information technology (IT) is at the core of Information Systems (IS) research (Venkatesh & Davis, 2000). Although there are many theories that aim to understand these concepts (e.g., TAM), the Status Quo Bias (SQB) perspective by Kim and Kankanhalli (2009) offers fruitful added value, because it integrates existing literature and well-known concepts from the bounded rationality paradigm in order to explain user resistance prior to the implementation of a technology. The traditional models did great effort to show which factors influence acceptance and use but fail to account for the cognitive biases of the users. We want to find out which variables are responsible for the frequent technology resistance of employees within the public sector and to provide necessary skills to master the digital transformation in this domain. Against this background, we want to answer the following research questions (RQs):

RQ1: *Which variables influence user resistance towards technologies in the public sector?*

RQ2: *How can we reduce the user resistance towards technologies of public sector employees?*

We aim for obtaining a more holistic view of technology acceptance and use behaviour of public administration staff by reflecting on the cognitive biases they face. The goal of our work is to advance theory and to derive useful recommendations for action. The structure of this paper is as follows: Section 2 provides the theoretical background. In Section 3, we establish our hypotheses, naming the considered variables and boundary conditions. Section 4 presents the research design and methodology. Finally, section 5 contains a conclusion of our work, also pointing on promising avenues for future research.

22.2 Theoretical Background

Previous literature indicated different models for describing technology acceptance, from which one is used predominantly: the Technology Acceptance Model (TAM) (Davis, 1989). In contrast to this model supposing the rational decision-making of the user, the SQB perspective describes people's tendency to maintain original habits instead of accepting circumstances by accounting for their cognitive biases (Samuelson & Zeckhauser, 1988).

Technology Acceptance Model

To explain the decision-making behaviour of public administration staff when using IT, we base our considerations on fundamental technology acceptance research. Davis' pivotal work in the area of technology acceptance derived two significant antecedent of technology use: perceived usefulness and perceived ease of use (Davis, 1989). *Perceived usefulness* is "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320). A technology of high perceived usefulness has an increased use-performance- relationship. *Perceived ease of use*, in contrast, is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320). Davis' approach aims to provide a general explanation of the determinants of technology acceptance that can explain the users' behaviour across a wide range of end-user technologies and user populations, while being parsimonious and theoretically justified (Davis et al., 1989). Moreover, it seeks to provide a basis for understanding the influence of external factors on internal beliefs, attitudes and intentions. By doing this, the model is useful for predicting, as well as for explaining why a particular technology might be unacceptable to then conclude appropriate corrective action.

Status Quo Bias Perspective

Cognitive biases happen when "human cognition reliably produces representations that are systematically distorted compared to some aspect of [...] reality" (Haselton et al., 2015, p. 968). People are unconsciously influenced in their decision-making and judgement. In this respect, the „status quo bias [SQB] theory aims to explain people's preference for maintaining their current status or situation" (Kim & Kankanhalli, 2009, p. 569). Based on this approach, we seek to explain the resistance of public administration staff.

Samuelson and Zeckhauser (1988) pioneered todescribe why people tend to stick to present conditions instead of adapting to new circumstances. Their SQB perspective is divided into three categories: rational decision making, cognitive misperceptions and psychological commitment. As technology users often resist, even if technology use offers rational advantages, biases are present. Consequently, it is considered beneficial to adapt the original approach from psychology to the IS domain in general and to the public administration staff in specific. At the core of our investigation are the antecedents of user resistance, which is described "as opposition ofa user to change associated with a new IS implementation" (Kim & Kankanhalli, 2009, p. 568).

Rational decision-making deals with the cost and benefit comparison of change (i.e., transition costs and uncertainty costs). Transition costs happen by adapting a new system and can occur during or after a change to a new system (Kim & Kankanhalli, 2009). Uncertainty costs occur by switching to a new system and cause that users feel unsure or anxious about the upcoming results of that action. They automatically remember similar past situations, and in most cases, make the same decisions as before, because they do not want do take any risks (Kim & Kankanhalli, 2009).

Cognitive misperception describes the perceived loss of change. One phenomena of this category is loss aversion, which results in the fact that people assess even small changes from a current situation as higher than they are (Kim & Kankanhalli, 2009, p. 569), because they tend to weigh losses more heavily than gains (Kahneman & Tversky, 1979). Another type of this category is the anchoring effect, which refers to the existing propensities and expectations of a person, which serve as the basis for an initial value to evaluate the change in the context of the initial state (Tversky & Kahneman, 1974).

The third category is called *psychological commitment*, which consists of sunk costs, social norms and efforts to feel in control (Samuelson & Zeckhauser, 1988). Sunk costs refer to the value of earlier commitments, which lead to a reluctance to switch to a new alternative, such as skills that are related to the previous way of working and are lost when switching to a new system. Social norms refer to the prevailing norms towards changing the way of work, which can influence the SQB of an individual, such as a colleague's opinion that may influence the will to accept or resist a system. Efforts to feel in control arise from the desire to control or determine situations. This can lead to a distortion in the status quo of the person, because she or he does not want to lose control over a known system or working method (Kim & Kankanhalli, 2009). In general, psychological commitments deal with the users worry about wrong decisions they cannot reverse (Lee & Joshi, 2017).

Having presented the three categories of the SQB perspective, it becomes clear that Kim and Kankanhalli developed a framework that includes the theoretical foundation of the original technology acceptance literature and additional concepts from the bounded rationality paradigm in order to explain user resistance. The authors aimed at understanding how the implementation of technologies is assessed and acknowledged that beliefs generate a favourable or unfavourable attitude towards behaviour (Kim & Kankanhalli, 2009).

22.3 **Research Model**

Now, the main categories of the SQB are closely examined and explained in the context of user resistance to technologies among public sector employees. The theoretically developed model is based on the SQB perspectives by Kim and Kankanhalli (2009) and was adapted after conducting qualitative interviews with five public sector employees to refine the framework. Now, it includes four categories.

The first category is *rational decision-making* and contains four variables: uncertainty costs, transition costs, perceived value and switching benefits. In addition to uncertainty costs and transition costs, we extended the model by two further variables: Perceived value indicates whether the usefulness of the new system is considered high or low. Switching benefits name the perceived resource plus (e.g., time, money) of switching to a new system.

The second category is about *cognitive misperception*. It refers to perceived losses of a change and consists of loss aversion and the anchoring effect. Loss aversion influences the perceived value of using a new system, because it acknowledges that people weigh losses greater than gains (Tversky & Kahneman, 1974). Next, the anchoring effect points at the expectation of using a new system when considering past experiences and thresholds.

The third category, *psychological commitment*, is built of sunk costs, efforts to feel in control and social norms. We deviate from Kim and Kankanhalli by moving social norms in another category to measure it more appropriately within context of the public sector.

The fourth category is about *organizational and social influences* and contains four variables. As mentioned above, we placed the variable social norms in this category and divided it into two separate parts: colleague opinion and management as role model. The aim is to account for hierarchy in the public sector and to separately measure the influence of the opinion of direct colleagues as well as of higher-ranking employees such as managers. We also added two other variables this category: organizational support and perceived value for others. The first one is about the organization helping in times of change. The second one refers to the estimated benefit for others, in our case, for citizens.

We also consider several control variables, i.e., self-efficiency, habit of using technologies at work, personnel responsibility, ranking within the organization, duration of work and other demographic data (e.g., age and gender). These variables may influence user resistance in a way that people might have a greater technical affinity and are more open minded for the new. However, correlations could also go in the other direction and make employees more afraid than necessary, when it comes to digitization and technology use, due to general skepticism.

22.4 Hypotheses Development

Based on the theoretical foundation, we derive twelve hypotheses. Pointing at the first category ('Organizational and social influence'), colleague opinion is defined as the perception that colleagues support the changes associated with a new IS implementation. We suggest that a positive opinion towards using a technology by colleagues on the same organizational level reduces user resistance, because employees directly see improvement and chances.

***H1:** Positive colleague opinion has a negative effect on user resistance.*

Organizational support for change often appears in the form of training and resources. This can reduce the perceived difficulty of adapting to new systems. Consequently, the higher the organizational support for change, the lower the transitions costs in terms of time and effort to learn the new way of working. Therefore, organizational support for change is expected to reduce user resistance.

***H2**: Organizational support has a negative effect on user resistance.*

Higher ranking employees, such as the mayor herself or himself, can act as role model and thereby influence the staff. For this reason, there is a high probability that the resistance to a new system decreases if the top management uses it itself.

***H3**: Management acting as role model has a negative effect on user resistance.*

The perceived value for others (e.g., citizens) reflects the result of one's work. On this basis, it can be suggested that the resistance to use a new technology decreases when the employee notices the positive effects, this change has on others. If, for example, the citizens' satisfaction with public sector services increases after forms of eGovernment have been introduced, the staff directly sees the benefit and is probably more inclined to embrace eGovernment technology than before.

***H4**: A high perceived value for others has a negative effect on user resistance.*

Considering the second category ('Psychological commitment'), it is important to both ensure that employees remain in control of their own actions and to make the investments they already made (i.e., their sunk costs) as appropriate as possible, among other things, by keeping new investments to a minimum. This is achieved, for example, by making technology very easy to use to make employees quickly feel able to use and understand it. Furthermore, the learning effort and the hurdle to further training remain low.

H5*: A low effort to feel in control has a negativeeffect on user resistance.*

H6*: A low perception of sunk costs has a negative effect on user resistance.*

Keeping in mind the third category ('Cognitive misperception'), it is worth considering that people always remember past situations and base their current actions on them. Thus, it is important to set the anchors present in the anchoring effect are not too negative for the employees. For example, it is useful to remind them of training courses that they have enjoyed. It is also possible to familiarize them with systems that are very easy to use and then remind them that they have already mastered the introduction of a technology very well. This also reduces the fear of making mistakes and losing a lot by introducing a technology, i.e., their loss aversion.

H7*: A low loss aversion has a negative effect onuser resistance.*

H8*: Setting pleasant anchors has a negativeeffect on user resistance.*

Finally, addressing the last category ('Rational decision making'), switching benefits refer to the perceived value of changing to a new system. Noticing one's higher performance, among other beneficial outcomes, could increase the perceived value of a change and decrease the resistance to using a new system.

H9*: Switching benefits have a negative effect on user resistance.*

As mentioned before, perceived value describes whether the perceived benefit of a new system is higher than its costs. If the perceived value of a new system is low, it is more likely that resistance to that system occur. The fact that the benefit of using a system must be higher than the cost, stresses the need to find ways to increase the overall perceived value of technological change. This also means that the transition and uncertainty costs that changes entail are kept as low as possible.

H10*: Perceived value has a negative effect on user resistance.*

H11*: Low uncertainty costs have a negative effect on user resistance.*

H12*: Low transitions costs have a negative effect on user resistance.*

22.5 Research Design, Methodology, and Outlook

In cooperation with a small municipality in Germany, we plan to conduct a three-stage mixed method study. In this study, we seek to combine the traditional acceptance model with the SQB perspective. To this day, we already conducted a qualitative pre-study with a focus group to derive a scenario of a typical technology implementation and to identify missing independent variables in our theoretical framework. The implementation of a document management system was selected as a typical case. Moreover, we ran a pilot survey with a small set of employees (n=5) to further revise the questionnaire. However, it should not remain unmentioned that our work is not yet complete. In the next phase, the survey will be sent to all employees of our partner municipality in an online format. The following step will be comprehensive data cleansing and analysis. Based on this, we hope to identify significant correlation and cause-effect relationships and to better understand the resistance of new technologies in the workplace by public administrations staff. The goal is to further develop our theoretical model. This potentially leads to a more condensed model and motivates future investigations of the identified factors. The overall aim is to contribute a theoretical added value on how to integrate different models stemming from the rational choice or bounded rationality paradigm as well as a practical surplus by providing recommendations for action.

In sum, our study is intended to provide a guide how public sector employees can adapt to changes caused by the digital transformation. In this context, we aim to derive promising strategies on how to counteract their skepticism and anxiety when dealing with novel processes and technologies. The results can easily be scaled to transfer knowledge to other municipalities and organizations.

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23. Paper 17: Cognitive Biases in the Digital Age

Title	**Cognitive Biases in the Digital Age – How Resolving the Status Quo Bias Enables Public-sector Employees to Overcome restraint**
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Table 69. Fact Sheet Publication

Cognitive biases in the digital age – How resolving the status quo bias enables public-sector employees to overcome restraint

Abstract. *The use of technology has increased significantly in public administrations in recent decades and has become the norm rather than the exception. As a result, the acceptance of or resistance to technology by employees plays a crucial role in local digital developments. Few existing theories address the reliable determinants of the use of technology and consider the cognitive biases of the users. Our study fills this gap by considering the status-quo-bias perspective. We conduct a mixed-methods study of three German municipalities and develop an integrated theoretical model of the employees' resistance to technology. Our results indicate that resistance to technology is best explained by perceived value, sunk costs, switching benefits, and value for citizens. Based on our findings, we derive preliminary recommendations for action and discuss valuable directions for future scientific work. Our study contributes to the understanding of the resistance to technology in public administrations and opens the door to a vivid discourse on the use of technology in multilevel organizations.*

Keywords: *Acceptance of technology, Resistance to technology, Cognitive bias, Status-quo-bias perspective, Public administration, Bounded rationality.*

23.1 Introduction

Public organizations worldwide are implementing digital technologies with the aim of making processes more efficient and effective (Janowski, 2015; Layne & Lee, 2001; Lindgren, Madsen, Hofmann, & Melin, 2019; Liu & Yuan, 2015). Due in large part to the marked increase in the application of information systems since the beginning of the global coronavirus pandemic, the extensive use of technology has become the norm rather than the exception (Virkar, Edelmann, Hynek, Parycek, & Zenk, 2019). In this context, public sector employees' skills as well as their acceptance of or resistance to technology have become increasingly relevant. Considering the wide and diverse array of public sector technologies, this specifically applies to technologies that are relevant to a wide range of employees, and whose purpose is to improve the overall efficiency of public services (e.g., document management systems). The ongoing digital transformation, however, poses extreme challenges to those in charge, especially in public institutions that have had to be quickly restructured due to COVID-19. On the one hand, implementing information technologies requires comprehensive change management at both the technical and the organizational level (Mergel, Edelmann, & Haug, 2019). On the other hand, the use of these technologies depends on the extent to which users accept or resist them.

Some employees might be skeptical of these changes, worried about losing individual autonomy, and fear being replaced if they do not master the new tools. Their reluctance to adapt leaves the potential of available technologies underutilized, which in turn results in many disadvantages, including time loss or financial costs (Kim & Kankanhalli, 2009). Understanding the drivers and barriers of the resistance to technology in public administrations will help derive recommendations for action in this domain and open the door to a vivid discourse on the use of technology in multilevel organizations.

The acceptance of technology and the intention to use information and communications technology (IT) lie at the core of research on in- formation systems (IS) (Venkatesh & Davis, 2000). Although many theories have sought to provide a better understanding of these concepts (e.g., the Technology Acceptance Model (TAM)), the status-quo-bias (SQB) perspective proposed by Kim and Kankanhalli (2009) offers fruitful added value to the discussion by integrating existing literature and well-known concepts from the bounded rationality paradigm in order to explain user resistance. Thus far and to the best of our knowledge, however, hardly any existing approaches have placed adequate focus on the employees of public administrations. Traditional models have revealed which factors influence the acceptance of technology but have failed to account for the cognitive biases of the users (Fleischmann, Amirpur, Benlian, & Hess, 2014). Our aim is thus to uncover which variables are responsible for the frequent resistance to technology by employees within the public sector. We seek to answer the following research question:

> ***RQ:*** *Is the resistance to technology among public sector employees affected by a status quo bias – and if so, how?*

To answer our RQ, we worked with three municipalities in Germany and conducted a multi- stage mixed-methods study (n = 161) comprising a small town, a medium-sized town, and a large city. We generated a technology-related scenario via a search of the literature and a qualitative pre-study that was used to develop and test a quantitative questionnaire. Subsequently, the quantitative online questionnaire was sent to the employees, resulting in 161 responses.

Our approach can add extra value to current work because it takes a holistic view of the cognitive processes involved in technology use and by considering findings from research on IS and from psychology. In addition, it accounts for the difference between the private sector, in which business which is owned, managed, and controlled by individuals, and the public sector, in which institutions are owned, managed, and controlled by government.

The main differences of both sectors are their objectives (i.e., earning profit vs. providing service), their core areas of expertise (e.g., manufacturing vs. education), and their revenues (e.g., shares vs. taxes). Also, the working conditions differ (e.g., superior salary and incentives in a competitive environment vs. retirement benefits and allowances in a secure environment) as well as how promotion occurs (merit vs. seniority). All these aspects indicate a sector's organizational and personnel peculiarity what led us to believe that the sector's employees might react to technological changes in quite specific ways. Nevertheless, we bear in mind that the areas of expertise of both sectors can be very broad. We aim to gain a more comprehensive view of the technology use behavior of public-administration employees by reflecting on the cognitive biases they face. Being among the first studies that no longer see the users as a black box when interacting with a technology and a task helps derive promising implications for theory (e.g., insights on the SQB perspective) and practice (e.g., development of digitization strategies). In this context, this study can support change processes, which aim at using the digital transformation in a profitable way for the institution itself and in a beneficial manner for the employees concerned. Therefore, our article's overall objective is to present a future-oriented approach on the acceptance of or resistance to technology in public administrations. We put the specificity of providing public services in the core of our investigation and focus on the government nature of the sector. The structure of the paper is as follows: Section 2 provides the theoretical background. In Section 3, we establish a theoretical model and derive our hypotheses while naming the considered variables and boundary conditions. In Section 4, we present our research design and methodology, followed in Section 5 by a data analysis and the presentation our results. In section 6, we discuss our findings and reveal the limits of our work. Finally, Section 7 concludes.

23.2 Theoretical Background

The success of the implantation of an information system depends on the extent to which its potential users accept technology (Al-Tarawneh, 2019). The IS literature thus contains a variety of theories, models, and practical approaches for explaining the acceptance of technology. Al-Tarawneh (2019) revealed the most-relevant and widely accepted theories and models used in investigating the acceptance of technology (c.f. Table A1 in the Appendix), namely the Theory of Reasoned Action (TRA), the Theory of Planned Behavior (TPB), the Decomposed Theory of Planned Behavior (DTPB), the Technology Acceptance

Model (TAM), the Diffusion of Innovation Theory (DOI), the Social Cognitive Theory (SCT), the Motivational Model (MM), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Extended Unified Theory of Acceptance and Use of Technology (UTAUT2). According to Al-Tarawneh (2019), TAM (Davis, 1989) is used predominantly.

Despite the multitude of investigations, it is not clear why the huge potential of technology use is not yet exhausted. We close a gap in existing literature by taking into account the fact that the choice to use these technologies can be subject to limited rationality on the part of users in terms of their decisions and behavior, as manifold research from the field of psychology has revealed (Battaglio, Belardinelli, Belle, & Cantarelli, 2019; Kahneman & Tversky, 1984; Levy, 2002; Martin, 2017; Morvan, Jenkins, & W., 2017; Samuelson & Zeckhauser, 1988; Tversky & Kahneman, 1991; Tversky, Sattath, & Slovic, 1988). These studies form the basis for our subsequent work on the resistance to technology by public sector employees. They shed light on the gap between how people should theoretically behave from a rational point of view and how they behave and decide. Now, the underlying approaches are described in greater detail. The overview will demonstrate that resistance and acceptance are well-defined constructs as well as how rationality and irrationality are covered by existing models.

The acceptance of and resistance to technology

To explain the decision-making behavior of public- administration employees when using IT, we base our considerations on fundamental research on the acceptance of technology. Davis's (1989) pivotal work on the acceptance of technology derived two significant antecedents to the use of technology: perceived useful- ness and perceived ease of use. Perceived usefulness is "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320). A technology with high perceived usefulness has an increased use-performance relation- ship. Perceived ease of use, in contrast, is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320).

TAM aims to provide a general explanation of the determinants of the acceptance of technology and attempts to achieve this goal by identifying a small number of basic variables that address the cognitive and affective determinants of acceptance (Davis, Bagozzi, & Warshaw, 1989). Another key goal is to provide a basis for understanding the in- fluence of external factors on internal beliefs, attitudes, and intentions. In so doing, it is useful to determine appropriate corrective actions when predicting or explaining why a particular technology might be deemed unacceptable. The model highlights the crucial determinants of the acceptance of technology across a wide range of end-user technologies and user populations while being economical, parsimonious, and theoretically justified. Thereby, it also allows conclusions to be drawn about non-acceptance.

Although TAM is quite successful and reliable, it does not yet sufficiently explain user resistance as there is a difference between non- acceptance and resistance to technology. Non-acceptance of technology means that a person does not use a certain system to complete a task (Burton-Jones & Gallivan, 2007; Burton-Jones & Straub, 2006; Lapointe & Rivard, 2007). Resistance to technology, in turn, refers to a behavioral reaction of the user in which she or he expresses a reluctance to use the system (Coetsee, 2014; Lapointe & Rivard, 2005; Meissonier & Houze, 2010; Waddell & Sohal, 1998). Resistance is a behavioral or emotional response to the pressure to change the status quo (Koo, Chung, & Ham, 2017), which is perceived as a threat (Koo et al., 2017; Ram, 1987). The antecedents of user resistance lie at the core of our investigation. According to Kim and Kankanhalli, user resistance is described “as [the] opposition of a user to change associated with a new IS implementation” (Kim & Kankanhalli, 2009, p. 568). As public-sector employees often resist change, technology offers rational and objective advantages, biases are clearly present. Consequently, adapting the original approach from the realm of psychology to the IS domain has benefits in general and for the public-administration employees specifically.

Status quo bias

Cognitive biases can be defined as systematic errors in human decision-making (Wilkinson & Klaes, 2018) and “tend to be emotion-, content-, and task-specific” (Craske & Pontillo, 2001, p. 58). These biases illustrate “cases in which human cognition reliably produces representations that are systematically distorted compared to some aspect of objective reality” (Haselton, Nettle, & Murray, 2015, p. 968). People are unconsciously influenced in their decision-making and judgement. In this respect, the “status quo bias [SQB] theory aims to explain people’s preference for maintaining their current status or situation” (Kim & Kankanhalli, 2009, p. 569). Although psychological evidence found occasions where ‘irrational’ reasoning can be beneficial, e.g., by offering simple heuristics, we concentrate on the challenges arising from it. In this regard, the SQB is a widely recognized approach (Asamoah, Annan, Rockson, & Baah, 2019; Chernev, Bockenholt, & Goodman, 2015; Geng, 2016; Gerasimou, 2016; Kambi, 2014; Masatlioglu & Ok, 2014). It illustrates the tendency of a decision-maker to hold on to an existing situation or decision (Wu, 2016). Every decision that a person makes has a status-quo option that acts as an anchor for other alternatives and can influence the final decision. Based on this approach, we seek to study the technology-related resistance of public-administration employees. This line of research is promising because it follows individuals' tendency to maintain habits instead of adapting to new circumstances. Samuelson and Zeckhauser (1988) were among the first to describe why people tend to stick to present conditions. Their work differentiates among three categories: rational decision-making, cognitive misperception, and psychological commitment.

Rational decision-making

Human decision-making involves both costs and benefits, with value being conceptualized as a perceived benefit relative to a perceived cost (Kahneman & Tversky, 1979). In settings with low benefits, users are likely to resist change (Samuelson & Zeckhauser, 1988). On the contrary, if benefits are high, users tend not to switch to a new option (Sirdeshmukh, Singh, & Sabol, 2002). In addition to the overall value of a transformation, the replacement of old habits itself can increase benefits (Polites & Karahanna, 2012) by enhancing the effectiveness, speed, productivity, or quality of fulfilling tasks. Switching benefits thus involves the perceived gain of switching to a new information system. In comparison, so-called transition costs can occur during or after implementing a new information system (Kim & Kankanhalli, 2009). For example, if a person purchases a new good that uses a specific information system, she or her will tend to buy a compatible good when purchasing a new version to avoid the costs of complete replacement (Samuelson & Zeckhauser, 1988). Furthermore, uncertainty costs refer to the limited knowledge people have about new information systems due to their lack of experience (Polites & Karahanna, 2012). People often feel unsure or anxious and thus avoid risks. As people automatically remember similar past situations, in most cases, they tend to make similar decisions (Kim & Kankanhalli, 2009). Uncertainty costs can be an important peculiarity of the public sector because its working conditions can differ to great length from the private sector (e.g., being in a competitive vs. in a secure environment). This points at the employees' ability to deal with the world's volatility, complexity, and ambiguity. Because it became more challenging to anticipate the future, risk-avoidant (biased) decision-making can be one of the cognitive mechanisms that can apply more to the public than to the private domain (Buurman, Delfgaauw, Dur, & van den Bossche, 2012; Pfeifer, 2011). The category includes the following hypotheses:

H1: *Switching benefits have a negative relation to user resistance.*

H2: *Transition costs have a negative relation to user resistance.*

H3: *Uncertainty costs have a negative relation to user resistance.*

H4: *Perceived value has a negative relation to user resistance.*

Cognitive misperception

Cognitive misperception describes perceived loss, or more specifically, loss aversion, which is defined as "a psychological principle" (Kim & Kankanhalli, 2009, p. 569) by which losses are weighed more heavily than gains (Kahneman & Tversky, 1979). For example, if the introduction of a new information system is associated with the abolition of the existing information system, this introduction implies losing previous knowledge because new skills are required. The former learning phase is subjectively perceived as being more valuable than new experiences (Rey-Moreno & Medina-Molina, 2017) because time and effort were invested and (Novemsky & Kahneman, 2005) people might not be willing to spend these resources again. Lee and Joshi (2017) added the anchoring effect to this category. The anchoring effect refers to existing propensities and expected thresholds (Tversky & Kahneman, 1974). For example, a user's efforts spent during a past learning phase can anchor the assessment of the learning needed for a new information system (Lee & Joshi, 2017). We state the following hypotheses:

H5: *Loss aversion has a negative relation to user resistance.*

H6: *Pleasant anchors have a negative relation to user resistance.*

Psychological commitment

The third category, psychological commitment, consists of the concepts of so-called sunk costs, the effort needed to feel in control, and social norms (Samuelson & Zeckhauser, 1988). Psychological commitment addresses the fact that people often worry about making a wrong decision that cannot be reversed (Lee & Joshi, 2017). First, sunk costs have to do with the value of prior commitments and can cause a reluctance to switch to a new alternative. Sunk costs can lead to the tendency to continue an action after an irrecoverable investment has already been made. Although they should not play a role from a rational point of view, sunk costs can lead to a justification of past commitments (Rey-Moreno & Medina-Molina, 2017). Second, the effort needed to feel in control arises from the human desire to regulate one's environment. People want to be able to achieve outcomes and to select and inhibit certain thoughts or actions in favor of others. In technology-related settings, users tend to avoid losing an overview of a situation, techno- logical device, or process (Kim & Kankanhalli, 2009). The fear of losing control can cause resistance to technology because the users aim to decide how much to invest in a goal in a self-determined way. Third, social norms refer to prevailing habits among colleagues that can reduce uncertainty as well as transition costs (Kim & Kankanhalli, 2009). In this context, organizational support for change plays a significant part (Kim & Kankanhalli, 2009), also pointing at the need to involve managers as a role models (Lee & Joshi, 2017). Organizational support is the "perceived facilitation provided by the organization to make [a] user's adaption to new IS-related change easier" (Kim & Kankanhalli, 2009, p. 573). By offering incentives or training, organizational support can influence the cognitive biases of users who would otherwise choose to avoid the new technology (Hirschheim & Newman, 1988). The category encompasses the following hypotheses:

H7: *Efforts to feel in control have a negative relation to user resistance.*

H8: *Sunk costs have a negative relation to user resistance.*

Based on qualitative evidence gained in our mixed-methods study (c.f. Chapter 3), we deviate from Kim and Kankanhalli (2009) and further expect organizational and social influences:

H9: *Organizational support has a negative relation to user resistance.*

H10: *Supportive management has a negative relation to user resistance.*

H11: *Supportive colleague opinions have a negative relation to user resistance.*

H12: *Value for others has a negative relation to user resistance.*

23.3 Toward an Integrated Theoretical Model

Having presented the three original categories of the SQB perspective by Kim and Kankanhalli (2009), we can see that the authors developed a theoretical model that included both the literature on the acceptance of technology and additional concepts from the bounded- rationality paradigm (Simon, 1990) to explain user resistance. They provided a reasoning for how the implementation of new technologies is assessed, introduced promising control variables, and acknowledged that beliefs generate an attitude toward behavior (Kim & Kankanhalli, 2009).

Nevertheless, the existing model could not be transferred one-to-one to the public sector. Against this background, the SQB categories are next examined and slightly adapted to the context of resistance to technology among public-sector employees. After providing a qualitative assessment, our approach includes four categories. The first category is rational decision-making and contains four variables: uncertainty costs, transition costs, perceived value, and switching benefits. The second category involves cognitive misperception and consists of loss aversion and the anchoring effect. The third category is psychological commitment and is composed of sunk costs, efforts to feel in control, and social norms. We deviate from Kim and Kankanhalli (2009) by moving social norms to a fourth category (organizational and social influences) to measure it more appropriately within the context of the public sector. Colleagues' opinions and management as a role model both point toward social norms. The aim of differentiating between hierarchy levels is to account for status and to separately measure the influence of the opinion of similarly ranking colleagues as well as of higher-ranking officials. We moved organizational support to this cate- gory. In addition, we added the perceived value for others, which refers to the estimated benefit for external actors – in our case, for citizens. We also consider several control variables to examine possible alternatives that could explain resistance, such as experience using technology during work, personnel responsibility, ranking within the organization, work experience, and demographic data (e.g., age and gender). The integrative model is shown in Figure 23.1. It encompasses twelve hypotheses (see Chapter 2.2.1, 2.2.2 and 2.2.3).

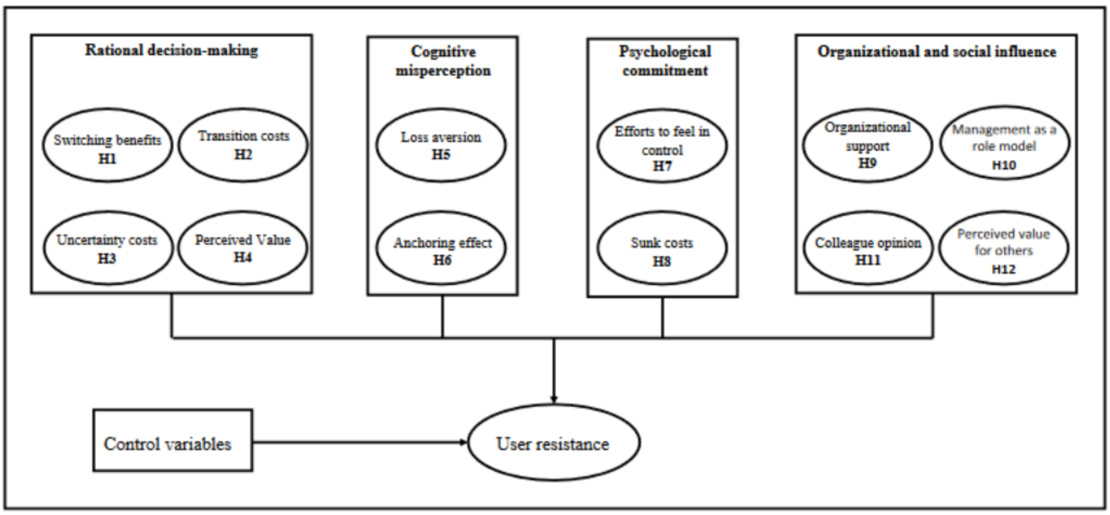

Figure 23.1. Theoretical Model

23.4 Research Design and Methodology

We collaborated with three municipalities in Germany and applied quota sampling to account for regional distribution, socioeconomic structure, and size while bearing in mind that our findings might not be representative. However, this method resulted in a satisfying response rate and enabled us to collect meaningful information. The sample is based on the common classification of cities and municipalities used in statistical evaluations and comprises a small town, a medium-sized town, and a large city (in the review, we call them Municipality A, Municipality B, and Municipality C, respectively).

Sample characteristics		**Data**	
Gender	Female	71	(44.1%)
	Male	54	(33.5%)
	Not specified	36	(22.4%)
Job Position	General administration or municipal utilities (commercial area)	112	(69.6%)
	Public utilities (technical area, including building yard)	15	(9.3%)
	Janitor, cleaner, pool attendant	2	(1.2%)
	Others	32	(19.9%)
Job experience (in years)	0–3	33	(20.5%)
	4–6	17	(10.6%)
	7–9	12	(7.5%)
	10–11	14	(8.7%)
	> 11	85	(52.8%)
Digital-specialist-processes experience	Yes	132	(82.0%)
	No	29	(18.0%)
Document-management experience	Yes	39	(24.2%)
	No	122	(75.8%)
Personal responsibility	Yes	38	(23.6%)
	No	114	(70.8%)
	Not specified	9	(5.6%)
Total		161	(100%)

Table 70. Overview of Main Study Respondents

Municipality A was selected based on an existing collaboration in a third-party funded project. Municipality B and C were selected out of 396 municipalities in our nationwide database who we asked for support. They were approached digitally to promote data collection even in times of the global pandemic. Table 70 shows the sample characteristics of the main study.

Municipality A has about 20,000 citizens, is divided into 23 districts, and employs 175 administrative officials. Municipality B has about 19,000 citizens in 22 districts and 92 administrative employees. Municipality C has about 102,770 citizens in 23 districts with 931 employees. Although Municipality A and B hardly differ in terms of population, they have a distinct number of employees due to budgetary reasons. Taking these municipalities as use cases, we conducted a multi- stage mixed-methods study that consisted of a qualitative pre-study, a test run, and a quantitative main study. Table 71 illustrates the design.

Study	**pre-study**	**test run**	**main study**
Data acquisition	semi-structured interview with two focus groups (n=9)	pilot survey (n=5)	questionnaire, online (n=161)
		pilot survey (n=28)	
Method	qualitative	qualitative / quantitative	quantitative
Goal	refine the questions; develop a technology-related scenario	check the intelligibility of our questions; identify missing variables	identify significant correlation and cause-effect relationships

Table 71. Overview of the Multi-Stage Mixed-Methods Design

First, we conducted a qualitative preliminary study with a focus group (n = 5) to determine a typical scenario of technology implementation in public administrations. This scenario was then to be used as the introduction to the online questionnaire. The focus-group participants came from different divisions of Municipality A: infrastructure and recreation; living, urban, and village development; safety and regulation; regional development; and central services. The group selected the implementation of a document-management system as a fitting scenario. This selection was further discussed and refined with another focus group (n = 4) in Municipality B to validate the results. The second focus group consisted of the mayor; a general representative of the mayor; the head of education, social affairs, and regulation; and the head of central and citizen services. The participants agreed that the implementation of a document-management system was highly relevant for most municipalities. After our literature search and having considered current theoretical approaches, we developed a preliminary questionnaire based on the items presented by Kim and Kankanhalli (2009). With these questions, we conducted a test run with randomly selected administrative officials from Municipality A (n = 5) to identify missing variables and refine the wording, if necessary. After several rounds of feedback (n = 28), we began our main study (n = 161) (c.f. Table 71).

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Qualitative pre-study

The focus-group discussion took place in Municipality A and aimed at finding a suitable technology-related scenario for our study. It was recorded and captured as a written transcript. Two researchers started with a brief introduction and moderated the discussion with open questions in a form of a partly standardized interview. The different backgrounds of the participants helped disclose the diverse perspectives and opinions of the group and allowed to discover the promising generalizable trends when implementing a system.

In a first step, each employee was asked to describe her or his daily tasks and habits pertaining to the use of technology[5] indicated that each department within the administration seems to work differently and accordingly uses different systems for their work. In addition, the interviewee pointed out that the storage of documents is handled differently, which costs an enormous amount of work and time. Accordingly, we recorded different tools, procedures, and attitudes. In general, the employees stressed that the implementation of a document- management system had been keeping them all busy. The use of this system across departments illustrates two problems: First, some departments could not access digitally stored documents. Employees without access were missing important information, stored crucial in- formation on paper, and sometimes failed to find an original copy of a document. Second, there was no standard form of labeling[6]. complained: "(…) no uniform designation of documents, they are difficult to find again, especially for other colleagues. It would be easier if each employee follows a general form of labeling documents, at least within the department."

As soon as another employee – either from the same department or from a different one – wanted to access a specific document, she or he could not find it and needed help. A document-management system addresses the need for files to be handled uniformly and across departments. Such a system can be used to organize and coordinate the development, revision, storage, monitoring, and distribution of all types of documents over their life cycle in a central database. "Problems arise when a colleague wants to access the saved document but cannot find it, and it becomes even more problematic when the colleague who filed the document cannot be reached", stated[7]. With a document-management system, the search for, access, and exchange of documents between employees in different departments is simplified to enable a smooth flow of information. Furthermore, uniform labeling can be introduced as this system provides a predefined number of characters and categories. The document-management system is perceived as a promising example of existing barriers for the acceptance of and resistance to technology in the public sector because it shows that many cognitive biases connect here. In specific, the employees' familiar working life with paper and filing cabinets is directly affected, so they think about how many costs are necessary to change and adapt and what added value can be expected (i.e., rational decision-making). They will remember experiences they have already made (i.e., cognitive

[5] Interviewee 1: Male, Infrastructure and recreation department.
[6] Interviewee 3: Male, Safety and regulation department.
[7] Interviewee 5: Female, Central services department.

misperception), may feel as if they cannot influence the change themselves (i.e., psychological commitment), and possibly make their behavior highly dependent on the behavior of colleagues and managers (i.e., organizational, and social influence). In this regard, we found that crucial factors, which were previously vaguely summed up as "social norms" needed to be named more explicitly, as they also neglected the perceived value for others (i.e., for citizens). For instance, Interviewee 5 highlighted that "(…) the focus should not only be on the employee, but also on the citizen. Employees can be positively influenced if they see the meaning behind it. If they see that the result of their work is not only for the files, but that the citizens can get a benefit from it." Thus, we readjusted our model here and made theoretical changes to existing concepts, which differentiates this study from prior studies on the SQB. For the organization, the risk of the cognitive biases is to not use the potential of implementing efficient digital processes and to lose temporal and financial resources. For the individual, they can lead to loss of productivity, motivation, satisfaction, and well-being at work. The feeling of anger can occur as well as burnout, depression, or anxiety. All in all, as implementing a document management system can require extensive resources, the scenario was seen as particularly meaningful.

Test run and quantitative main study

After the pre-study, we conducted a test run using a slightly adapted version of the questionnaire by Kim and Kankanhalli (2009) (see Chapter 2). Because the authors worked in the context of implementing a new information system in a private organization, we adjusted some items. The major difference was that the company-owned NOP system considered by Kim and Kankanhalli (2009) had been replaced by a public document-management system. We conducted several rounds of feedback on comprehensibility and missing variables. Based on these feedback loops, we described some terms in more detail, such as "fear" and "skepticism." Moreover, we reformulated some sentences. For example, we changed "The new way of working with the new system will increase my effectiveness at work" to "The new way of working with the new system increases my effectiveness at work." At first sight, this appears to be a simple rewording, but the focus group indicated that the more that the public administration employees were able to put themselves in the situation rather than to imagine how it might be, the better they could become involved. Furthermore, we avoided misunderstandings. For example, some questions that require technical experience were introduced with the phrase "If this does not apply to you, we ask you to put yourself in the described position and assess your personal expectation of the situation." The new version of the survey was sent to thirty employees for further feedback. Two employees did not reply. After we had integrated the employees' comments (especially those acknowledging refined data protection rules), we subsequently distributed the final online questionnaire. The respondents gave their informed consent and agreed to our university's data-protection rules. They answered questions using seven-point Likert scales. Agreement with the questions was presented in ascending order from one (1) to seven (7), with (1) = "strongly disagree" and (7) = "strongly agree." An overview of all items in English is given in the Appendix. The original questionnaire in German is available on request from the authors. After data collection, we focused on comprehensive analysis to identify significant correlation and cause effect relationships as well as to better understand the resistance to technology by public employees.

23.5 Data Analysis and Results

The data analysis was carried out with IBM SPSS Statistics, version 27.0. We collected data from 161 employees, resulting in a response rate of 17.3% (c.f. Table 70). All respondents answered a random attention check appropriately ("Please tick 'strongly agree.'"). The descriptive analysis of both the demographic and control variables did not show surprising values. Both the skew and kurtosis as well as the standard errors and variance were in a normal band. The answer options from minimum to maximum were almost always exhausted. The reliability coefficient of Cronbach's alpha was used to measure the consistency of the model and had an overall value of 0.876. Since a value of between +/– 0.8 and 0.9 is satisfying, this result indicated internal consistency (Ursachi, Horodnic, & Zait, 2015). For three variables, Cronbach's alpha showed a lower value (– 0.563 for the anchor effect, 0.594 for loss aversion, and 0.502 for uncertainty costs), and we therefore paid particular attention to these variables. The regression requirements were tested for simple linear regressions and the variables were interval-scaled. Following the Gauss-Markov assumptions, we checked the linearity of the coefficients as well as whether we had collected a random sample, whether the error value had an expected value of 0 for each value of the independent variables, whether the values of the independent variables were not constant, whether the error value had the same variance for each value of the independent variable (homoscedasticity), whether the error values did not depend on one another, and whether the error values were approximately normally distributed. After the prerequisites were satisfactory, we checked for statistical significance. To calculate whether the simple regression models were significant overall, an F-test was carried out (c.f. Table 72). The results indicate that perceived value ($F(1,59) = 93.154$, $p < .001$), switching benefits ($F(1,59) = 30.497$, $p < .001$), transition costs ($F(1,59) = 7.114$, $p = .008$), sunk costs ($F(1,59) = 55.088$, $p < .001$), management as a role model ($F(1,59) = 13.641$, $p < .001$), college opinion ($F(1,59) = 12.154$, $p = .001$), self-efficiency ($F(1,59) = 12.931$, $p < .001$), organizational support ($F(1,59) = 18.376$, $p < .001$), perceived value for others ($F(1,59) = 28.044$, $p < .001$), and efforts to feel in control ($F(1,59) = 11.961$, $p = .001$) had a significant effect on user resistance as the dependent variable. The three concerning values of Cronbach's alpha were again inadequate as there was no significant relation between anchor effect, loss aversion, or uncertainty costs on the one hand and user resistance on the other in any case. The adapted model is shown in Figure 23.2.

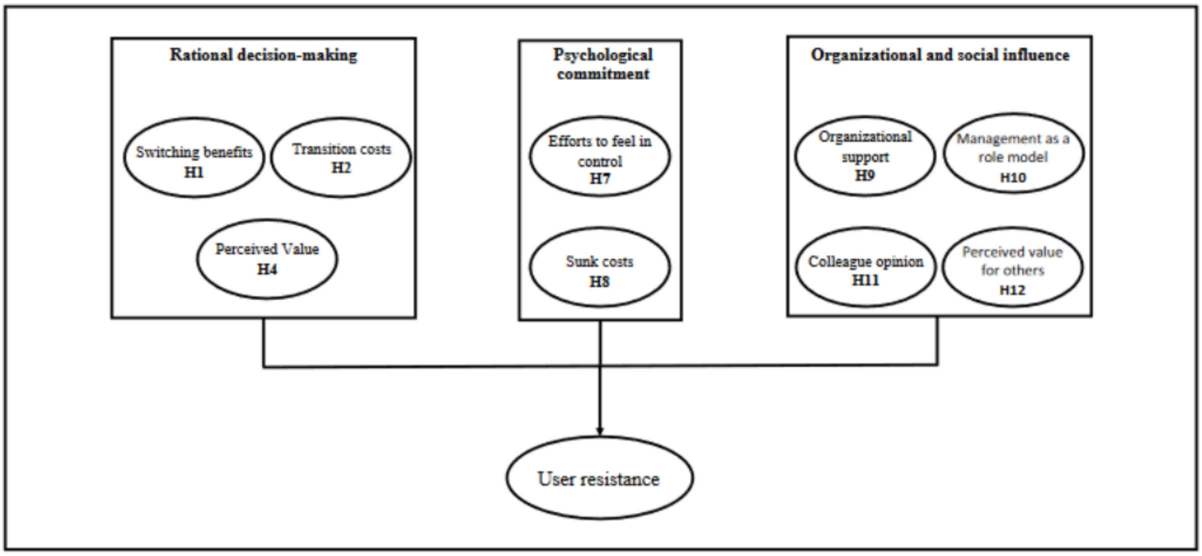

Figure 23.2. Evidence-Based Model of Resistance to Technology by Public-Sector Employees

After simple regressions had been performed, we continued with a multiple-linear-regression analysis in which we monitored the regression coefficients (betas) and t-values for each of the regression coefficients. The values for perceived value (H4) ($t = -9.652$, $p < .001$, intercept $t = 15.904$, $p < .001$), for switching benefits (H1) ($t = -5.522$, $p < .001$, intercept $t = 11.796$, $p < .001$), for transition costs (H2) ($t = -2.667$, $p = .008$, intercept $t = 11.252$, $p < .001$), for sunk costs (H8) ($t = -7.422$, $p < .001$, intercept $t = 13.611$, $p < .001$), for management as a role model (H10) ($t = -3.693$, $p < .001$, intercept $t = 7.896$, $p < .001$), for college opinion (H11) ($t = -3.486$, $p = .001$, intercept $t = 9.716$, $p < .001$), for organizational support (H9) ($t = -4.287$, $p < .001$, intercept $t = 10.258$, $p < .001$), for the perceived value for others (H12) ($t = -5.296$, $p < .001$, intercept $t = 10.135$, $p < .001$), and for efforts to feel in control (H7) ($t = -3.458$, $p = .001$, intercept $t = 7.025$, $p < .001$) turned out to be significant. Based on the findings, the Hypotheses H1, H2, H4, H7, H8, H9, H10, H11, H12 were supported, and we rejected Hypotheses H3, H5, and H6 (see Table 72). Table A2 in the Appendix shows the correlation matrix of the variables. Multicollinearity is not an issue, because we do not find a large variance inflation factor (VIF) (or tolerance) (c.f. Table A3 in the Appendix), as all values are below 5 (Hair, Black, Babin, & Anderson, 2014; J. H. Kim, 2019). The Durbin-Watson test, which can take values between 0 and 4, results in a value of 1.965, which further indicates no autocorrelation between the residuals. We do not expect nonlinearity between the independent and the dependent variable(s), because no relation is evident in the regression plot. On top of that, as there is no nonlinearity, heteroskedasticity is of no concern.

According to Cohen (1988), the variables show a high goodness of fit: 36.5% of the total variance in resistance can be explained by perceived value, 25.3% by sunk costs, 15.6% by switching benefits, 14.5% by perceived value for others, 9.8% by organizational support, 7.3% by management as a role model, 6.4% by efforts to feel in control, 6.5% by colleagues' opinions, and 3.7% by transition costs. We continued our analysis based on the theoretical model and summarized the concepts in superordinate categories (see Chapter 3): rational decision-making, cognitive misperception, psychological commitment, and organizational and social influence. We again conducted a multivariate regression analysis. The results indicate that the model provides a satisfying explanatory contribution ($F(1.56) = 21.180$, $p < .001$). Rational decision-making ($t = -2.116$, $p = .036$), psychological commitment ($t = -3.991$, $p < .001$), organizational and social influence ($t = -3.054$, $p = .003$), and the constant (intercept $t = 11.816$, $p < .001$) became significant, which reveals that the regression coefficients had a significant influence on user resistance. The regression coefficients were – 0.155 for rational decision-making, – 0.322 for psychological commitment, and – 0.272 for organizational and social influence, indicating that when one unit of that category increased, user resistance decreased by the same number of units. For cognitive misperception ($t = -1.235$, $p = .219$), no significance was determined as this category exerted no significant influence on the dependent variable.

In sum, we succeeded in shedding light on the frequent resistance to technology by employees in the public sector. By applying an integrated theoretical approach, we provided a satisfying explanatory contribution to the current literature when accounting for rational decision-making, psychological commitment, and organizational and social influence.

Employee resistance to the use of technology is best explained by perceived value, sunk costs, switching benefits, and perceived value for citizens.

Results			**Adjusted R-square**
H1	Large switching benefits → (-) User resistance.	supported	0.156
H2	Low transition costs → (-) User resistance.	supported	0.037
H3	Low uncertainty costs → (-) User resistance.	not supported	---
H4	High perceived value → (-) User resistance.	supported	0.365
H5	Low loss aversion → (-) User resistance.	not supported	---
H6	Setting anchors → (-) User resistance.	not supported	---
H7	Low effort to feel in control → (-) User resistance.	supported	0.064
H8	Low perception of sunk costs → (-) User resistance.	supported	0.253
H9	Organizational support → (-) User resistance.	supported	0.098
H10	Management as a role model → (-) User resistance.	supported	0.073
H11	Positive colleague opinions → (-) User resistance.	supported	0.065
H12	High value for others → (-) User resistance.	supported	0.145
**Note.* A non-significant (n.s.) result indicates no effects at the 5-percent level.			

Table 72. Overview of Hypotheses and Results

23.6 Discussion

In the present study, we contributed to a better understanding of technology use and resistance to technology by public-administration employees and reflected on the cognitive biases to which these employees are exposed. In the context of the increasing use of new technologies within public administrations, especially in times of COVID-19, it is even more important to support those who face challenges in the context of technological change. Many employees of public administrations react to the implementation of new information systems with skepticism (a cognitive barrier) and are afraid of losing control or of being replaced (an emotional barrier). As a result, they do not fully exploit the potential of innovative technologies, and instead of desired benefits, disadvantages arise both for employees and for the organization. Naturally, this does not disregard the fact that there can also be problems if public administrations fully rely on technologies (e. g., reliance on external providers) or that there are potential risks that come with increased digitalization of public sector activities and processes (e.g., giving up some degree of control, leaving room for external access and security threats). However, to broaden and deepen our understanding of how to prevent this downward spiral of restraints, we developed our research model based on existing literature for the context of public administrations. Our work provides a holistic view of public employees' behavior toward new information systems and aims to advance theory and derive useful recommendations for action. Below, we examine the theoretical and practical relevance of our study.

Theoretical implications

Our integrative theoretical model can serve to motivate future investigations into the identified factors behind employees' skepticism about new technologies. This paper expands existing studies by being more explicit about organizational and social influences on user resistance as well as by considering the cognitive biases the employees' face. It succeeds in deriving a lean, more concrete model specifically for the public sector. Researchers such as Kim and Kankanhalli (2009) have explored reasons for user resistance to new technologies among employees in the private sector. With this in mind, we adapted the SQB perspective to the context of the public sector, which is why our results differ from other studies on user resistance. The research was able to be appropriately transferred to our area of interest, even if one underlying category (cognitive misperception) had to be omitted in our adapted model after loss aversion and the effect of anchors both showed a non-significant relation the resistance. Moreover, uncertainty costs did not significantly relate to it. Instead, it was worth adding a new category to the initial model to consider the social context and structural uniqueness of public organizations. Public administrations are not the same as private companies because they have to comply with regulations set by federal and state governments. Our model takes specific public-sector characteristics into account and thus focuses on the three evidence-based categories of rational decision-making, psychological commitment, and organizational and social influence. Future research could focus mainly on these categories and use them when studying digital transformation in public organizations. For example, it could investigate how comparable public administrations in other countries implement new information systems and how they support their employees in this implementation or whether the acceptance or resistance of employees depends on specific information systems. In future empirical work, our results can be scaled and validated to transfer knowledge to other municipalities and organizations. On the one hand, as educators are public administrators too, following studies can expand our work to better identify the factors that can influence the use of technology in the education sectors, which can help identify further contextual specificities. On the other hand, fellow researchers are invited to gain further insight by replicating our study, by comparing different groups of employees, by adding additional control variables (e.g., using privately-owned technology at the workplace vs. using company-owned devices), and by developing other scenarios (e.g., artificial intelligence, chat bots, or language assistance). The inclusion of the technological self-efficacy of employees as an independent variable can be particularly valuable. The concept describes personal confidence in one's own ability to adapt to new situations. In our study, the control variable of self-efficiency initially showed a univariate correlation with the dependent variable. In our further multivariate investigations, however, the variable showed no significance. Future research could study this relationship in greater detail. To provide additional insight, Lee and Joshi (2017) discussed how and why some of the key constructs used in SQB perspective provided by Kim and Kankanhalli (2009) were not properly interpreted or oversimplified in their operationalization. Based on the authors' call for clear conceptualizations, we see a lack of studies in this area as a promising new avenue for understanding IS acceptance and resistance.

Practical implications

The results of our study allow recommendations for action in public administrations to be derived in terms of how the resistance to technology can be reduced among employees. The findings are closely connected to acknowledged recommendation of action by change managers. First, the value of the information system as well as the benefits for all participants can be brought into focus, for example, by means of vividly prepared presentations, whiteboards, or posters in the workrooms so that all employees have permanent access to the information and can foster a positive attitude toward the new system. Above all, this step can also lead to more transparency. The greater the awareness of the benefits, the more likely people are to take the necessary steps in the ongoing digital transformation of the public sector. Second, sunk costs tempt people toward user resistance because people do not want to give up their previous investments – for example, the effort and time already invested. In order to undermine or even prevent the effect of sunk costs, making a form of technology easier to use can have great success. The goal is to make technology easier, faster, and more useful. Special training at an early stage of implementation, on the one hand, can reveal which advantages of the form of technology can be used in what way and, on the other hand, can reduce the individual effort required of a user because she or he does not have to learn on her or his own, but in a guided manner. Third, considering switching benefits, the potential goals of the implemented technology have to be illustrated, for example, by reinforcing a generally positive attitude toward change. In addition, special bonuses – for example, when technology-related key performance indicators are achieved – can lead to a clearer awareness of the benefits of the use of technology. Fourth, the value for citizens has to be made clear. Employees in public administrations as well as the citizens should be made aware of the added value, they will gain from changing old habits within their municipality. In addition to saving time and effort by implementing more-efficient processes, self-efficiency can grow, and the shortage of administrative specialists can be reduced. These advantages can be demonstrated by showing videos, by contributing to social-media channels, or by involving the local press in a campaign. Experience reports from citizens can also be collected and displayed. Fifth, employees' existing competencies should be strengthened through organizational support, and new competencies should be taught. Training courses on digital literacy as well as on how to conduct both office hours and anonymous Q&A sessions appear promising. In addition, a culture of openness to mistakes is conducive to learning as soon as a new information system or a new method of working is introduced. Moreover, open online courses (OOC) can be used to actively support and assist employees. Sixth, management should act as a role model first and foremost by using the form of technology itself and by showing enthusiasm for its implementation. In addition, management can report on past experiences – not only positive ones – to show why the new technology is more beneficial and to highlight the benefits of being open to errors. In all cases, management should be able to support employees in the event of minor difficulties. Seventh, the perceived effort needed to feel in control also influences user resistance. Clear communication can help. Employees need to realize that they are in control of their work due to their existing skills and knowledge, independent of the technology that they use as a tool to do their job.

Training courses and coaching can be used to support these employees and to give them more control. Most importantly, employees should have the freedom to have open conversations about meeting the challenges of the digital age. It is also helpful to remind employees that they are already familiar with multiple information systems. Eighth, the opinion of similarly ranking colleagues plays an important role in the decision-making process. Good relationships in which colleagues support and help one another can change the mood and attitude toward technology for the better. For example, informal meetings with colleagues, such as a lunch- or coffee break, can strengthen cohesion and create a positive atmosphere, thereby reducing the tendency to resist the use of new technology. Ninth, transition costs can be avoided or kept low, especially with a quick and smooth transition phase from old to new technology. Employees develop a resistance to something when they realize that it is not working properly. Technological support should be provided in case of difficulties and to prevent the feeling of being lost.

Limitations and future research

The simple linear regression models revealed which of our hypotheses could be supported and which could be falsified. However, they were only a first step in empirically assessing our RQ. Against this background, we invite future researchers to collect more data on the proposed relationships. Our insights were based on a non-random, nonrepresentative quota sample. Against this background, the results may lead to distortions and thus cannot be generalized for the entire population of German municipalities. It would be more useful to collect more data as well as data from several organizations of the same size. We suggest that future studies conduct the survey in municipalities with many employees to increase the chances of reaching more respondents. In addition, further studies could be conducted that focus on information systems other than the document-management system. Also, our findings went hand in hand with similar studies related to change management. Therefore, the specificity of the public sector invites future research to consider additional concepts and studies of this domain. In addition, a review in other countries and states outside of Germany would also be valuable and could provide useful insights into the extent to which differences exist across national boundaries and whether the factors identified also apply elsewhere – and to enhance external validity. Moreover, future researchers may choose a different methodological approach. On the one hand, the common-method bias (e.g., that the respondents draw conclusions about the underlying hypotheses from the questionnaire and adjust their response behavior accordingly) should be considered to demonstrate construct validity. Although we controlled several causes (e.g., ambiguous indicators, guaranteed anonymity, and confidentiality, assumed underlying theory), several are not yet tested (e.g., social desirability, leniency bias, consistency distortion). Using alternative sources of information (e.g., different types of scales) for some of the constructs is promising. On the other hand, it would be possible to include many more interviews. We conducted interviews with two focus groups (n = 9) but double the number of interviews could lead to different findings and possibly to the discovery of more variables that should be considered. For instance, it would be promising to consider the affinity for technology that has already been discussed critically in the context of TAM, TAM2, and UTAUT. Researchers could consider other theories and models in the future and extend our existing model, if necessary. Furthermore, it would be interesting to see whether future researchers conduct their research over a longer period. Future work could conduct studies before (preliminary study), during (monitoring), and/or after an implementation takes place (evaluation). In addition, future research could compare the results of several municipalities within a federal state or pay special attention to specific regional visions and goals for designing the digital transformation of administrations.

23.7 Conclusion

As employees play an important role in the implementation of new technologies in organizations, it is more important than ever to understand the decisive factors involved in the resistance to these technologies. Our work provides a guide for how public-sector employees can adapt to changes and to the digital transformation. We accounted for cognitive biases in finding an explanation to the resistance to technology. Using a mixed-methods study in municipalities in Germany, we were able to reveal which variables influence participants' resistance to technology, and we could allude to promising interventions. The resistance to technology by public-sector employees was best explained by perceived value, sunk costs, switching benefits, and value for citizens. The overall aim was to contribute both theoretical added value in terms of how to integrate different models that stem from the bounded rationality paradigm and practical value by providing recommendations for action. Our goal was to deliver richer explanations for the resistance to technology in public administrations. Keeping our findings in mind, future work should be able to derive additional strategies in terms of how to counteract the resistance to novel processes and technologies.

Appendix A. Supplementary data to this article can be found online at https://doi.org/10.1016/j.giq.2021.101611.

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24. Paper 18: Exploring the Role of Cognitive Bias in Technology Acceptance

Title	**Exploring the Role of Cognitive Bias in Technology Acceptance by Physicians**
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Table 73. Fact Sheet Publication

Exploring the Role of Cognitive Bias in Technology Acceptance by Physicians

Abstract. The healthcare domain faces arising challenges. Caused by an ageing society, inequitable access to primary care, and the increasing demand physicians face, the digitization of medical processes emerges as a promising measure. The application of information technologies enables physicians to treat more patients while maintaining quality. Hence, physicians are potentially obliged to implement such technologies and acquire the needed skills to use them. Questions arise on what factors predict their IT acceptance behavior. Literature on technology acceptance broadly looked at technical features and assumed rational behavioral outcomes regarding perceived efforts and benefits of IT use, neglecting psychological aspects such as cognitive biases that inhibit rational decision- making. We propose a mixed-methods study to develop an integrated theoretical model based on the 'Status Quo Bias Perspective'. To provide a holistic view on physicians' technology acceptance and intentions, we further compare our tested model with established acceptance theories in IS research.

Keywords: *Bounded Rationality, Technology Acceptance, Status Quo Bias Perspective, Cognitive Bias, Mixed Methods, Healthcare.*

24.1 Introduction

Over the last decades, the healthcare domain has undergone major changes. Due to several shortcomings in today's healthcare systems, the need for improving clinical, primary care, and therapeutic processes arises to safeguard comprehensive care while maintaining service quality and patient satisfaction. The aging society and associated health issues (Demiris and Hensel 2008), paired with a decline in availability of primary and clinical care resulting in rural undersupply and inequitable distribution (Wilson et al. 2009), lead to increasing demands and challenges soon. These puts increasing pressure on practicing healthcare professionals since they are confronted with higher per capita demands while supply declines. More than ever, technologies are seen as a promising way to antagonize health-related disadvantages and societal risks emerging from deficient care (Martínez et al. 2004). Hence, one major driver is the increasing digitization of healthcare practices and treatments. Former analogous medical practices become more and more augmented by technologies, for instance in the form of digital communication channels between healthcare providers and patients, creating more spatial and temporal independence (Kvedar et al. 2014), or the collection of vital parameters through mobile sensory equipment (Pantelopoulos and Bourbakis 2010). These developments promise a relief of physicians, who are enabled to treat larger amounts of patients while maintaining quality and safety (Karsh et al. 2010). Researchers looked at digitized healthcare practices and support from different perspectives, such as patients, caregivers, and medical professionals in therapy, primary care, and clinical medicine. The healthcare and medical domain exhibits a strong culture, social roles and identities physicians acquire as well as societal expectations towards their profession (Cruess and Cruess 2008). Aggravatingly, adoption rates of health IT in healthcare are low (Karsh et al. 2010). This calls for investigations looking at physicians' attitudes towards this technological shift as well as their IT acceptance and use patterns.

One major factor that has been subject to many studies in IS research over the last thirty years is technology acceptance, often measured by constructs like 'intention to use' (Bhattacherjee and Hikmet 2007) or the invers 'resistance towards use' (Hsieh et al. 2014). To accomplish an optimized care in the light of contemporary health-related challenges, technology acceptance (i.e., a behavioral intention) by actors who provide healthcare services is of major importance since it represents a precondition of IT adoption and actual continuous use (Venkatesh and Davis 2000). Studies have investigated technological dimensions of user acceptance and resistance towards adopting and using innovative technologies for healthcare, focusing on properties like 'perceived ease of use' or 'perceived usefulness' (Bhattacherjee and Hikmet 2007). Additionally, former models take claims of rationality as a basis. Constructs like 'effort expectancy' (Venkatesh et al. 2003) imply that there is a calculable trade-off, leading to a specific decision and intention. However, modern health technologies are under constant development, rarely applied in standard care, and thus lack medical evidence (Chaudhry et al. 2006). Amongst other, one notable example is the development of applications based on 'Artificial Intelligence' algorithms and procedures. Such applications are expected to support the diagnosis and treatment of diseases in an efficient way, potentially relieving physicians and medical staff. As a result, the usefulness and individual operation of a system becomes hard to measure. Hence, traditional acceptance models fall short in explanatory power, calling for new perspectives looking at psychological factors that potentially explain individuals' use intentions.

One theoretical approach receiving scientific attention in the technology domain are cognitive biases that root in the concept of 'Bounded Rationality' (Kahneman 2003; Kahneman and Tversky 1979; Simon 1955). The concept states that the rationality of decisions individuals make is limited due to cognitive boundaries and informational gaps, opposing the belief in rational decision-making based on weighing off costs and benefits that come with a course of action (i.e., 'homo oeconomicus'). Cognitive biases occur, for instance, in the form of maintaining the status quo (e.g., continuing to use an established IT system) and by this sticking to previous decisions, although there might be better alternatives (Lee and Joshi 2017). Several IS studies utilize cognitive biases to explain user behavior when it comes to accepting and adopting new technologies (e.g., Hsieh et al. 2014; Li et al. 2016). While rational decision-making is one defining component of human behavior, these approaches go beyond rational choices and look at bounded rational or even irrational factors that lead to decisions. Thus, human decisions are increasingly seen as an interplay of rational and less rational processes. However, research lacks a common view on what aspects of cognitive bias in decision-making need to be considered when explaining user acceptance, leading to heterogeneous models incorporating various constructs. Further, Lee and Joshi (2017) name several shortcomings of prior studies on cognitive biases in technology acceptance, such as the neglect of 'regret avoidance' forming a user's psychological commitment and the lack of distinction between behavioral and decisional control. Thus, our research is guided by the following research questions (RQs):

RQ1*: How can different factors of status quo bias be integrated in a theoretical model?*

RQ2*: To what extent can the model explain physicians' behavioral use intentions of health IT?*

RQ3*: What is the model's explanatory power compared to established technology acceptance models?*

24.2 Theoretical Background

Technology Acceptance by Healthcare Professionals

To date, different theoretical approaches have been deployed to explain technology acceptance by individuals within the healthcare domain. Technology acceptance plays an important role when it comes to supplementing, substituting, or transforming medical practices through innovative technologies. Looking at the IT acceptance and adoption behavior of healthcare professionals, studies take different perspectives and contexts, such as therapists (Chen and Bode 2011), nurses (Pai and Huang 2011), and physicians (El Halabieh et al. 2017). However, when it comes to the need for comprehensive healthcare supply, the perspective of medical professionals in the form of primary care physicians becomes important. The use of technologies supporting diagnoses, treatments, therapies, and rehabilitation in most cases roots in the physician's initiative and willingness to put effort into implementation and use daily. A physician's intention to acquire such a technology and the associated decision-making processes depends on many factors and is crucial to the provision of health IT, yet it appears to be elusive and hard to measure (Gewald and Gewald 2017; Lowenhaupt 2004). According to Gewald and Gewald (2017), "*we are not aware of any study which is sufficiently and significantly able to really explain why physicians do not show the same adoption behavior as users in other industries*" (p. 3412). Chau and Hu (2002) state, that physicians' decision-making and IT acceptance and adoption behavior differs from users in other domains. Despite being less experienced in the use of technologies, they exhibit great expertise and knowledge regarding their professions. Studies have shown that physicians are reluctant when it comes to implementing and using IT "*that interferes with their traditional routines*" (p. 298). Physicians value their degree of autonomy in their work (ibid.). Technology might be seen as a threat to their professional autonomy, which has a negative effect on use intentions (Walter and Lopez 2008).

When looking at theoretical models applied to explain healthcare professionals' IT acceptance, three specific models stand out. First, researcher broadly utilized the 'Technology Acceptance Model' (TAM) and its extended forms to explain acceptance and use behavior in healthcare (Chen and Bode 2011; Chismar and Wiley-Patton 2003; El Halabieh et al. 2017; Pai and Huang 2011). Second, the 'Unified Theory of Acceptance and Use of Technology' (UTAUT) formed the theoretical baseline of many studies on health IT (Kohnke et al. 2014; Samhan 2017; Wills et al. 2008). Third, researchers applied the 'Theory of Planned Behavior' (TPB) as a theoretical lens to investigate technology use intentions (e.g., Chau and Hu 2002). As mentioned above, these 'traditional' acceptance models fall short due to several reasons. Firstly, they do not incorporate dispositional psychological factors such as inertia and loss aversion, which do not necessarily relate to the technology itself but its user. Yet, models like the TAM focus on technical properties of the system under investigation such as 'ease of use' and 'usefulness' (Venkatesh and Davis 2000), which might apply within evaluative settings but not in prescriptive ones such as the future application of, for example, 'Artificial Intelligence' (AI) for diagnostic processes, which might hold great potential for patient treatment when spatial access to care declines. Secondly, they greatly depend on the premise of rationality, for instance in the form of calculable performance and effort trade-offs as suggested by UTAUT

(Venkatesh et al. 2003). Rational thoughts, evaluations, and actions form one component of human decision-making and are incorporated in many theoretical approaches. However, a considerable number of decisions and behaviors is rooted in bounded rationality or even irrationality. Hence, concepts beyond rationality (e.g., cognitive biases) have the potential to deliver further insights on why users behave the way they do. Thirdly, the models' explanatory power might be weakened in the given context of primary care due to the technologies' novelty. Modern innovations like AI-based diagnosis support (for instance, calculating a likelihood for certain diseases based on symptoms) are not broadly implemented and used. Use cases and potentials of disruptive technologies like AI within the healthcare domain are still subject to research, medical evidence gathered from clinical trials are scarce if not non-existent (Chaudhry et al. 2006). As a result, innovations lack normative valuation as well as concrete design features and use scenarios in which technology acceptance studies can be conducted. Another issue in research on acceptance and adoption is that "*the literature is diffuse, and articles seldom build on earlier ones to increase the theoretical knowledge*" (Boonstra et al., 2014, p. 16). The investigation of cognitive biases promises deeper insights on IT acceptance. It can help us to expand our understanding of acceptance by physicians and achieve an integrated view on antecedents of use intentions.

Status Quo Bias Perspective

Technology acceptance literature implies rational decision making, which assesses relative costs and benefits. It presupposes that users systematically select among possible choices and base their reasoning on facts. However, individuals oftentimes stick with established or familiar decisions, even though alternative information or conditions exist that are objectively superior (Kahneman et al. 1991). Against this background, rational decision-making seems to insufficiently explain the underlying mechanisms of how users evaluate technological change (Kim and Kankanhalli 2009). A promising point of origin for further understanding how users adopt or resist new technology is the stability bias of IS use, which has already been investigated in the context of technology post-adoption (Fleischmann et al. 2014). In specific, the status quo bias perspective (SQBP) provides a novel explanation of user decision making and resistance by advancing the understanding of how users evaluate technology-related change (Kim and Kankanhalli 2009). The approach accounts for cognitive limitations that lead to bounded rationality and helps conceptualize some core IS constructs more accurately (Lee and Joshi 2017).

Samuelson and Zeckhauser (1988) distinguish three dimensions of the people's preference for maintaining their status or situation. They deduce a) rational decision making, because individuals consider transition costs (e.g., transient costs) and uncertainty costs (e.g., perception of risk) which leaves them fearful and skeptical; b) cognitive misperception, because individuals tend to loom losses greater than gains which makes them to perceive even small losses much larger than given (Kahneman and Tversky 1979); and c) psychological commitment, because previous commitments, prevailing working environments (i.e. social norms) and the desire to be in charge (i.e. control) of individuals leads to feeling unfamiliar and insecure with alternatives. Thus, although implementing a new technology can improve performance, a common reaction to new systems is resistance (Kim and Kankanhalli 2009).

Cognitive stability biases were hardly examined in the health care industry (Fleischmann et al. 2014), although they provide unique insights into 'bias' in human decision-making in its presentation of bounded rationality (Lee and Joshi 2017). To study how physicians evaluate the implementation of new systems, the SQBP understands the impact of maintaining the status or situation as inhibiting perceptions (e.g., regret avoidance) of using new systems (Hsieh et al. 2014). It provides a useful theoretical explanation for phenomena where individuals disproportionately make decisions to continue an incumbent method rather than switching to a new (potential better) solution (Li et al. 2016). By doing so, we deem SQBP as particularly suitable to understand why many physicians do not intend to use promising technology such as AI. To theoretically understand the failure to switch from an incumbent system to a new one is not derived uniformly, although combined in the SQBP. There are many different approaches using this perspective, but no consensus as to which factor affects which outcome or what dependent variable is at core (Lee and Joshi 2017). For instance, the concept of inertia is on the one hand described to moderate between the dimensions of the bias and use intention (Polites and Karahanna 2012) and on the other hand seen as a sub-dimension of cognitive misperception (Hsieh et al. 2014). Another example is the concept of regret avoidance, which several prior studies seem to oversimplify or exclude (Lee and Joshi 2017). Our work consequently views regret avoidance and social norms as distinct concepts and models them independently. The lack of conceptual clarity opens the door for our explorative approach to study how new technology use is intended or resisted.

24.3 Theoretical Foundation for an Integrated Acceptance Model

To investigate the SQBP and its main categories within an integrated theoretical approach, their characteristics, and relationships regarding IT use intentions by physicians are explained in the following.

Rational decision-making refers to a cost-benefit analysis users perform when it comes to using a new technology. Users offset potential costs that accompany adopting the system (e.g., learning efforts) with perceived values (e.g., time savings). Users form an attitude towards the technology influencing their acceptance, thus leaving the status quo (Lee and Joshi 2017). The following constructs play a major role:

Uncertainty. Novel technologies impose psychological uncertainty on their users regarding potential outcomes and risks of using it. To resolve uncertainties, users need to search for system-related information, analyze incurring probabilities, and potentially weigh-off alternatives. Hence, decision making comes with high efforts, which might lead to refraining acting and maintaining the status quo (Hsieh et al. 2014; Lee and Joshi 2017). Uncertainty thus is expected to be negatively connected with use intentions.

Transition costs and perceived value. Transitioning and adapting to the new situation (i.e., using the new system) comes with costs as well. Transient costs refer to the switching process and involved efforts such as learning and getting used to the technology. Permanent costs arise in the longer term after the adoption (such as a loss of service quality due to false use) (Hsieh et al. 2014; Kim and Kankanhalli 2009). Transition costs are supposed to negatively correlate with use intentions, whilst perceived value behaves invers to that.

Cognitive misperception describes individual assessments of technology properties and use rooted in research on human decision-making (Kahneman and Tversky 1979). When it comes to deciding (i.e., adopting a system), cognitive biases can occur due to the overvaluation of properties or potential outcomes. The following constructs describe important forms of cognitive misperceptions:

Loss aversion. Users tend to weigh losses greater than gains that come with “risky” decisions (Kahneman and Tversky 1979), in this case to adopt a technology. Perceived efforts relating to implementing a new system can outweigh potential benefits, even though these benefits might exceed efforts. Potential losses originating from leaving the current state are perceived as higher as they might be (Lee and Joshi 2017). Loss aversion thus is expected to be negatively related to use intentions.

Anchoring effects. These effects have been widely neglected within prior IS studies (Lee and Joshi 2017). An 'anchor' refers to a starting value individuals set as a reference point when assessing upcoming changes. Once the current form of practice evolves into a habit, anchors become much stronger and deteriorate perceived costs and benefits (ibid.). In our case, anchors may be formed by medical practices that do not involve digital technologies, yet, such as measuring a patient's vital parameters. Thus, comparing 'non-technical' anchors with digitized forms of practice represents a challenge in our study while promising novel insights. Stronger anchors might hamper use intentions, implying a negative relationship.

Inertia. Polites and Karahanna (2012) define inertia "*[…] as attachment to, and persistence of, existing behavioral patterns (some of which are habituated) even if there were better alternatives and incentives to change*" (p. 22). In other words, individuals prefer the current or past courses of action and tend to stick to the status quo, "*[…] because this is what they have always done […]*" (Hsieh et al., 2014, p. 7). High inertia thus lowers use intentions and hampers decision making in favor of IT adoption.

Psychological commitment refers to a form of obligation an individual perceives when it comes to substituting courses of action with new ones. Individuals that are highly committed tend to stick to their preferences even in the light of conflicting information regarding potentially higher performing alternatives (Crosby and Taylor 1983), maintaining cognitive consistencies (Pritchard et al. 1999). Hence, individuals stay loyal towards their actions. The following forms of commitment can explain cognitive biases:

Sunk cost. Sunk cost refers to the amount of commitment and efforts by the individual relating to previous decisions and behavior (Samuelson and Zeckhauser 1988). For instance, the level of skill a user had to acquire to follow a course of action, e.g., using a technology, is strongly bound to the status quo. When it comes to switching to an alternative (e.g., a new technology) these learning efforts are perceived to get lost (Kim and Kankanhalli 2009). Higher perceived sunk costs thus can hamper use intentions.

Regret avoidance. This construct inclines individuals to refrain from decisions that they may regret later (Lee and Joshi 2017), potentially forming a resisting attitude towards new technologies. Potential regret can further depend on the organization or domain the IT adoption takes place in. The environment of the individual exhibits norms that might influence the way failure is viewed (Kane and Labianca 2011). Domains with a more conservative culture valuate risky decisions as unfavorably, promoting the urge to avoid regrets (Lee and Joshi 2017). High levels of regret avoidance might lower use intentions.

Decisional control. Control can be viewed from two perspectives. First, decisional control (DC) can be seen "*as an individual's authority to control autonomous decision-making*" (Lee and Joshi, 2017, p. 746), referring to a pre-adoption process. Second, behavioral control (BC) describes the individual's ability to handle a post-adoption situation. BC refers to the user's self-efficacy, which is often mistakenly used to measure DC (ibid.). Hence, BC and DC must be distinguished. In the context of SQBP, DC forms psychological commitment and is expected to be positively connected with use intentions.

Organizational and social influences describe different factors affecting the perception of and individual attitude towards a new technology, holding great potential to further differentiate and explain variables provided by SQBP dimensions. Since many studies that incorporate cognitive biases did not consider these factors (Lee and Joshi 2017), claims for an integrated explanation of user acceptance emerge.

Social and organizational norms. When looking at physicians, their decision-making, and adoption behavior, norms occur in different forms and can influence biases towards using a technology (Hu et al. 2011). In our case, norms can be looked at in two ways. Social norms originate from (a) the societal environment and incumbent expectations towards healthcare quality and physician performance (Bauchner 2001; Cruess and Cruess 2008), and (b) other actors within the healthcare domain such as colleagues (Kim and Kankanhalli 2009). Organizational norms depart from individual opinions and are much more based on the culture, tradition, and convictions inherent in the healthcare domain. For instance, large amounts of medical decision-making are based on evidence (Bauchner 2001). However, innovative technologies aiming for supporting medical processes such as patient treatment lack clinical evidence due to their early development state (Chaudhry et al. 2006; Karsh et al. 2006). Thus, the medical community might grade using a novel technology as reprehensible. Norms favoring the use of technology thus are expected to positively correlate with individual use intentions.

Organizational support. Kim and Kankanhalli (2009) define organizational control as "the perceived facilitation provided by the organization to make users' adaptation to new IS-related change easier" (p. 573). Hence, organizational support can influence the prevalence of cognitive biases, for instance through provision of resources and training. Studies have shown that organizational support can reduce user resistance towards change (Huang

2015), thus implying a positive effect on use intentions. In our context, the organization a physician works in needs to be re-framed. Although many primary care physicians are established, they still are embedded in national healthcare systems. The construct needs to capture how these systems can support or inhibit the implementation of technologies within practices. Table 74 provides short definitions and the expected correlations.

Construct	Definition	Correlation
Uncertainty	The degree of uncertainty underlying the decision to use the new technology.	Negative (-)
Transition costs	The amount of costs associated with implementing and using the new technology.	Negative (-)
Perceived value	The extent of value and benefit coming with the implementation and use of the new technology.	Positive (+)
Loss aversion	The degree to which the user seeks to avoid losses that might come with using the new technology.	Negative (-)
Anchoring effects	The degree to which the new technology has to withstand the expectations formed by the current way of working.	Negative (-)
Inertia	The tendency of the user to stick to current behavioral patterns and avoid changes.	Negative (-)
Sunk cost	The number of efforts and resources the user has already put into the current way of working.	Negative (-)
Regret avoidance	The degree to which the user seeks to avoid decisions they might regret in the future.	Negative (-)
Decisional control	The degree of freedom and autonomy the user has when deciding to choose, use, or reject the new technology.	Positive (+)
Organizational norms	The degree to which the organization (i.e., actors in the healthcare system) considers the new technology useful.	Positive (+)
Social norms	The degree to which social queues consider the technology useful.	Positive (+)
Organizational support	The extent of support provided by the organization (i.e., actors in the healthcare system) in implementing and using the new technology.	Positive (+)
Colleague opinion	The degree to which colleagues consider the new technology useful.	Positive (+)

Table 74. Construct Definitions and Expected Correlations with Intention to Use

We include several control variables within our model to check for possible alternatives to explain use intentions. Besides demographics, individuals' judgements might be influenced by past experiences related to technology use. Self-efficacy and computer self-efficacy might have further explanatory weight. Job responsibility, social desirability, and perceived (personal and job-related) threat represent additional controls. Polites and Karahanna (2012) suggest propensity to resist change, routine seeking, and personal innovativeness as controls. Figure 1 illustrates our resulting theoretical framework. We include 'Intention to use' as our dependent variable (DV), since it is an established measurement for the acceptance of technologies (Bhattacherjee and Hikmet 2007). Our framework suggests the examination of (1) direct effects the four SQBP dimensions have on the DV as well as (2) correlations within and between the dimensions. For instance, we expect organizational support to influence transition costs, since first empirical insights suggest that higher degrees of external support reduce perceived efforts.

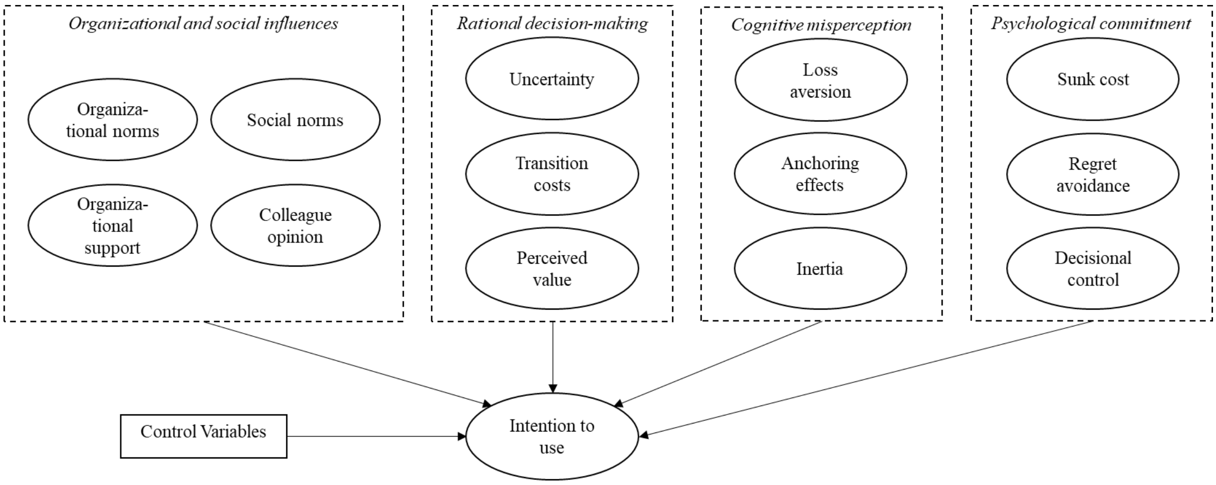

Figure 24.1. Theoretical Framework

24.4 Research Agenda and Preliminary Discussion

Pre-study and Pilot. As our pre-study, we conducted a focus group with primary care physicians (n=6, 54 years on average, all male) to elaborate a treatment scenario integrating health technologies into treatments and medical processes in the light of upcoming challenges (e.g., rural undersupply and scarce care access). As a result, the technological scenario that forms the foundation for empirical investigations consists of three incremental versions of a telemedical system for patient treatment whereby each version includes and supplements the features of the previous one: (1) Live video conferencing engaging spatially separated patient and physician, enabling face-to-face consultation and rudimental video-based examinations (e.g., wounds). (2) Patient-sided application of sensors that can measure vital parameters of importance to the physician (e.g., blood pressure). The captured data is transferred to the physician, enabling its immediate analysis. The physician can assess and potentially adjust the treatment and arrange a physical meeting if needed. (3) Ad-hoc data analysis, for instance in the form of an algorithm based on Artificial Intelligence that pre-analyses data before the result is shown to the physician. In that case, the physician will only be provided with relevant information drawn from raw data, for instance if certain vital parameters surpass a critical threshold. Next, we develop an initial questionnaire by adapting measurement items from literature to our context. To check for comprehensibility and meaningfulness of item and scenario wording, we conduct a pilot test with a small sample of primary care physicians (n=5). The final scenario will be used in both upcoming surveys. To account for potential effects the different versions of the setting might have on the way respondents answer our surveys, we include an additional control asking whether the whole scenario has been understood and is seen as meaningful and feasible. If not, the respondents are asked to indicate the system version (1, 2, or 3) that appeals to them most. In doing so, we can group our data set according to the indication and look for differences across our sample.

First survey. After revising the questionnaire, we conduct a large-scale survey in the form of an online questionnaire following a within-subject study design. Each participant will be provided with the same scenario described above. The survey link will be distributed to primary care physicians via a regional network consisting of primary care physicians and facilities as well as a state-wide healthcare network to ensure enough respondents (n=150 targeted). The goal of the first survey is to exploratively develop our theoretical model and check for significant correlations, using regression analysis and co-variance based path modelling. We further expect some of the constructs to not be highly selective when describing physicians' perceptions (e.g., perceived value and loss aversion). Hence, by performing an Explorative Factor Analysis, we seek to group related and (partially) overlapping constructs and form coherent predictors of technology acceptance. In doing so, we account for potential overlaps the different model dimensions and variables exhibit (e.g., loss aversion and regret avoidance). This potentially leads to a more condensed model and motivates future investigations of identified factors.

Second survey. Once we formed our final theoretical model, we conduct a second survey via an online questionnaire analogous to the first survey. To acquire a new sample that differs from the first one and avoid biases, we distribute the second survey link via a nationwide healthcare network to reach physicians across the country. We include a variety of items to measure our model as well as established acceptance models like TAM and UTAUT, enabling us to compare the explanatory power of each model, gaining insights on the suitability of SQBP as a theoretical basis and the potential need for an integrated model and further investigations. Since we aim for testing our model against established ones, we target a sample size of at least 500. For data analysis, we use regression analysis and co-variance based path modelling.

24.5 References

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25. Paper 19: Demigods of Technology Use

Title	**Demigods of Technology Use – How Beating the Overconfidence Bias Can Prevent Medical Errors**
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Table 75. Fact Sheet Publication

Demigods of Technology Use – How Beating the Overconfidence Bias Can Prevent Medical Errors

Abstract. *The healthcare domain faces considerable challenges due to the digitization of medical processes and routines. Information technologies are designed to enable physicians to treat more patients and to increase service quality and patient safety. Despite acknowledging the rapid digital transformation of healthcare, research often neglects whether physicians can effectively decide which technology to use in which setting and whether their technology use thus effectively enhances quality and safety. Literature on cognitive biases already looked broadly at related errors in judgment and action and questioned rational behavior. Nevertheless, overconfidence, being one of the most common cognitive biases, has barely been linked to the accurate adoption and use of technology by physicians. Against this background, this research-in-progress paper proposes a framework for conducting a mixed-methods study based on the particularities of overconfidence in healthcare. We invite future research to compare our approach with established theoretical frameworks in IS research.*

25.1 Introduction

Up to 40 percent of annual deaths in the United States are preventable [6]. Lethal errors happen in roughly 6 percent of hospital admissions [8, 9]. Literature shows that most preventable deaths are caused by social determinants [e.g., 35, 36]. However, no less important and representing an emphasis of this research-in-progress paper, many medical flaws and treatment inaccuracies occur due to cognitive biases, because physicians are susceptible to errors in judgment and decision-making [e.g., 11, 49]. When medical practitioners are selective about what they pay attention to, distorted thinking and cognitive biases occur. In the digital age, that also applies to their adoption and use of information technology (IT).

A cognitive bias is an error in thinking, which results from the attempt to simplify information processing. It is defined as a systematic deviation from rationality, whereby inferences are drawn in an illogical fashion [30, 45, 2, 3, 27]. Cognitive biases are the reason why individuals often come up with divergent or even 'wrong' conclusions when processing and interpreting information about the world around them [25]. Although many cognitive biases serve an adaptive purpose as they allow to make sense of the world rather quickly, they often outplay well-considered but time-consuming decisions.

Information Systems (IS) research acknowledged that human decision-making is one decisive area of interest in the IS domain [23]. This seems to be especially true for action-oriented biases such as overconfidence [16]. Pressing issues such as privacy, trust, and security, fuel academic interest in this respect. Because the body of psychological knowledge often facilitates to advance the discipline and to provide valuable recommendations for practitioners [16], our study seeks to continue progressing on that path. There is a huge opportunity for combining IS research with behavioral economics principles such as cognitive biases to shed light on technology use and to inform design science research. In particular, the growing area of NeuroIS demonstrates potential to bring explanatory power to cognitive effects [13].

Against this background, it is surprising that cognitive biases received only limited attention in the technology-related healthcare domain [16]. The massive amount of information available to physicians at the point they must decide on whether or how to use a certain technology can lead to information overload, which can result in greater reliance on heuristics and greater susceptibility to biases. In fact, many studies already showed the influence of cognitive biases on erroneous decisions in other fields (e.g., aviation accidents [54]). Assessment tools have been applied to reduce shortcomings and to improve quality [e.g., 64]. Bearing in mind those related findings and guidelines, we focus on the healthcare domain due to its high vulnerability to human failure. Since physicians' errors can be fatal and costly [39, 32, 5, 34], we strive to understand and to improve decisions regarding whether or how to use a certain technology in that occupation.

We will focus on the occurrence of overconfidence because it is considered one of the cornerstones that illustrate shortcomings in human information-processing capacities, thereby marking human irrationality. It is associated with diagnostic inaccuracies or suboptimal management [49] and correlates with an underestimation of risk factors and tolerance to ambiguity [45]. Thus, understanding the impact of overconfidence on a physician's decisions is a promising path illustrating how behavioral economics and IS research can travel together. As literature leads to the assumption that overconfidence might be a crucial cause of medical errors, which occurs in the form of biased calibration, biased precision of numerical estimates, and biased placement of performance, we ask:

> ***RQ1***: *How does overconfidence affect the accurate adoption and use of technology by physicians?*
>
> ***RQ2:*** *How does overconfidence affect the medical errors made by physicians?*

Seeing the cognitive bias of overconfidence as an important area of interest when it comes to why and how physicians use technology, our work has four objectives: 1) to highlight the value to consider cognitive biases in the healthcare domain, 2) to show the benefits of linking technology adoption and use of physicians to overconfidence, 3) to present a research agenda on how to evaluate the influence of overconfidence on prevention, diagnosis, treatment, and rehabilitation, and 4) to guide future research. It is important to note that our paper thereby focuses on exceptions of daily medical practice, namely the times when cognitive processes fail while using technology, which implies that a medical action is missed or wrong. We expect that physicians have a high confidence in their technology use behavior, which leads to underappreciating the chance of medical errors due to inappropriate usage. The overall goal is both to highlight the practical implications of our findings to derive valuable recommendation for medical practice. Moreover, our work strives for understanding the impact of overconfidence on medical technological decisions to offer a theoretical contribution to advance the field.

25.2 Theoretical Background

In our outline, the physicians' technology adoption and use cover the whole band width of health technology and can easily be itemized into specific application scenarios (e.g., adoption and use of telemedicine or artificial intelligence software).

Cognitive biases in the healthcare domain

According to the paradigm of rational choice, people decide, and act based on thorough cost-benefit analysis to maximize profits. The prerequisites for rational choices are that people 1) know exactly what they want and prioritize, 2) have a set of alternative courses of action, and 3) know the likelihood of the events which they include in their calculation of costs and benefits [62, 15]. It quickly becomes clear that this approach has a few shortcomings and does not correspond properly to 'real' life. The most fundamental drawback is that no human knows everything, nor has s/he ideal mathematical methods. *Homo sapiens*, in contrast to *Homo oeconomicus* (aka *Humans* in contrast to Econs [57]), is unable to accurately identify all characteristics needed for an optimal decision. And even if s/he could: Calculating complex situations would take too long to make sense in an efficient manner. Knowledge deficits as well as restrictions in time and cognitive resources limit truly rational decision and action.

This leads to the concept of bounded rationality. According to the paradigm of rational choice, a sub-optimal calculation of costs and benefits is seen as irrational and obstructive for the realization of human goals [45]. However, the decision-theorist Herbert Simon (Nobel Prize 1978) was a pioneer to assume that choices are naturally bounded by a number of factors [e.g., 50, 51]. For instance, humans consider only few alternatives; usually only two (which he termed 'satisficing'). Moreover, they tend to value things they own more highly than the things they could achieve by changing action ('endowment effect'). In addition, they tend to continue previous behavior even at considerable costs ('status quo bias'). Having named just a few examples, it becomes clear that humans are happy with reasonably satisfactory solutions, even if there is a good chance that there is a much more favorable option [see for further insights 4, 60, 10, 21].

So how do humans decide? Are humans bounded in the sense that they can no longer effectively choose what to do? Gigerenzer and his colleagues negate this attitude and assume that the rational consideration of all relevant factors at hand often brings no advantage [22, 19]. In many situations, heuristic decision-making, based on a very narrow information base and following simple rules, is just as or almost as efficient as complex arithmetic operations – but much faster and cheaper. Heuristics focus on a few salient features that can be used to decide between alternatives. One of the most common heuristics is the awareness of past experiences (for instance due to 'framing' or 'anchoring'). Humans rate the popularity of things by how easily concerning information is retrievable from their memory ('availability' heuristic). Simple and fast procedures often prevail.

However, simplistic rules of thumb do not always bring benefits. Literature demonstrates severe cognitive limitations when it comes to complex decisions (e.g., decision-making in the healthcare domain). Human behavior in complex systems falls short in particular by: 1) starting without sufficient prior analysis of the situation, 2) disregarding the positive and negative influences of most factors and measures, 3) focusing on immediate events while ignoring long-term and side effects, 4) the rigid belief to have the right method, 5) fleeing into new projects when things are about to go wrong or 6) taking more and more radical measures when things get out of hand [14]. This lesson is highly relevant to the healthcare domain. In particular, the physicians' belief to have the 'right' method (i.e., 'overconfidence') seems untenable against the background of the prevalence of biases.

IS research acknowledged the relevance of human cognition and decision-making biases related to information systems [16, 23]. By providing a review of cognitive bias-related research in the IS discipline, Fleischmann et al. [16] revealed that the literature in this domain mainly concentrated on perception and decision biases (ibid.). They invited future research to be more diverse. Our work travels well with their idea to focus on action-oriented biases (e.g., ‘overconfidence’).

To sum up, many studies show the influence of cognitive biases on decision-making and provide valuable insights for the progress of our study. Although many cognitive biases serve an adaptive purpose as they allow to make sense of the world more quickly, they often outplay well-considered, but time-consuming, decisions. The fact that there are various sensitive issues where an elaborate analysis and decision-making is required [such as choosing whether or how to use a certain technology for diagnosis or treatment, see e.g., 20], is a fruitful start to study the accuracy of physicians’ technology adoption and use.

Overconfidence in the healthcare domain

Based on a structured review by Saposnik and his colleagues [49], common cognitive biases associated with medical decisions are based on perception biases (such as ‘framing’ [e.g., 44, see also 7]) or stability biases (such as ‘anchoring’ [e.g., 52, see also 1]). Approaches considering action-oriented biases (such as ‘overconfidence’) were also considered (c.f. Table 76). Action-orientated biases are a distinct subgroup within the category of decision biases [16]. Because premature decisions based on optimism without considering all relevant information are pressingly relevant for physicians as well, this paper seeks to further integrate action-oriented biases into the current debate.

Overconfidence is considered one of the cornerstones that illustrate shortcomings in human information-processing capacities, thereby marking human irrationality. It occurs in case our reliance related to judgments, inferences, or predictions is too high when compared to the corresponding accuracy [45]. Overconfidence is associated with diagnostic inaccuracies or suboptimal management [49] and leads to overestimation, over-precision, and over-placement [40]. Additionally, it correlates with an underestimation of risk factors and a high tolerance to ambiguity. Table 76 sums up general findings on overconfidence, which are relevant for our work.

Author (Year of Publication)	**Title**	**Source**
Keren (1997)	“On the calibration of probability judgments: Some critical comments and alternative perspectives”	[31]
Klayman et al. (1999)	“Overconfidence: It depends on how, what, and whom you ask”	[33]

McGraw et al. (2004)	"The affective costs of overconfidence"	[37]
Moore and Healy (2008)	"The trouble with overconfidence"	[40]
Nandedkar and Midha (2009)	"Optimism in music piracy: A pilot study"	[42]
Rhee et al. (2005)	"I am fine, but you are not: Optimistic bias and illusion of control on information security"	[47]
Tan et al. (2012)	"Consumer-based decision aid that explains which to buy: Decision confirmation or overconfidence bias?"	[55]
Van der Vyver (2004)	"The overconfidence effect and IT professionals"	[59]
Vetter et al. (2011)	"Overconfidence in IT investment decisions: Why knowledge can be a boon and bane at the same time"	[61]

Table 76. Preliminary Literature on Overconfidence

The three most typical forms of overconfidence are "(1) calibration, (2) the precision of numerical estimates, and (3) people's placement of their own performance relative to others" [45:291]. They point at the fact that the subjective confidence exceeds objective accuracy, the subjective confidence intervals are too narrow, and people tend to better-than-average estimations of their own contribution or skills relative to others. Subjective confidence is based on self-knowledge and helps make quick judgements, although objective quantities are unknown, unstructured or by other means rough [63]. Closely linked to overconfidence is the illusion of control as well as the stable individual trait of optimism [45].

Overconfidence is also of interest for IS research. The domain studied the bias's occurrence in many settings such as enterprise resource planning [e.g., 28], innovation management [e.g., 18], and performance [e.g., 41]. As technology use became ubiquitous in the healthcare domain, the number of studies concerning technology use for medical diagnoses and treatment began to rise. However, a comprehensive review of the available literature and current thinking related to these issues is missing in this discipline [16]. This hampers both theorizing and finding practical solution to improve the accuracy of medical decision making while using technology.

Evidence suggests that the incidence of overconfidence is likely to be greater among top executives (ibid.). Physicians are without question seen as such experts who are ambitious, competent, and obstinate. The benefits of overconfidence can be threefold for them [45:91 ff.]: First, it might have a consumption value of feeling good. People naturally enjoy receiving positive feedback, praise, and approval (also from thinking well of themselves). Second, it might have a motivation value. People with high confidence set high goals and persist in the face of adversary. Third, it might be a valuable signal for convincing others. Optimism about future events can positively affect those developments. A physician being overconfident about a particular treatment can be considered as the cause of a self-fulfilling prophecy or placebo effect. Against this background, it is of crucial importance to consider overconfidence, when the 'demigods in white' decide on whether or how to use a certain technology. Table 77 sums up recent findings on clinicians' overconfidence [see 49], also taking into account literature regarding the effect of overconfidence on medical errors.

Author (Year of Publication)	**Title**	**Source**
Friedman et al. (2005)	"Are clinicians correct when they believe they are correct? Implications for medical decision support"	[17]
Meyer et al. (2013)	"Physicians' diagnostic accuracy, confidence, and resource requests: a vignette study"	[38]
Crowley et al. (2013)	"Automated detection of heuristics and biases among pathologists in a computer-based system"	[12]
Saposnik et al. (2013)	"Accuracy of clinician vs risk score prediction of ischemic stroke outcomes"	[48]
Stiegler et al. (2012)	"Decision-making and safety in anesthesiology"	[53]
Ogdie et al. (2012)	"Seen through their eyes: residents' reflections on the cognitive and contextual components of diagnostic errors in medicine"	[43]
Saposnik, et al. (2016)	"Cognitive biases associated with medical decisions: A systematic review"	[49]

Table 77. Preliminary Literature and Current Findings on Clinicians' Overconfidence

25.3 Model Development

Based on the theoretical background, we developed a preliminary research model. Overconfidence is considered as the independent variable. On the one hand, we propose a relation between overconfidence and technology use and seek to answer RQ1. On the other hand, we want to find out how overconfidence affects medical errors made by physicians to answer RQ2. We integrate technology use as a moderating variable that affects the strength of the relationship between medical errors and overconfidence. It is expected to have an amplifying effect. We will test for the moderating relation in an analysis of variance, where it is represented by the interaction effect between the dependent variable and the factor variable.

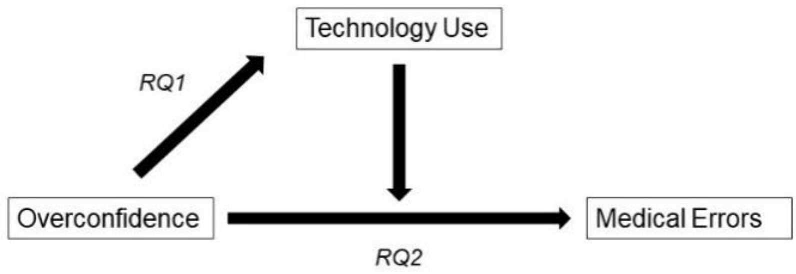

Figure 25.1. Model Development

25.4 Research Design and Data Analysis

Studying a complex decision in the healthcare domain offers tremendous potential. Because behavioral economic researchers rely mostly on experiments, it is a great opportunity to test their findings against other data [23]. As IS researchers have quite some knowledge in collecting and assembling observational datasets of technology adoption and use, these datasets provide a valuable source to fulfil this goal – also pointing at the potential of field experiments (e.g., in IT-mediated environments) to provide a middle ground between laboratories and observational data (ibid.). However, since there is no potential existing dataset to utilize, we propose a two-step mixed-methods approach to answer our RQs.

As noted above, physicians increasingly have many healthcare technologies at hand to decide whether or which one to use. Although there may be just one integrated healthcare information system for a hospital, especially resident physicians may have the luxury of multiple healthcare technologies. These can be various software, different possibilities for video consultation, sensor technology in medical devices or an integration of artificial intelligence (e.g., in the anamnesis of new patients). The multitude of technologies as well as their possible modes of operation is constantly increasing. Therefore, we do not want to commit to a specific technology in this work yet. However, the selection of a specific technology and a concrete application scenario is to be worked out in the proposed study directly at the beginning.

In a first step, we hand out a short survey to a group of physicians. We thereby want to answer RQ1 (*How does overconfidence affect the accurate adoption and use of technology by physicians?*). Table 78 provides initial questions regarding the proposed survey. Please note that actual objective answers are not available, but also not necessary, as the subjective answers illustrate a specific percentile of the entire reference population (e.g., top half) which makes the comparison of the percentage of people who believe they are in this percentile with the percentile itself meaningful.

Concept	**Selection of questions**
Tolerance to technology-related uncertainty [46]	It is fine for me that… …there are always new developments in the technologies we use. …there are constant changes in computer software. …there are constant changes in computer hardware.
Aversion to risk [24]	I am a cautious person who generally avoids risk. I am very willing to take risks when choosing a job or project to work on. I usually play it safe, even if it means occasionally losing out on a good opportunity.
Confidence in the appropriateness of technology adoption and use [adapted from 45]	How high do you rate the correctness of a patient's medical history created by artificial intelligence software? How likely is it that you integrate this information into your daily work routine?
Confidence around numerical estimates of technology use [adapted from 45]	In which year will the first fully electronic surgery take place?
Placement on rankings [adapted from 45]	To what extent are you taking advantage of telemedicine opportunities compared to your fellow colleagues? Do you think you finished your final exam in the top half of your class?'

Table 78. Sample Questions for the Later Survey

The survey will be piloted with 50 respondents. Its items are adapted from the ones provided by Pohl [45]. Since our institute has a large network of doctors (outpatient and inpatient), we then aim to distribute the survey to at least 200 physicians of all disciplines.

The specific discipline and the place of work (outpatient or inpatient) are controlled. First, we want to identify critical personality traits (e.g., tolerance to uncertainty, aversion to risk and ambiguity) and demographics. Second, we present questions pointing at overconfidence but disguise them as questions about general education and attitude (e.g., 'Do you think you finished your final exam in the top half of your class?'). Great exemplary questions are presented by Pohl and the collected authorship of his omnibus [45]. Because of the concealment, we will seek an ethical motion given by the University's ethics committee. Successively, we will inquire 1) the mean confidence in the appropriateness of technology adoption and use (e.g., (I) 'How high do you rate the correctness of a patient's medical history created by artificial intelligence software? (II) How likely is it that you integrate this information into your daily work routine?' (both questions rated on a Likert scale from 1-7)), 2) the subjective confidence around numerical estimates of technology adoption and use (e.g., 'In which year will the first fully electronic surgery take place?'), 3) the mean subjective placement on rankings (e.g., 'To what extent are you taking advantage of telemedicine opportunities compared to your fellow colleagues?' (on a Likert scale from 1-7)). These findings provide us a picture of the overall overconfidence among physicians as we expect that the physicians' confidence on whether and how to use a certain technology exceeds objective accuracy, that their subjective confidence intervals are oftentimes too narrow, and that they tend to better-than-average estimations of their own contribution or skills relative to others.

In a second step, we chose a qualitative research design as we seek to understand and interpret events from the perspective of the physicians involved. We thereby want to answer RQ2 (*How does overconfidence affect the medical errors made by physicians?*). First, we present a short film (3 min) about a typical treatment situation to each participant in which no medical mistakes are made. An interviewer discusses the presented situation in a semi-structured manner and asks (subsequently implicitly and explicitly) about the occurrence of cognitive biases (e.g., overconfidence and illusion of control). Second, we present a short film (3 min) to the same person about an atypical treatment situation in which a medical mistake is made. Again, the interviewer discusses the presented situation and asks (subsequently implicitly and explicitly) about the occurrence of cognitive biases (e.g., overconfidence and illusion of control). Then, the physicians are thanked and debriefed. The interviews are seen as beneficial to understand how overconfidence can impact medical errors, focusing on the individual cognitive processes of each physician. We identified a selection of exemplary questions concerning our proposed scenarios (c.f. Table 79).

Concept	Selection of questions
Overconfidence [among others adapted from 38]	How would you rate the likelihood of committing a medical error in this situation? How much would you rely on the presented technology when treating this patient? How would you rate the amount of risk factors? Do you feel that this situation is ambiguous?
Optimism [adapted from 26]	In this situation, … …the use of technology is enhancing our standard of treatment. …treatment will be easier and faster with technology. …technology is a fast and efficient means of getting information. …technology can eliminate a lot of tedious work.
Illusion of control [adapted from 29]	How would you rate the amount of control you have over this work situation? How would you rate the amount of control you have over your contribution to the well-being of this patient?

Table 79. Sample Questions for the Later Interview Guide

The quantitative part of the study is analyzed using empirical social research methods. On the one hand, a confirmatory factor analysis is conducted to check whether the three expected subcategories of overconfidence (i.e., calibration, precision of numerical estimates, placement of performance) are reflected in the data. The relationships are further studied by executing univariate and multivariate regression analysis. Next, the qualitative part of the study will be audibly recorded and transcribed. The analysis consists of the identification of analysis units and the definition and coding of structured dimensions. The transcripts are interpreted independently by two researchers and finally checked for intercoder reliability. The analysis phase closes with a quantitative evaluation, a final interpretation, and a derivation of recommendations for actions from the analysis units.

Figure 25.2 shows the proposed research agenda, the related RQ for each step and the sample as well as sample size. The first sample covers the physicians in the pilot test. The second sample encompasses the physicians in the actual survey.

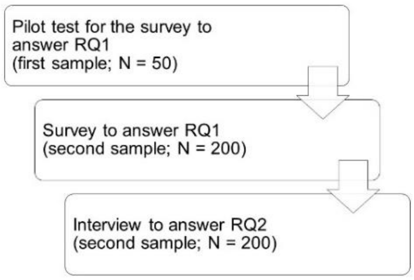

Figure 25.2. Research Agenda

We keep in mind that overconfidence might depend on the sampling procedure and how performance is assessed [45]. Besides, the sampling procedure can be confounded with item difficulty and overconfidence can co-vary with item difficulty. Besides these potential limitations, the advantage of our mixed-method study is that it provides a complete picture of the particularities of overconfidence and assumptions about the underlying mechanisms of technology adoption and use. The design is well suited to explain the physicians' reality. It takes advantage of both methodological approaches and minimizes associated pitfalls. As a result, the qualitative results can be statistically generalized, and the relevance and replicability of the quantitative findings can be increased.

25.5 Concluding Remarks on how to Beat Cognitive Biases by Design

Against the background that the healthcare domain faces major changes and challenges, questions arise on whether physicians can effectively decide which technologies to use in which setting and whether their technology use subsequently enhances treatment quality and thus patient safety. Literature on cognitive biases broadly looked at errors in judgment and decision-making, while questioning rational behavior. However, overconfidence, being one of the most common cognitive biases, has barely been linked to the accurate adoption and use of technology by physicians. We proposed a mixed-methods study based on the particularities of overconfidence. The study's main aims are to provide new insights that may affect patient outcomes (e.g., avoidable hospitalizations, complications related to a procedure, prevention of unnecessary tests or medication, etc.) and to help attenuate medical errors. To stress the importance of these aims, we briefly address the implications of our work.

Theoretical implications. To provide a holistic view on the IS domain, we invite future research to further compare our findings with established theoretical frameworks in IS research (e.g., theory of planned behavior). This can also mean adding further variables to the model (e.g., perceived ease of use, perceived usefulness). Since most literature about technology adoption and use is based on the rational choice paradigm, our investigation has the potential to question and test human decision-making and judgement. In addition, there is a chance that IS research and behavioral economics research travel together and learn from one another. Moreover, a theoretical direction is that the effects of biases can be manipulated by nudging humans in directions that will make their lives better and easier [58]. Thus, the nudge paradigm is seen as very promising in the healthcare domain, too, and opens the door for further question on the physicians' technology adoption and use. Digital health solutions that incorporate nudges [e.g., interactive text-message reminders or haptic medication alerts, see 56] might create innovative pathways and can be studied as use cases.

Implications for practice and design. As an outcome of our research, it can be discussed how technology can be designed to reduce overconfidence of physicians. Thus, future research can promote direct insights into how to design technologies for everyday medical practice to reduce medical errors. Future quantitative studies can objectify and embed these results. On top of that, future work is invited to review existing tools to reduce the occurrence of cognitive biases (e.g., checklists, cognitive calibration) to provide further recommendation on how to reduce overconfidence. When it comes to training and education for physicians, one can also think of new digital technologies such as augmented reality and virtual reality, which have a demonstrably positive effect on learning success. Since effective educational strategies are needed to overcome the effect of cognitive biases on medical judgement and decision-making when adapting and using technology, prospective studies evaluating and comparing different training strategies are highly valuable.

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26. Paper 20: Digitally Influenced Relationships

Title	**Constituting Factors of a Digitally Influenced Relationship between Patients and Primary Care Physicians in Rural Areas**
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Table 80. Fact Sheet Publication

Constituting Factors of a Digitally Influenced Relationship between Patients and Primary Care Physicians in Rural Areas

Abstract. *In times of an ageing society and a rural exodus ofprimary care physicians, healthcare systems are facing major challenges. To maintain comprehensive care and an equitable access to healthcare services, today's technological advancements represent a promising measure. Technologies empower patients by providing innovative tools such as sensors and applications for self-measurement, leading to self-initiated interventions, while supporting physicians in handling rising demands through telemedicine and spatially detached solutions. These enhanced treatments come with patient and physician-sided challenges such as incorrect digital information provided to the patient, negatively affecting treatment quality and leading to high issue resolving efforts. To investigate the perspectives of rural physicians on treatment digitalization and effects of patient empowerment, we conducted a qualitative study using semi-structured interviews. Our findings show that patient activation, impacts on treatment process, patient differentiation, and patient-physician-interaction are relevant factors in the physicians' valuation and willingness to use health technologies.*

26.1 Introduction

In times where digitalization and innovative tools have an impact on multiple areas of life, technological advancements promise benefits for therapeutic treatment processes and healthcare in general. The possibility to overcome long distances, while technical limitations are declining due to structural expansions and governmental investments, enable an unprecedented and timely alternative to common care structures and processes. Today's healthcare systems exhibit shortcomings that threaten the maintenance and stable provision of comprehensive care. In many countries and rural regions in particular, the endemic healthcare system is hardly suited to adequately face ongoing demographic changes and the rising numbers of age-related health issues [9]. Increasing patient numbers lead to a demand surpassing the current healthcare supply, which is reinforced by medical professionals and graduates moving to urban and often more attractive regions. The resulting rural undersupply leads to a spatially as well as temporally limited access to care and an inequitable distribution of care facilities [36]. This development increasingly pressures practicing physicians and professionals.

Technologies potentially provide alternatives to analogous, location-based, and often unilateral care [20]. For instance, modern communication tools such as live video conferencing enable geographically detached physician consultations [18]. Body-worn sensory equipment, ranging from medical products developed for health and treatment purposes to consumer technologies such as smartwatches [27], further enable mutual therapeutic processes in which patients take more active roles by measuring their personal vital signs [23], informing themselves about health issues and treatments [1], and showing increasing degrees of overall health literacy [17]. Both examples show how to overcome mobility issues caused by illness or infrastructural shortages.

Since digital innovations empower patients and physicians in either managing their condition or performing treatments and work processes in the face of high demand, new questions and challenges arise. On the consumer side, patients are confronted with a plethora of available technologies and health-related information offered by the internet and mHealth applications. Difficulties arise when a user needs to judge on what technologies to use and how, which represents a major factor in ageing societies [14]. Furthermore, while potentially delivering benefits for effective self-management and behavior in case of health issues, the assessment of information and data can lead to misinterpretation, misguidance, or excessive demand, while information quality and correctness is oftentimes questionable [29]. On the provider side, physicians and medical staff are obliged to incorporate technological solutions into their work routines, supplementing or even altering their way of working. They need to acquire competences to implement digital processes and to use the provided devices in an efficient and appropriate way [6], while guidance and financial support is oftentimes scarce [31]. In addition, physicians must deal with issues arising from patient-sided activities and empowerment. Problems originating in misusing, misinterpreting, or relying on flawed information led to an increased workload to resolve these issues and safeguard treatment quality and patient health [1].

Consequently, bringing together challenges in rural areas and the perceptions of physicians regarding the application of health technologies for patient treatment as two major factors influencing successful IT implementation and adoption, the physician perspective needs to be illuminated in more detail. To date, research on how physicians in rural areas perceive, anticipate, and evaluate treatment digitalization and accompanying patient empowerment under the light of emerging challenges is scarce. We conducted an explorative, qualitative study in the form of seven semi-structured interviews to investigate and fill this gap. Thus, our paper contributes to our understanding of the potential impacts, benefits, and issues that arise from digital interventions in rural areas, enabling the design of needs-based and acceptable solutions in times where IT adoption rates in healthcare are low [16]. To gather perspectives rural physicians have on applying technologies in patient treatment, the interview guideline used in our study covers questions on (1) the interviewees' general perceptions regarding rural healthcare, digitalization, job and patient related factors, and (2) assessments of a concrete technical setting. This setting describes a video-conferencing tool that can be used for patient-physician communication, supplemented by sensors that capture data and transfer them to the physician. We see our paper as an initial step of investigation where we focus on the physician side. Perspectives of the patients, thus, remain a future research topic enabling comparative studies and insights. The study at hand is guided by the following research question (RQ):

> ***RQ:*** *What factors constitute the perspectives of physicians on the utilization of patient-empowering digital technologies in rural areas?*

26.2 Theoretical Background

As a theoretical baseline for our study, we look at related work concerning patient empowering effects of healthcare and treatment digitalization as well as specifics of rural areas that affect the applicability, necessity, and evaluation of digital interventions.

Digital Patient Empowerment

Whereas traditional treatment settings commonly involve bilateral relationships between patients and physicians based on interpersonal factors [13], the introduction of digital technologies into therapeutic processes creates trilateral scenarios by introducing health technologies as a third actor in the treatment process [34]. Besides the physician and the patient, technologies can take active (e.g., by actively informing the user when certain parameters surpass thresholds) and/or passive roles (e.g., by solely reacting to user queries such as health information retrieval) supplementing treatments by, for instance, measuring health data [22, 35], delivering information [19], or enabling communication [18].

Health technologies and digitized treatment support enable a deliberation of healthcare service provision as well as treatment execution and adjustment, empowering patients to take more care of themselves and increase their levels of health efficacy. As a result, "*[a]dvances in technology have empowered patients to be informed, which enabled them to play* *an active role in clinical encounters with the doctor*" (p. 1) [26]. As an essential characteristic of the deliberative physician-patient relationship model, Emanuel and Emanuel [10] describe that "*[…] the aim of the physician-patient interaction is to help the patient determine and choose the best health- related values that can be realized in the clinical situation*" (p. 2222). The model stipulates that the physician should suggest which health-related values should be pursued and, based on that, figure out the best and most desired way of treatment in cooperation with the patient. Physicians and patients step into a co- creation of therapeutic treatment [26].

Looking at current advancements in digitally supplemented healthcare such as the technology- enabled self-measurement of vital parameters (e.g., via smartwatch) or looking up and discussing health- related information online, deliberation takes place in a new form. Values about diseases, appropriate therapeutic measures, and desired outcomes can be increasingly generated and assessed by the empowered patient [34]. Through activities like information seeking and accessing health-related information via the internet or peers, patients oftentimes form expectations and preconceptions on (a) their condition and (b) what treatment allegedly suits them best before even consulting a physician or therapist [34]. As a result, patient empowerment leads to an increase in patient-sided sense of mastery and control as well as self-efficacy and potentially improved decision-making [5]. This development has several implications for both healthcare providers and consumers. While digital tools have the potential to improve and, in case of rural undersupply and scarce access to care, enable treatments without temporal and spatial bounds, technologies can have negative impacts as well. Misunderstandings and potentially harmful actions patients may take based on flawed information [29] have to be counteracted by physicians and technology providers as well [1]. Consequently, the examination of patient and physician perspectives on treatment digitalization is of major importance for health technology design, application, and evaluation.

Specifics of Rural Healthcare

Rural areas exhibit several characteristics that influence the applicability and necessity of digital interventions as a supplement for care processes and structures. In addition, the given rural circumstances potentially shape the way people perceive, adopt, and use technologies implemented to support treatments and enable access to care.

Healthcare issues in rural areas appear in different forms. For instance, environmental, geographical, and infrastructural circumstances can lead to adverse and inequitable spatial distributions of care facilities and professionals [36]. Patients as well as physicians are obliged to travel long distances either to consult a professional or to visit patients in need of care at home [3, 7]. Furthermore, many physicians and young medical graduates tend to practice in urban or suburban areas [30]. The rural exodus of healthcare professionals, inter alia, is driven by a huge (on-call) demand for care while supply is scarce, leading to exhaustion and work-life-balance issues [33], and (perceived) benefits of structurally stronger regions such as the quality of education [37], attracting physicians to settle. In addition, rural areas suffer from inferior access to specialized and appropriately educated healthcare providers as opposed to urban areas [15]. Hence, the rural population faces greater issues regarding the availability of specialized practitioners (e.g., cardiologists), leading to a lack of supply beyond treatment of common diseases and basic care. Further, studies report on barriers towards healthcare that rural areas struggle more with compared to urban areas. Besides others, resource limitations (e.g., the lack of colleagues that physicians can consult for council), confidentiality limitations (i.e., concerns about reporting sensible data to authorities), and overlapping roles (i.e., physicians meeting clients in private life) are increasingly noticed [3]. As a result, disparities about access to care and population-wide health status emerge [28] and "*[…] traditional concerns about access to primary and hospital care continue to dominate rural health policy*" [12] (p. 1675).

However, while potentially delivering benefits for maintaining a comprehensive care soon, technologically supported treatments come with challenges. For instance, digital tools require a certain degree of skill and efficacy, rendering a proportion of patients and physicians unable to use them. Especially in times of ageing societies, which particularly emerge in many rural areas across both developed and developing countries [2, 8, 39], this issue becomes apparent and calls for higher involvement and guidance [14, 25]. In addition, valuation of technology is often rooted in social cues and opinions that affect users' adoption and use behavior. This effect is potentially reinforced by rural structures, where health literacy can be low [38] and trust often solely roots in statements and assessments by professionals [13]. This can impede the effectiveness of health information delivered by technologies. However, as studies have shown, the willingness and confidence to use telemedical systems does not significantly differ when comparing rural and urban

populations [11], showing that the path for telemedical systems in healthcare can be made once sufficient education is provided and awareness granted [21].
The circumstances found in rural areas and populations described above illustrate the need for a dedicated investigation of rural areas as a reasonable space for digitalization. Literature has unveiled significant issues and barriers healthcare providers as well as consumers have to deal with, further motivating the study at hand. Apparently, physicians are facing major challenges when providing comprehensive care, reinforcing the issues associated with the future application of health technologies for patient treatment. Their perspectives on the potentials as well as constraints of health technologies are identified as a major scientific and practical demand.

26.3 Methods

Case Description

We conducted a qualitative study involving seven semi-structured interviews with primary care physicians. The study took place within a regional project on digitalization of primary care practices and processes. One major focus is the investigation of health technology acceptance by rural primary care physicians, which are potentially obliged to implement, adopt, and continuously use technological tools soon due to declining amounts of accessible physicians. Here, the perceived influence and impact of digital tools on the patient-physician relationship, the treatment process, and the physicians' performance form promising predictors of technology acceptance and adoption behavior.
The technological setting that our empirical investigation is based on consists of three incremental versions of a telemedicine system for patient communication, treatment, and diagnosis: (1) Establishing a live video conference between a spatially separated physician and patient, enabling face-to-face communication and basic examinations (e.g., check for wounds or skin abnormalities via webcam). (2) Enhancing the video solution with body-worn sensors that can measure relevant vital parameters (e.g., blood pressure). The captured data can be transmitted to the physician without temporal restrictions, enabling an immediate inspection by the physician. As a result, the physician can adjust the treatment and, if needed, arrange a physical meeting. (3) Analyzing the data right after its acquisition, for instance by using Artificial Intelligence (AI) algorithms that pre-analyze the data before the results are transferred. Consequently, the physician has the option to

only receive information gathered from the raw data, such as incidents where given vital parameters surpass critical thresholds and call for intervention. This contains the potential to save valuable time since the expert does not have to look through all the data arriving throughout the day.

Data Collection and Analysis

The seven interviews took between 50 and 120 minutes (75 minutes on average) and were conducted on the physician site. We followed a convenient sampling approach. Interviewees were recruited via a regional governmental gatekeeper reaching out to physicians willing to participate in the aforementioned project. The sample yielded three female and four male interviewees. Interviewees were aged between 41 and 66 years (52 years on average) and had between

15 and 34 years (25 years on average) of job experience as a physician. Due to the recruitment process, all participants were in the same region dealing with comparable circumstances. As a prerequisite to gather meaningful and rich data, all participants exhibit a sufficient degree of technical affinity and interest enabling them to fathom the technological setting and potential impacts.

The participants were interviewed in two blocks on two consecutive days due to temporal limitations originating in the physicians' time schedule and obligations. The interview guideline was not changed between sessions, representing a non-iterative procedure. This led to an ex post data analysis that was performed after the last interview had been conducted. In doing so, we tried to increase variance in physician perceptions while reducing bias by extending interviews with previous findings.

The interview process consisted of two phases. In phase one, the interviewees were asked about their general opinion on the state of rural healthcare, associated opportunities and challenges for change, and their own job-related conditions. In addition, we asked for the participants' view on digitalization, particularly in healthcare and patient treatment. Sample questions are "*What chances and risks do you see regarding progressing digitalization?*" or "*Are you willing to digitalize your practice in the future?*" In phase two, questions revolved around the technical setting described above. After introducing the scenario involving three incremental system versions, interviewees were asked to assess the described digitized setting regarding feasibility, functionality, usefulness, as well as arising challenges and issues that are associated with implementing and using the system. Sample questions are

"*Do you consider the described system suitable for daily use?*" or "*What do you think is important for patients to accept the system?*" This two-phased approach allowed us to gradually increase the questions' reference to digitalization, thus gathering more general as well as specific data on the physicians' perspectives on health technology. The interviews were conducted in German, audio recorded, and transcribed non- verbatim while containing the meaning and formulation. For analysis, it was translated into English.

For data analysis, we followed a Grounded Theory approach consisting of open, axial, and select and passages are assigned with (partially in vivo) labels. After that, axial coding seeks to categorize open codes that relate to the same phenomenon and meaning. Finally, selective codes are identified that can describe and subsume all axial codes.

The coding procedure was performed in three steps, following, and adapting the procedure described by Mueller and Heger [24]. First, two of the authors independently coded the data. This led to two separate schemes including open, axial, and selective codes. Second, the authors discussed and compared their schemes. For that, open and axial codes were reframed, partially renamed, and finally merged into a new categorization scheme. Next, the authors analyzed whether the identified selective codes withstand, or new categories arise. This led to a new comprehensive scheme involving 4 selective codes and 9 axial codes. Table 81 shows a coding example. Third, each author re-coded the data according to the agreed coding scheme. Subsequently, the assignment of elaborated codes to the data was discussed once more, resolving disagreements, and yielding in a final data coding.

Open Code	**Axial Code**	**Selective Code**
"In the past [...] you have looked something up in books or magazines, today you visit the Internet. The self-treatment is not wrong, takes place at any time [...]" (Interviewee 6)	Patient Self-Information	Patient Activation
"Many [patients] come with [...] the most dramatic and severe they could find [...] and so they arrive already frightened because they can't deal with what they read and ultimately can't classify it." (Interviewee 4)	Patient Insecurity	

Table 81. Coding Example

26.4 Findings

Based on the seven interviews, we built four main categories to generalize relevant content regarding our research question: (1) Patient Activation, (2) Impacts on Treatment Process, (3) Patient Differentiation, and (4) Patient-Physician-Interaction. Each main category comprises subcategories, which can be considered as an accumulation of axial codes. To prevent the potential identification of interviewees, for instance by delineating interviews by means of their order, we assigned each interviewee a random number [24].

Patient Activation

We divided the main category **Patient Activation** into three subcategories: *patient self-information*, *patient insecurity / unwanted framing* and *patient motivation*. The first subcategory *patient self- information* contains statements about the effects of a digitally assisted confrontation of the patients with their own symptoms or process of disease from the physician's perspective. Frequently, those statements refer to a patient self-initiated internet research of symptoms before visiting the physician's practice. The majority of physicians appreciated a proactive informational process of patients: "*I even recommend doing research, but for example I mention patient organization […]. There are even apps for young people from companies containing fantastic information [...].*" (Interviewee 7). Two participants highlighted the benefits of a preceded research by the patient because of its impact on a dynamic therapeutic process: "*[…] I like that, because it's always good if there is an informed patient than to explain everything from the beginning. Most of the time, patients know relatively well what it is about […]*" (Interviewee 5) or "*[...] Actually, I appreciate it when there is a patient with advance information. This way, you can sort things out for them, sort things out with them together*." (Interviewee 2). In contrast, the second subcategory *patient insecurity / unwanted* framing describes the physician's view on mostly negative effects from self-initiated internet research. These effects are related to a process of manifesting a special belief or assumption of a possible diagnosis for the patient's own symptoms or rather pathology: "*Well, the middle generation, youths as well, they are reading a lot on Wikipedia and sometimes, as a result, there appear some curious things and of course this is what makes them feel even more insecure […].*" (Interviewee 6) or "*Most of them got anything from Google. Most of the time, always, it's just the most dramatic and severe they could find. A small pigmentation becomes syphilis and so they arrive already frightened because they can't deal with what they read and ultimately can't classify it.*" (Interviewee 4). While Interviewee 4 and 6 describe tendencies of the patient to consider the most pessimistic interpretation of specific symptoms because of a lacking ability to differentiate, one physician mentioned the patient's general need to interpret their symptoms as a possible explanation: "*Sometimes a lot of those stressing reactions are simply masked, people are looking for something to fit their symptoms and don't recognize where it is actually coming from.*" (Interviewee 3). The participants described consequences of those unwanted effects as well: "*Well, in this way, you always encourage illness- awareness as well, not just health-awareness. That is not good.*" (Interviewee 5) or "*[…] you are questioned when you don't say the same thing that is on the internet, then you aren't a good physician, I mean then, you didn't think of it as an important thing to mention […]*" (Interviewee 3). While the first two subcategories of Patient Activation refer to different facets of an informational process, patient motivation characterizes an actual intention to act due to collected information or technological opportunities. Physicians portrayed hypothetical and present motivational effects relating to digital technology, e.g., a shortened time period until a therapy might start or the time-saving use of online requests for prescriptions: "*[…] but some might come earlier, so that they don't delay three weeks, but have a shorter way […]*" (Interviewee 3) or "*[…] but also elderly patients manage to use it well or ask their relatives for help and don't make their request personally here in our practice, but the electronic way is used more and more.*" (Interviewee 2). Built from the subcategories, **Patient Activation** comprises patients' use of technologies to self-manage their own symptoms or process of disease with different outcomes on a therapeutic situation concerning physician and patient, while the physicians' perspectives include hypothetical and actual effects.

Impacts on Treatment Process

We divided Impacts on Treatment Process into the subcategories *effort reduction/increase* and *technological reliability*. While the hypothesis appears appropriate, that nearly any factor concerning the digitalization of primary care practices might influence the treatment process itself, some aspects of the mentioned subcategories were stated explicitly in the interviews. In our first subcategory, physicians state their believes and experiences in terms of beneficial or adverse use of digital technologies as well as perceived technological boundaries for therapy. On the one hand, high expectations of positive technological effects are mentioned: "*[a faster] communication […] with a safe connection, that would make work easier.*" (Interviewee 6) or "*With help from telemedicine technology you* *could spare some time…he [the patient] doesn't have to come, I don't have to visit…that's a real advantage.*” (Interviewee 5). In this context, not only aspects of a time-winning communication were referred to, but also hypothetical advantages of new data infrastructures: “*[…] you got access to patient's data fast, e.g., from a cloud […]*” (Interviewee 6) or “*Home visits cost a lot of time. If you are able to select by necessity […] you could save a lot of time.*” (Interviewee 1). On the other hand, skeptical quotes were extracted from the interviews. Participants worried about additional efforts caused by new technology: “*All in all it [telemedicine] might be useful for trivialities, but the time it takes might exceed the time I spend during consultation hours.*” (Interviewee 6) or “*If you have to differentiate it [data] yourself in the first place, I don't know if it really is time saving.*” (Interviewee 6) or “*No, it's not helpful. It [patient's insecurity through internet research] takes time.*” (Interviewee 7). One physician concludes that complexity and usability of technology might be a reason for reservation: “*It is [online appointment allocation] not wanted in our practice, because it's said that nobody is able to operate it, to manage it technically.*” (Interviewee 3). Furthermore, one physician drew parallels to a consumer-oriented self- conception of patients causing additional efforts: “*[…] if every patient […] has the right to consult his physician via monitor, you are faced with an uncontrollable flood of demands. That won't work of course.*” (Interviewee 5). Conclusively, physicians formulate technological reliability as an important factor concerning Impacts on Treatment Process. Differentiated from possible boundaries, a lack of security worries or scares the interviewees: “*Strangers having access to data or misusing data, possibly having different interests than our patients.*” (Interviewee 1) or “*I'm noticing a huge risk in not realizing a decent data security.*” (Interviewee 5) or “*Privacy, that is important […] see what's already been hacked, we're scared of course.*” (Interviewee 4). Together, both mentioned subcategories explicate conditions and hypothetical effects of a medical digitalization from the physicians' point of view, illustrating technology-related expectations.

Patient Differentiation

During the interviews, physicians outlined specific differences between potential or actual users of healthcare-related digital technology. We merged those contents to our third main category **Patient Differentiation**, including the two subcategories *case dependency/characteristics* and *stereotyping*. While the first category contains statements in which physicians explained or justified a differentiated hypothesis about patient's use of technology, the second category includes heuristic and generalized statements about a large group of patients or people. As an example for the first subcategory case *dependency/characteristics*, one physician emphasizes individual technical skills and competencies of their patients: "*That's [use of online requests for prescriptions] totally various. Most of our patients under 30, of course, but our elderly patients […] as well […] are getting help from their relatives […]*" (Interviewee 2). Additionally, physicians differentiated the benefit of technology use about specific patient groups, e.g., known/unknown patients, chronical/non-chronical patients, and severe/non-severe diseases: "*Concerning chronical patients it [telemedicine] might be useful […]. As said before, in exceptional cases […] for bedridden patients, patients with a severe disease […]*" (Interviewee 5). Besides type and seriousness of disease, the status of a personal relationship between physician and patient was seen relevant: "*Anyway, I would only consider it [telemedicine] useful for patients I already know. Where I know their surroundings.*" (Interviewee 1). One physician expressed their idea of filtering patients that might be able to use and accept telemedicine services: "*Eventually, you need someone to select those patients fitting […]*" (Interviewee 3). Another participant concludes a need for individually configurable algorithms analyzing patient data: "*Geriatric patient's measurements […] it needs different thresholds […] I should be able to determine a threshold value for an algorithm […] a standardized configuration, that's not possible.*" (Interviewee 2). Unlike examples of underlining individual characteristics of patients' technological competencies, several statements of the participants generalize patient groups in terms of their age or place of residence: "*In urban areas I envisage a use of online appointment allocation […]. Here, that's not possible.*" (Interviewee 6) or "*Our generation, surely [accept telemedicine services] but not elderly people, they struggle with those things.*" (Interviewee 3) or "*I think it depends on their age [use of telemedicine services]*" (Interviewee 3). As well as the other two main categories, **Patient Differentiation** shows an ambiguity between individualizing and generalizing patient characteristics.

Patient-Physician-Interaction

In our last main category, we explicate the physicians' statements concerning their experience in their therapeutic relationship to a patient. In contrast to **Impact on Treatment Process**, the category **Patient- Physician-Interaction** does not include general aspects but ones of direct, situated interaction between patient, physician, and technological artefacts. We divided this category into the two subcategories *physician-patient collaboration* and *personal/bodily contact*. The first subcategory concerns strategies to actively deal with a modified informational state of patients using online sources to fathom their symptoms: "*Everyone has ideas about something. I've got my ideas as well and as a consequence […] we try to bring them together […]*" (Interviewee 6) or "*I'm telling my patients: You might read everything you like, write it all down, but visit me afterwards and talk with me about it.*" (Interviewee 7). In this context, one physician pointed out the need to accept the patient's own research to integrate it into the therapeutic process: "*That [patient's worry about self-researched symptoms] is just the way it is - you have to take care of it, you have to sort things out.*" (Interviewee 4). Therefore, physicians state in which ways they deal with effects of modern information technology (as mentioned within the main category **Patient Activation**). While it might appear conceivable that the participants mention similar solutions for other technological novelties, especially telemedicine services are considered more of a limiting aspect for interaction. Physicians underline the consequent lack of personal or bodily contact constituting the second subcategory: "*When complex problems occur, it is sometimes important, to have personal contact […] that means to meet the person and see his surroundings.*" (Interviewee 1). Two physicians described their intuitional perception of a patient as an important factor for diagnosis and the lack of it using telemedicine systems: "*You are feeling it, don't you? And that's absent in a video […] you can't touch him or her [patient].*" (Interviewee 6) or "*And […] I don't feel the patient. I can't describe it […] you got a feeling that is appropriate most of the time.*" (Interviewee 6). The decrease of social interaction within a therapeutic process through a telemedicine system appeared to be another possible reason for a rejecting position: "*Because personal contact is very important, especially for elderly patients or those in need of home visits being helpless […]*" (Interviewee 2). One physician summarized the perceived disadvantages: "*Generally, contact between physician and patient is always important […] the way somebody speaks, acts, walks through the door…are things a video can't show […]*" (Interviewee 5). While these statements sound resolute, more relativizing perspectives can also be reported from one interview: "*[…] sometimes it is important to touch a patient. It doesn't have to be at the first visit, but it has to be possible some time during the treatment process […]*" (Interviewee 2) and "*[…] because fundamental trust is necessary, you can't gain it electronically and for patient's treatment it is mandatory.*" (Interviewee 2). Hence, our last main category describes a physician's direct involvement with challenges arriving through aspects of medical digitalization, differentiated in already experienced solution strategies and hypothetical limits of telemedicine services.

26.5 Discussion

Noteworthy, physicians contrasted the patients' self-management in the form of self-initiated research concerning symptoms or their process of disease through (1) more positively perceived and (2) more negatively perceived **Patient Activation**. One might assume that from the physicians' perspective, the outcome of a patient's self-initiated process of information, which can be viewed as a digitally assisted empowerment, depends on his ability to select, sort, and analyze information relating to their symptoms or process of disease. While a neutrally informed patient appears to be preferable, a deep analysis of information might frame a patient so sustainably, physicians perceive a need to revise the patient's belief resulting in a time-costly effort and/or a negative effect on the relationship between patient and physician. To reconstruct a patient's self-initiated informational process might be an interesting approach for future work to understand motives and motivations, probably on a way to a self- made diagnosis. Subsequent work might be able to formulate implications for a precise and self-reflected way for patients to gather health-related information affecting themselves or relatives.

By means of the second main category, **Impacts on Treatment Process**, the physicians' expectations related to digital technology use in practice can be described simultaneously. Concerning our interviews, the main factor to measure reduction or increase of effort might be the time spent on a specific task. Because many physicians in rural areas have a high case ratio, a deducted hypothesis might be that the benefit of digital technology and the intention to use it depend on the actual time saved or caused by it. As a factor probably predicting a physician's intention to use health-related digital technology or as a measure of technological usability, 'time spent on a specific task' might be considered as a variable in future studies (especially as a pre-post comparison), but not without critically reflecting on an increase in efficacy for merely economic reasons.

Regarding a differentiated view on a patient's technological abilities and intentions, physicians considered the individual use of technology they already knew (e.g., online requests for prescriptions) or thought helpful (e.g., telemedicine services for well-known patients), positive in some cases. Considering a specific technological novelty not practical or useful, physicians underlined basic differences between patient groups (e.g., old vs. young). Cautiously hypothesized from quotes of our main category **Patient Differentiation**, physicians might sometimes justify a misuse of technology with stereotypes or generalized statements about their patients. Discussing stereotypes as well as perceived barriers of use and clarifying technical obstacles might be considered an important aspect of health-related technological implementation and practice.

Statements from the main category **Patient-Physician-Interaction** demonstrate a physician's strategy to adopt technological aspects concerning their relationship with patients directly. To deal with partially worrying or misinterpreted information patients gather from online research, physicians formulated an understanding dialogue or process of negotiation as a possible solution. This might be considered an interesting example for an adaption of digital-technological change into the relationship between physician and patient. Besides, physicians seem to consider a personal or bodily presence of the patient an essential component of the relationship between patient and physician. Despite relativization, absence might function as a limiting factor of technological novelties and their implementation. This result can be seen as a possible impulse to increase theoretical work on phenomenological approaches to digital technology in healthcare, as it already is discussed in the medical field [4]. Similarly, specific technological requirements, such as the necessity to see the patient within their surroundings (i.e., not isolated from it) or to experience haptic feedback, are implicitly stated in our interviews. For us, especially the seeming contradiction of telemedicine services and sophisticated primary care is considered an innovative and challenging field for future work.

26.6 Conclusion and Outlook

Following our research question, we examined factors constituting physicians' perspectives on patient empowerment through digital technology. Findings of seven interviews with primary care physicians suggest that level and quality of informational knowledge attained through online resources affect the view on a patient. While an objective and reserved handling of information by the patient is seized as an improving factor, physicians may consider a restricted belief about a patient's own symptoms disruptive. Additionally, the interviewees valued the usability of digital health-related technologies as well as possible resulting empowerment of patients according to the effort of time needed to fulfill a task with or without its help. Furthermore, the interviewed physicians classified patients' capabilities of technology use due to their individual or general characteristics (e.g., morbidity, age). As a constituting factor, physicians described the direct effect of technology on a personal (bodily) relationship between themselves and their patients.

Our empirical study underlies some limitations. First, we did not differentiate our sample and the gathered data by areas of expertise and potential specializations. Whereas all of the interviewees are practicing in primary care, some of them are specialists in certain areas (e.g., diabetes). In addition, prior studies identified age influencing IT adoption and assessment [25], which we did not factor in as well. Further, all participants reside in the same area, thus neglecting potential regional differences (e.g., about population size and characteristics). Considering these differences during data collection and analysis could yield new insights. Second, we have engaged a rather small sample size using a convenient approach, affecting the external validity of our findings. Addressing a wider population, for instance by deploying quantitative methods such as broad surveys, yields more generalizable insights.

Our study at hand opens several future research opportunities. First, our findings motivate the formulation of hypotheses testing the effect identified factors (i.e., main categories) have on important dependent variables such as behavioral use intentions and actual IT adoption and use behavior. For instance, perceived patient insecurity occurring when using health technologies might negatively influence physicians' intentions to use such a system. Second, the investigation of patient-sided perspectives on the digitalization of treatments and the accompanying empowerment through digital tools can deliver novel, complementary, or even conflicting insights. The comparison of health consumers and providers, thus, represents a fruitful avenue for subsequent studies.

26.7 **References**

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III Digital Innovation

27. Paper 21: On Implementing Design-thinking Collaboration in Smart Cities

Title	**Invite Everyone to the Table, but not to Every Course – How Design-thinking Collaboration can be Implemented in Smart Cities to Design Digital Urban Services**
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Publication Outlet	Electronic Markets – International Journal on Networked Business
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Table 82. Fact Sheet Publication

Invite everyone to the table, but not to every course – How Design-Thinking collaboration can be implemented in smart cities to design digital urban services

Abstract. *Innovative-collaboration strategies are a promising tool for fostering the governance of smart cities while acknowledging citizen centricity. During implementation, however, determining the number and background of the involved actors is challenging. The Design-Thinking (DT) approach appears suitable for addressing this issue as it offers a concrete and adaptable course of action. The present contribution involves a study on implementing DT principles in a German health resort and identifies three critical components: (1) team, (2) process, and (3) workspace. Our use case is an adaptable project- and workshop plan that encourages the implementation of DT collaboration in smart cities when designing digital urban services. Our results provide initial guidelines on how to involve diverse actors, when to integrate trained DT coaches, and how to design innovative collaboration in a digital way. The practice-oriented insights gained in the study can be applied, adapted, and discussed in other smart cities and citizen-centered projects.*

Keywords: *Smart City, Smart Governance, Citizen-Centric Government, Innovative Collaboration, Design Thinking, Digital Services.*

27.1 Introduction

Today, information and communication technologies (ICT) are used in big cities and small municipalities alike for the creation of new societal developments. However, a technology-focused perspective on smart-city development often excludes citizen involvement. While an informative and constructive exchange between residents and their representatives can lead to solutions that shape life in a social, ecological, and economic sense, smart governance encourages the development of smart-living environments (D'Onofrio et al., 2019). A citizen-centered approach can enable the development of new socio-economic and participatory models of society.

As tremendous need for collaborative innovation in smart cities exists (Wegrich, 2019), public managers and elected officials must make use of new problem-solving tools in order to account for today's "wicked problems" (Linders, 2012). A multi-actor collaboration strategy in the public sector (Torfing, 2019) may help provide the information needed to develop these tools. Such a collaboration can foster "thinking outside of the box" and lead to the development of practice-oriented solutions that can be immediately tested and evaluated. The Design-Thinking (DT) approach appears suitable for implementing such a strategy and taking collaboration in smart cities to the next level because its principles (e.g., radical collaboration, experimentation, prototyping,) reflect the citizen-centered, problem-solving perspective of collaborative innovation while being concrete and adaptable.

The DT approach can be useful in addressing central challenges to today's smart cities, including how to access, process, and use data in the urban landscape (see Finger & Portmann, 2016; Tabacchi et al., 2019). To determine the effectiveness of this approach, we investigate a joint project between seven German municipalities that utilizes in the concrete implementation of a project based on a use case. To use urban knowledge and to redesign the information exchange in these municipalities, we place equal weight on technical and human factors in the design process. Moreover, we promote transparent collaboration between partners (universities, businesses, administrations, and society).

Our analysis involves a use case in which traditional health resorts are intended to be transformed into modern health resorts as well as attractive residential and business locations. Germany has more than 350 health resorts (*Kurorte* and *Heilbäder*) that combine health services and therapies, treatment programs, naturopathic treatment, wellness programs, nutrition programs, and tourist offers. However, the number of visitors and the average length of stay has been decreasing over the past two decades, and an innovative approach to remaining an important healthcare provider is thereby needed. In redesigning these health resorts, we highlight the value of a user-centered solution that is implemented via DT collaboration. While our project clearly only represents one scenario in a small number of rural municipalities, it offers a valuable starting point for drawing conclusions about how to implement a multi-actor collaboration strategy in the public sector.

Using information systems (IS) and Design Science Research (DSR) (Hevner et al., 2004), we derive a theory-driven, practice-oriented concept for smart cities with the aim of translating citizen centricity into action. In greater detail, we draw on the work of Peffers et al. (2007), Sonnenberg and vom Brocke (2012), and Sturm and Sunyaev (2019) in developing a DSR framework. Our research question (RQ) is:

> ***RQ:*** *How can DT collaboration be implemented in smart cities in the designing of digital urban services?*

In answering this question, we offer three main contributions: First, we provide a toolbox for transparent and participatory collaboration in smart cities. Second, we add to literature by demonstrating how information exchange between citizens and public representatives in smart cities can be improved. Third, we contribute to existing theoretical knowledge and provide new information that can be used to inform smart-governance models. Our insights can thereby help inform future practice, design, and research.

The manuscript is structured as follows: First, we describe the current state of research and highlight the streams of innovative collaboration and DT. Second, we derive a suitable method for answering our RQ while keeping in mind our health-resort use case. Third, we switch from theory to practice and share insights on the concrete implementation of our use-case-based project. We illustrate our findings and the resulting design rationales, which lead to a guiding project plan regarding how to actually implement DT collaboration when designing digital urban services. Fourth, we discuss our insights and address exemplary solutions to the challenges as well as the limitations of our work. Finally, we provide a summary and suggest avenues for future study.

27.2 Theoretical Background

Innovative Collaboration in Smart Cities

Managing urban and rural areas is one of the most important social and economic requirements of the 21st century (Gil et al., 2019). This management poses challenges to infrastructure, education, health, security, and energy alike and thus goes hand in hand with vast socio-economic problems, such as resource scarcity, poverty, and the digital divide. To address these issues, local processes of societal and economic reform have been increasingly often discussed in recent years. In addition to growing research on metropolitan regions and big cities, a deeper understanding of rural regions is needed as the people who live in these regions are equally culturally diverse. Notably, however, a higher proportion of residents in rural areas are active in associations or are civically involved (Ruhlandt, 2018), which invites us to take a closer look at smart governance in these areas.

The term “smart city” refers to developments aimed at increasing efficiency, sustainability, social inclusivity, and technological advancement in cities. Smart cities make use of ICT in order to increase the quality and efficiency of services while simultaneously reducing costs, inequality, and consumption (Yigitcanlar et al., 2018). Moreover, these cities aim to improve interactions between government, citizens, and businesses (Alawadhi et al., 2012). Due to the complex nature of smart cities, the definition of the term differs among disciplines and has evolved over time. Chourabiet al. (2012) identify eight critical factors of smart-city success (i.e., management and organization, technology, economy, infrastructure, natural environment, people and communities, policy, and governance), with smart governance representing the critical challenge that smart cities must tackle.

Governance refers to a form of governing in which a network of public- and private actors (i.e., stakeholders) share the responsibility of regulating and providing public services (Chourabi et al., 2012). The concept gained momentum in the late 1980s in response to citizens' demand for transparency, efficiency, and legitimacy (e.g., the "Governance and Development" report by the World Bank (*Governance and Development*, 1992)). In the 2000s, other institutions supported strategies aimed at consolidating governance via the Web and social media (e.g., the European Union (EU) (*European Governance – a White Paper*, 2001)), which marked the beginning of so-called electronic governance (e-governance), or smart governance. Smart governance is defined as applying ICT in a government's interactions with its citizens and businesses as well as in government operations (Backus, 2001). Citizen participation has become prominent (Allen et al., 2020; Sharp, 1980) in the form of input or feedback from citizens on the administration in regard to design policies, programs, and services (Feeney & Welch, 2012).

However, participation ("being involved") has now been replaced by the demand for collaboration ("working with partners") because public managers and elected officials need new problem-solving tools to account for today's challenges (Linders, 2012). Most of these so-called "wicked problems" cannot be appropriately tackled by traditional leadership or from a single-stakeholder perspective (Poocharoen & Ting, 2015). Instead, the concept of "vivid collaboration" was introduced and involves "(…) the process of facilitating and operating in multi-organizational arrangements to solve problems that cannot be solved or solved easily by single organizations" (Poocharoen & Ting, 2015, p. 588). The prospective aim of smart-city stakeholders is thus to constantly integrate multiple actors into their decision-making processes in order to increase value for the general public (Chatfield & Reddick, 2018; Hilgers & Ihl, 2010; Hossain & Kauranen, 2015). This citizen support can take the form of crowd sourcing, co-delivery, and reporting in addition to consultation and ideation in designing services (Allen et al., 2020). While informative and constructive exchange between residents and their representatives can lead to solutions that shape life in a social, ecological, and economic sense (D'Onofrio et al., 2019), it is necessary to determine how smart governance can encourage the development of smart-living environments.

Throughout the evolution of smart governance, citizen centricity has remained a critical point. Although the number of smart-governance solutions and participation initiatives has increased remarkably in recent years, critics claim that technological possibilities rather than user need often determine the design of such solutions (Verdegem & Verleye, 2009). However, a technology-focused perspective of smart-city development often excludes citizen involvement, and the call for citizen-centered solutions has thus grown louder in order to increase citizens' satisfaction and engagement (Dawes, 2008). Against this background, smart cities can be conceived as spatial units that use ICT for the progress of society and space. By using technology, governments seek to provide resources, set rules, and mediate disputes, all while empowering their citizens, unleashing social innovation, and reinvigorating democracy (see O'Reilly, 2011). The citizen-centered approach helps developing new and sustainable socio-economic and participatory models of governance.

To promote innovation, civil society has become a critical source of new ideas alongside science, business, and government. Collaborative innovation represents one promising approach to strengthening citizen centricity in smart cities (Angelidou, 2015; Wegrich, 2019) and requires new infrastructures for networking, exchange, and coordination as well as new regulatory frameworks. Against this background, scientists have initiated studies on managing knowledge and innovative capabilities (Wulfsberg et al., 2016). In line with Wegrich, we define collaborative innovation as "[…] a governing arrangement where one or more public organizations engage other state or non-state stakeholders in a collective, consensus-oriented, and deliberate decision-making process with the goal to design and implement new, creative solutions to current governance challenge." (2019, p. 12).

Collaborative-innovation strategies can help meet social needs, yet most public organizations are plagued by a scarcity of resources (Torfing, 2019). Moreover, these strategies can foster an exchange of urban knowledge and thus better tackle the aforementioned "wicked problems" because newcomers can learn from those who are more experienced at building a broad knowledge base and at allowing new ideas to emerge (ibid.). Furthermore, collaborative innovation strategies in the public sector differ from those in the private sector as they lack competition and profit motives (Roberts, 2000), which facilitates a focus on value and purpose. In addition, collective creativity (Crosby et al., 2017) is enabled by promoting perspective-taking and empathy, which allow people to share risks and fail early. The emergence of collaborative innovation has thus fundamentally changed the innovation landscape. Nevertheless, how this innovation can be implemented remains to be determined.

We identify and address two major challenges to innovative collaboration in smart cities. First, executives must strike a balance between homogeneity and heterogeneity in their groups (see Koppenjan & Klijn, 2004; Skilton & Dooley, 2010). Homogeneity results in a decreased ability to think outside the box, whereas heterogeneity may lead to chaos due to many differing viewpoints. If stakeholders' viewpoints are too similar, fewer innovative solutions are found, but if they are too distinct, it becomes difficult to find common ground. To overcome this dilemma, we more-closely examine the different steps of the creative process: During problem solving and ideation, it is important to bring several perspectives and diverse expertise to the table (i.e., heterogeneity). During problem identification, synthesis, and implementation, it is crucial to combine ideas and develop concrete solutions that can be tested or evaluated (i.e., homogeneity). In a nutshell, after important stakeholders have been involved (i.e., they are all invited to the table), they do not all have to be present at every stage of development (i.e., they do not all have to partake in every course). Throughout the present work, we expand on this metaphor in detail.

Second, smart-city representatives aim to legitimize their decision-making by implementing collaborative strategies with multiple feedback loops (Allen et al., 2020). Thoughtfully improving the relationship between governments and their citizens enables governments to better justify their actions to public-sector organizations. To fulfill this social responsibility, promising scientific approaches are required that offer recommendations based on empirical evidence and that can be directly implemented. However, most of the literature either proposes conceptual work with broad claims and theoretical analysis (Wegrich, 2019), neglects close interaction with practitioners (Torfing, 2019), or offers narrow recommendations for specific techniques that do not account for the broad picture of collaboration. In order overcome these limitations, we combine theoretical and practical implications that can be applied to different target groups. The strength of our work lies in the concrete implementation of a use-case-based project in which we empower various stakeholders to design social solutions for their living environments that can be directly implemented.

Design Thinking as Multi-Actor Collaboration

The DT approach is suitable for implementing a multi-actor collaboration strategy in the public sector and for taking collaboration in smart cities to the next level. This addresses the need to find a suitable approach for implementing innovative collaboration approaches to involve multiple actors in decision-making processes (Torfing, 2019). DT is a practical approach that fosters innovation, and design thinkers seek to realize the citizen-centered, problem-solving perspective of innovative collaboration through concrete, agile, and adaptable working methods. The DT approach involves – inter alia – radical collaboration, human values, experimentation, drafting, prototyping, and process orientation and has tremendous potential to foster smart-city innovations. The approach comprises a concrete process for designing citizen-centered solutions. However, no common definition of DT exists in the academic literature (Liedtka, 2015). To render the concept more tangible, we briefly present the historical development of the approach.

In the 20th century, theorists in architecture- and design schools began to examine the process of designing (Bazjanac, 1974; Liedtka et al., 2017). As linear problem-solving methods often fail when problems become complex and ambiguous, designers began to deal with increasing uncertainty and diversity, with problem-centeredness, nonlinearity, optionality, and ambiguity affecting their work (Liedtka, 2015, p. 926). As a result, Cross introduced the DT approach (Cross, 2011; Liedtka, 2015) and described how to think and work as a designer. Management science adapted the concept to business (Schön, 1983; Simon, 1967) and invited design thinkers to change the way organizations develop products, services, models, and strategies (Brown, 2008). As the transition to digital working methods resulted in an enormous need for agile management, businesses began to determine *who* should design (Owen, 2006) and to value empathy in better understanding collaborators and users (Brown, 2008; Liedtka, 2015). Not only did the private sector begin to implement DT increasingly often, but so, too, did the social and public sectors, for example, in their development of policies and services (Mintrom & Luetjens, 2016; Sirendi & Taveter, 2016). In recent years, elected officials and managers came to take on the role of agents of their citizens and opened the door to frequent innovations and new forms of governance. DT has undergone constant modification and is now used in many ways in various professions and sectors.

DT is a rich and complex process. In order to answer our RQ, we define three particularly important pillars of the approach (see (Liedtka et al., 2017) (Schmiedgen et al., 2016), see also (Schindlholzer, 2014)): 1) the team, 2) the process, and 3) the workspace. These pillars lead us to conclude that DT is successful due to its use of multidisciplinary teams, an iterative process, and an adaptable workspace. The DT approach 1) consists of teamwork. Being welcome to change and open and to experimentation is necessary. DT also requires a culture that views mistakes as learning opportunities ("fail early and often" (see for a further discussion Schön, 1983)). The literature emphasizes the importance of the team (Beckman & Barry, 2007; Liedtka et al., 2017) because an interdisciplinary group can generate more as well as more-original ideas than can one single person. Bringing various perspectives to the table, sharing knowledge and expertise, and appreciating different viewpoints are tools that enable both a better understanding of the task at hand and the development of useful solutions (Liedtka et al., 2017). Engaging different stakeholders, however, goes hand in hand with a certain challenge (i.e., the balance between heterogeneity and homogeneity) that needs to be considered when addressing our RQ.

The DT approach 2) entails a certain process whose structure helps make people "feel comfortable in being uncomfortable" (Liedtka et al., 2017) because it manages the ambiguity, complexity, and messiness of solving "wicked problems" (Liedtka et al., 2017). Although each DT school uses its own labels for the steps in the design process and subdivides them in some cases, a uniform structure of problem centricity and solution centricity can be recognized (see Figure 27.1): To begin, it is important to understand the problem (understand, observe, synthesize). Next, the participants generate ideas (ideation, prototyping), which encompasses divergent and convergent thinking as well as experimenting. In the end, the participants test their most-promising ideas (testing) to evaluate their usefulness and ease of use. All steps are interconnected and can be repeated iteratively. DT provides a toolbox for every step of the process (Carlgren et al., 2016). The tools are constantly combined, expanded, and further developed in different ways and within various event formats (Elsbach & Stigliani, 2018).

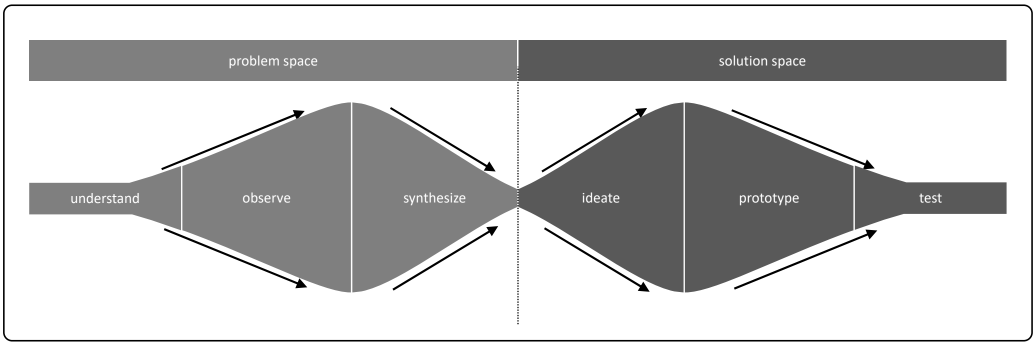


Figure 27.1. The DT steps according to Dark Horse Innovation

In addition to accounting for the team and the process, DT 3) highlights the importance of the workspace because the environment impacts significantly on the creative capacity of a DT group (Doorley & Witthoft, 2012). The surroundings should allow for constant interaction and collective learning and should be optimized in order provide the best environment for executing the steps in the design process. In practice, this requirement can be fulfilled by bringing easily movable furniture into largely empty rooms as well as by providing easily adaptable working material (Carlgren et al., 2016). A relaxed atmosphere (e.g., with pleasant colors, fresh air, music, and nooks in which one can retreat) is as important as supplies (e.g., healthy food and coffee, craft supplies, and protective clothing) and assistance (e.g., a help desk). Everything should be designed to be as pleasant, easeful, and uninterrupted as possible. In sum, Liedtka (2017) emphasizes the notion that the collaborative DT workspace should allow for a structured DT process, a deep understanding of user context, group heterogeneity with dialogue-based conversations, and the creation of and experimentation with multiple real-world solutions.

27.3 **Method**

Using the information-systems- (IS) and DSR paradigm (Gregor & Hevner, 2013; Hevner et al., 2004), we derive an applicable approach with which smart municipalities can translate the targeted citizen centricity into action. DSR[8] is built on theories of design in action (Theory Type V by Gregor (2006)) that provide explicit prescriptions (e.g., methods, techniques, principles of form and function) for construction. In contrast, theories that explain, predict, or analyze – which are known from the natural and social sciences – are not yet able to develop solutions for complex situations because they do not bring something new ("artificial") into existence, as Simon refers to it in his well-known work (Simon, 1967).

While traditional IS research focuses closely on technological artifacts, Lee et al. (2015) expanded this narrow perspective in line with the work of Hevner (2004), who introduced several forms of design-science artifacts: 1) constructs, 2) models, 3) methods, and 4) instantiations. In order to provide a better understanding of artifacts, Lee et al. (2015) divide artifacts into "information artifacts" (e.g., messages), "technology artifacts" (e.g., hardware and software), and "social artifacts" (e.g., charitable acts). For our work, this approach offers a promising opportunity to understand DT collaboration in smart cities because it explicitly considers social artifacts (e.g., citizen centricity as a social artifact). In addition, the approach also maintains a technology-focused perspective on the IT artifact – which is designed via collaboration (i.e., a technology artifact) – or on its content (i.e., an

[8] DSR and DT are often confused because they are not clearly delimited from one another. We view DSR as a scientific approach to producing knowledge – be it conceptual (e.g., theories, frameworks) or empirical (e.g., methodologies, research designs). In contrast, DT is an applied procedure that is utilized to satisfy user needs and create solutions that are testable in real-world environments.

information artifact). This perspective is important because the divided artifacts can interact and result in synergies that amount to more than the sum of their parts (Lee et al., 2015). In seeking to generate knowledge, DSR phases (e.g. Hevner et al., 2004) can be identified that are similar to those in DT process (see Footnote 1). All phases are connected with iterative feedback loops in order to more-precisely determine either (1) what the problem is (the relevance cycle), (2) how to build and evaluate artifacts or processes (the design cycle), or (3) which experiences or expertise to consider (the rigor cycle). According to Schön (1983), who introduced the concept of reflection-in-action to the field, the timing of these loops can be varied. Building on this stance, Peffers et al. (2007) call for immediate reflection and feedback on the artifact at every stage of the design cycle. Moreover, Sonnenberg and vom Brocke (2012) introduced not only a single ex-post evaluation, but also two evaluations (ex ante and ex post) for four core design activities that are linked via evaluation (i.e., problem identification, design, construct, and use). This approach opens two doors to our work: First, we can improve precision. Second, we can highlight the relevance of the artifacts by demonstrating the usefulness of their design. All in all, our project can simultaneously produce knowledge (i.e., DSR) and offer an applied procedure that enables solutions to be designed that are testable in a real-world environment (i.e., DT).

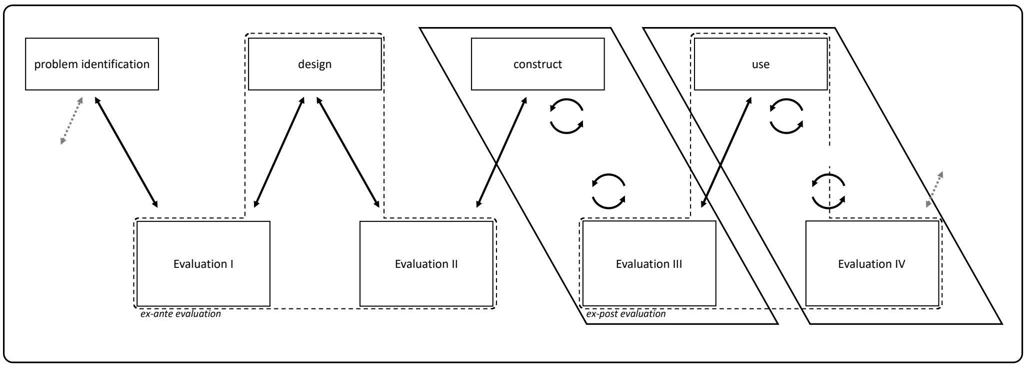


Figure 27.2. Our General DSR Framework

The applied methodology consists of four design activities (c.f. Figure 27.2), namely: 1) problem identification, 2) design, 3) construct, and 4) use. These activities are linked via iterative evaluations. The ex-ante evaluation consists of two evaluations: Evaluation I and Evaluation II. Evaluation I informs the design activity, and Evaluation II assesses this activity. The ex-post evaluation consists of two evaluations: Evaluation III and Evaluation

IV. While Evaluation III deals with the construct, Evaluation IV appraises the use of the innovative collaboration in a smart-city context and thus judges whether the solution appropriately meets the initial problem. The ex-post evaluation is conducted in a real-world setting (e.g., via workshops) and entails multiple feedback loops, which enables short evaluation cycles.

27.4 From Theory to Practice

A traditional health resort from North Rhine-Westphalia in Germany approached us with severe difficulties in preparing their municipality for the future (problem identification). They were struggling to derive promising measures to react to the major trends of our time, such as sustainability and digitalization. Together, we outlined the problem and agreed on a general goal, which was to define recommendations on how traditional health resorts can be transformed into modern health resorts that can also serve as attractive residential and business locations. By using urban knowledge and redesigning the process of information exchange in these health resorts, we aimed to place equal weight on the technical and human elements of the design process. Moreover, we promoted transparent collaboration between partners (universities, businesses, administrations, and society). After a discussion, our team conducted additional literature research and discovered that there are more than 350 health resorts in Germany (*Kurorte* and *Heilbäder*) that combine health services and therapies, treatment programs, naturopathic treatment, wellness programs, nutrition programs, and tourist offers. However, the number of visitors and the average length of their stay have been decreasing over the last two decades, and an innovative approach is therefore urgently needed to come up with sustainable, economically sensible solutions. To the best of our knowledge, no best-practice example yet exists for study.

In line with the current state of research (see Chapter 2), we followed a DSR framework to refine our plan and aimed to provide a validated artifact that offers promising recommendations on how to design innovative-collaboration strategies in these areas that can be directly implemented. Again, it was critical to give equal weight to technical and human elements of the design process. After the problem had been observed and documented, we conducted additional reviews of practitioners and highlighted the need for further research. In Evaluation I, we identified innovative collaboration as an essential tool in sustainable innovations. Our evaluation criteria were applicability, suitability, novelty, economic feasibility, and importance. Based on our evaluation activities, we derived initial ideas and design principles on how to implement innovative collaboration in traditional health resorts in Germany such that the people on site would feel empowered to design a health resort of the future. We discussed these propositions with various stakeholders in five different health resorts (i.e., from local administration, local companies, tourism, and gastronomy) and concluded that the DT approach could be a suitable way of tackling the identified problem. We then consulted DT experts from the Hasso-Plattner-Institut (HPI) in Potsdam, Germany, who supported our assessment. Based on this preparatory work, we sharpened our overarching RQ: How can DT collaboration be implemented in smart cities in the designing of digital urban services? Moreover, we agreed on a shared first objective, which was to apply for financial support from a federal ministry. To receive this support, we submitted a project application in which we specified our core project pillars (team, process, workspace) as well as our initial project plan (design). Evaluation II was thus carried out by the ministry's jury, which assessed the design objectives, tools, and methodology as well as the stakeholders of the design specification. The experts evaluated the various criteria (e.g., feasibility, internal consistency, clarity, completeness, and applicability). Our idea was then approved for funding.

After we had completed the initial phases of the DT-collaboration approach (i.e., problem identification (with Evaluation I) and design (with Evaluation II)), the project "Health Resort of the Future" ("*Kurort der Zukunft*") was officially launched. We drafted a preliminary project plan (construct), which served as a prototype that illustrated how DT collaboration can be implemented in health resorts. We discussed this prototype in multiple feedback loops with selected stakeholders in our consortium. Furthermore, we participated in three expert workshops (Evaluation III) with renowned DT experts, namely Dark Horse Innovation in Berlin, Germany, which helped validate our project plan and to set it in motion (use). The proof of applicability of the prototype was based on the criteria of feasibility, ease of use, suitability, effectiveness, efficiency, compatibility with real-world phenomena, and operationality. The methods encompassed a demonstration with the prototype (i.e., project proposal) and further expert interviews in a workshop setting.

Evaluation IV followed in a stakeholder workshop in which we implemented what we had learned about our core project pillars (team, process, workspace). The artifact paved the way for the three-year research project. The evaluation criteria were applicability, effectiveness, efficiency, compatibility, impact on the environment and user, internal consistency, and external consistency. The validation of the artifact (i.e., the collaborative innovation as illustrated the project plan) in a naturalistic setting produced new knowledge and proved useful.

In our illustrative-use case, we promoted transparent collaboration between our partners and applied the DT approach to create a citizen-centered solution to redesigning these health resorts. As indicated above, we referenced Peffers et al. (2007), Sonnenberg and vom Brocke (2012) and Sturm and Sunyaev (2019) and refined the framework (c.f. Figure 27.3).

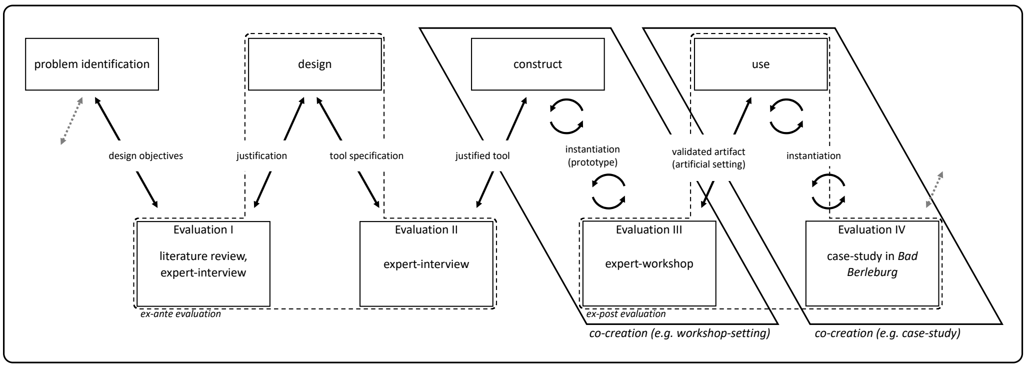


Figure 27.3. Our DSR Framework for German Health Resorts

Implementing DT Collaboration in the Designing of Digital Urban Services

The use case provides an opportunity to learn and to derive recommendations for action that are useful in addressing the challenges to innovative collaboration. We again focus on the three important pillars of the DT approach (team, process, workspace) because DT is useful thanks to its use of multidisciplinary teams, an iterative process, and an adaptable workspace. We interacted closely with practitioners and citizens throughout every step in the design process to derive theoretical and practical implications as well as social solutions to citizens' living environments that can be directly implemented. The exemplary project plan is illustrated in Figure 27.5.

Team-oriented findings. In smart cities, multiple stakeholders are of crucial importance and need to be invited to the table. However, they do not need to participate in every step of the process, especially if they personally benefit or suffer from the solution to the problem (emotional component), if cooperating with them has been difficult in the past or could be difficult in the future (behavioral component), or if they need to be intensively trained or carefully briefed beforehand (cognitive component). DT collaboration should bear in mind that some actors have little time or prior knowledge or prefer to stick to the status quo, especially when it comes to new approaches to work (c.f. Figure 27.5). Political considerations play an additional role and sometimes limit the feasibility of collaboration (e.g., social desirability, proximity to elections). Therefore, public relations-, communication-, and marketing needs matter. In our project plan, we clearly defined the project team, the stakeholders, and the thematic experts. The project team's ambidexterity comes into play in balancing administrative tasks and preparing for the changing demands of DT. To guarantee the success of collaboration, we therefore promote the inclusion of DT coaches who are open to the unexpected.

Process-oriented findings. To account for the balance between heterogeneity and homogeneity, we propose including a different number of actors in the different steps of the DT process: During problem solving and ideation, it is important to bring several perspectives, user groups, and diverse expertise to the table (i.e., heterogeneity). During problem identification, synthesis, and implementation, it is crucial to combine ideas and develop concrete solutions that can be tested or evaluated (i.e., homogeneity). Again, after important actors have been involved (i.e., everyone has been invited to the table), not everyone has to be present at every stage of development (i.e., not everyone has to partake in every course). All in all, based on our insights from the project, we recommend a group size of five to six people. Additionally, we propose the use of micro-planning to comprehensibly acknowledge the different DT phases. It appears wise to involve coaches who can guarantee that the steps, tools, and feedback loops are followed and applied smoothly. Figure 27.4 presents such a micro-planning agenda for a workshop. Micro-planning the project plan (c.f. Figure 27.5) allows for a clear overview of the team-oriented time budgets (working months) and the project's milestones.

Workspace-oriented findings. Innovative collaboration requires a workspace. In addition to the findings from the literature, our project had to meet radically new demands because it began during a worldwide pandemic. The coronavirus (COVID-19) has clearly demonstrated that implementing digital events is a must. In DT's newly emerging digital formats, it is important to ensure that assignments and tasks are clearly define as well as to avoid interruptions. Ease of use and the usefulness of the applications at hand should be optimized, which is important in reducing participants' digital stress or technostress and focusing on the problems and solutions at hand. This optimization includes guaranteeing that workers have enough breaks and get enough physical activity during remote work. Several experts from Dark Horse Innovation had the idea of working with Zoom

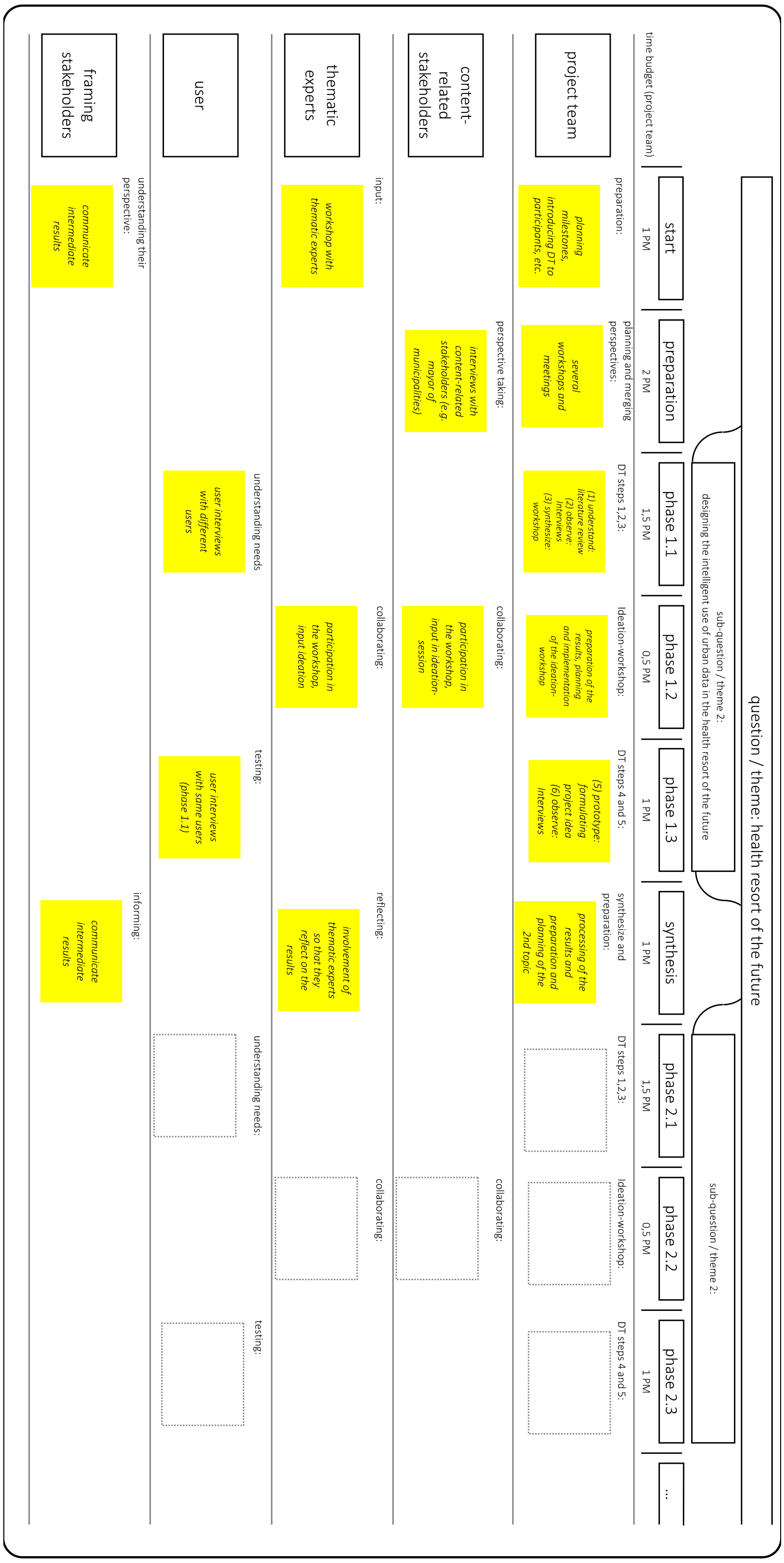
(zoom.us/) and with MURAL boards (mural.co/). We also involved DT coaches with further training in digital didactics.

To illustrate how to implement DT collaboration when designing digital urban services, we provide a project plan below based on findings from the literature and from several iterative discussions with DT experts. This project plan illustrates our design artifact and is conceptual in nature. It is considered a DSR social artifact and brings together our considerations about people, organizations, and technology. The plan can be freely accessed upon request from the authors, reproduced, and adapted. To highlight the applicability of the project plan, we refer to a sub-question of our use case, namely a question on designing the intelligent use of urban data in a health resort of the future. This sub-question has the advantage of being neither overly broad / general nor overly narrow / specific.

time	duration (min.)	activity
__:__	0:10	*zoom-room opening*
__:__	0:10	welcome and introduction
	0:03	*technical check-in*
	0:03	*welcome by host*
	0:03	*introduction of coaches*
__:__	0:20	check-in of the participants
__:__	0:15	overview and schedule of the workshop
	0:05	*Introduction to the project-theme*
	0:05	*roadmap of the project*
	0:05	*presentation of the workshop goals*
__:__	0:05	presentation of the sub-theme
__:__	0:15	break
__:__	0:40	presentation of the user testimonials
	0:10	*presentation of research agenda*
	0:10	*presentation of user testimonial (1)*
	0:10	*presentation of user testimonial (2)*
	0:10	*presentation of user testimonial (3)*
	0:05	*q&a*
__:__	0:10	warm-up
__:__	0:10	introduction to the brainstorming-session
	0:03	*introduction and brainstorming-rules*
	0:03	*presentation of the method (how-might-we-?)*
	0:03	*q&a*
__:__	1:25	ideation (break-out session)
	0:05	*introduction*
	0:10	*silent brainstorming*
	0:30	*idea pitch*
	0:10	*idea selection*
	0:10	*idea napkin*
	0:20	*idea presentation*
__:__	0:20	further procedure
__:__	0:10	check-out
		adoption

Figure 27.4. A DT-Workshop Approach to German Health Resorts

Figure 27.5. A DT-Collaboration Project Plan for German Health Resorts



27.5 Discussion

Our illustrative use case yielded several key insights: First, when dealing with smart-city developments, it is important to consider both urban and rural areas. In addition, it is necessary not only to adopt a technically driven perspective but also to include citizen centricity and the latest scientific insights in smart governance. Striking the right balance between heterogeneity and homogeneity, bridging the divide between theoretical recommendations and practical learning effects, and finally, delivering a concept of how collaborative innovation can be implemented in smart cities all proved challenging. As was demonstrated, it is expedient to invite everyone to the table, but not to every course. To make innovative collaboration in smart cities more tangible, we illustrated the cognitive, emotional, and behavioral components of working collectively, all of which need to be considered. Our project plan serves as a social artifact that also considers the dimensions of information and technology. The three pillars of team, process, and workspace help to structure the plan. For every pillar, the implementation of iterative feedback loops and adaptations is important to account for every new challenge, including a global pandemic. When addressing our RQ (*How can DT collaboration be implemented in smart cities in the designing of digital urban services?*), we noticed that participation ("being involved") became replaced by the demand for collaboration ("working with partners"). However, collaboration at any cost neglects the fact that the constant integration of multiple stakeholders also requires enormous resources, both human and financial. This conclusion does not contradict citizen centricity; rather, it simply calls for a very precise consideration of the design of participatory models.

Our insights do not suggest that this project plan effectively addresses the demand for transparency, efficiency, legitimacy, consolidation, and consequently, comprehensive smart governance because our project represents only one scenario in a small number of rural municipalities. Nevertheless, we offer a starting point for and open the door to further steps toward appreciating the application of ICT in the interactions of governments with their citizens and businesses as well as in government operations. In addition, we drew conclusions about how to implement a multi-actor collaboration strategy in the public sector and how to integrate citizens into the development of governance models to better inform researchers, designers, and practitioners.

Our main contribution to theory is our use of the DSR approach, which provided an appropriate framework for conducting research on DT in the setting of public-sector organizations. Future research can build on these findings and transfer the approach to other practical applications. The most-important benefit in practice is using DT as a collaboration strategy and bringing collaboration to public-sector organizations as well as bringing smart governance to life. DT opens the door to collaborating without previous knowledge and to adapting to tomorrow's changing demands and questions in an agile manner. Our use-case example provided an adaptable project plan that combined our findings about the needs of teams, processes, and workspaces. Of course, our approach is only one of many. Nevertheless, we have taken a beneficial first step that can be followed by many more steps in other projects. While future studies may build on or even contradict our findings, we welcome active participation in our project and new developments that change, transfer, and expand it.

All in all, our work – like any other – has weaknesses due to its limited scope. Conducting more workshops and iteratively revising the project plan for German health resorts can yield additional insights in the future. In addition, we are aware that every public-sector organization has individual characteristics and that our findings may not be transferable in an un-edited manner. However, our structural approach and the design rationales of our artifact provide a promising starting point.

27.6 Summary

Our conceptual work based on a use case offers a first step to making smart cities more efficient, sustainable, socially inclusive, and technologically advanced. The DT approach was used in several health resorts in Germany to address various central questions, such as how to use urban knowledge and how to design information exchange between multiple stakeholders. We summarize our findings on how municipalities can make use of ICT to increase the quality and efficiency of their services, to reduce costs, and to improve interactions between government, citizens, and businesses. Our exemplary project plan can be transferred and adapted by other smart cities to guide innovative collaboration and thus serves as a transparent tool that can inspire future participatory models.

When promoting innovation, civil society also provides essential ideas in addition to those from science, business, and the government. Citizen-centered strategies can foster an exchange of knowledge about cities and can thus better tackle "wicked problems" because these strategies allow for building a broad knowledge base and for the emergence of new ideas. Collaborative innovation thus represents a promising approach to strengthening citizen centricity; however, it requires infrastructures for networking, exchange, and coordination as well as new regulatory frameworks. Regarding the involvement of different actors, the following rule can be applied: Everyone should be invited to the table, but not everyone should partake in every course. In the future, establishing additional frameworks and guidelines as social artifacts, combining insights from different disciplines, and continuously evaluating and adapting these artifacts will lead to the further development of smart-living environments.

Acknowledgements

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28. Paper 22: Cultivating Creativity

Title	**Cultivating Creativity: Insights from German Local Governments about the Drivers and Barriers of Change**
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Cultivating Creativity: Insights from German Local Governments about the Drivers and Barriers of Change

Abstract. *There is a tremendous need for creative problem solving and innovation. While creativity is considered as a crucial resource in the private sector and in start-ups, creative methods such as design thinking are rarely used as a systematic approach for public innovation. Thus, individual creative work practices with their drivers and barriers are not yet fully understood in public organizations. We start to fill this gap by giving an overview on related work as well as on the foundations of creativity. Next, we present best practices from German local governments. We conduct a focus group interview and illustrate preliminary results. By doing so, we identify four main themes that determine the drivers and barriers when cultivating creativity in the public sector (i.e., creativity and self-efficacy, complexity and application, clearance, mindset). As a conclusion, we discuss our results and show avenues for further research.*

28.1 Introduction

In public sector, there is tremendous need for creative problem solving and innovation. For instance, evolving Smart Cities seek to answer questions about urbanization and globalization on all levels and with multiple stakeholders [16]. Public administrations are faced with the need to improve the economy, governance, mobility, environment and living in their cities [3, 9, 13]. They increasingly intend to solve their challenges and address the digital transformation with creative and agile methods, but they are often only at the beginning [22, 23].

New social challenges (e.g., pandemics like Covid-19) show that governments have to be resilient and agile in a way that they have to adapt to new situations more often and much faster than before [39]. These new challenges have to be tackled from all governments independently from their size, location and approach (techno centric or human centric) by implementing new technologies and innovations – in other words: ideas [18]. Also, digital services and multisector approaches for co-creation are under development in order to deliver promising services and thus increased value for citizens. Existing solutions fail and the need for new approaches and work practices is high [22].

Creativity is precedent for creative problem solving and innovation in organizations and cities. Thus, creative work practices offer a high chance for the public sector to tackle today's challenges and the need to innovate [5, 33]. We see the concept of creativity as broader as it is colloquially used, as we do not limit our understanding to haphazard Eureka-moments.

Instead, we approach creativity from a psychological perspective and see it as cognitive process with an interplay between flexibility ("the ease with which people can switch to a different approach or consider a different perspective" [26]) and persistence ("the degree of sustained and focused task-directed cognitive effort" [26]). Individual creativity is the origin and starting point for innovation – also in collaborative settings. While the state of knowledge is rich about public innovation [36], the understanding of drivers and barriers of individual creativity in the public sector is rare.

Private sector and start-ups in particular use this two-fold understanding of creativity with its associated techniques and mindsets to develop innovation and solve problem with the power of creativity [15]. Their idea of creative work practices differs from the idea of optimized processes and incremental improvement by going new ways with the help of new methods like design thinking [5]. In the public sector, innovation is not driven by competition or profit motives [36], what makes it different from private sector innovation. There are different strategies to foster public sector innovation. Collaborative settings are described as most promising according to Torfing [2019]. However, as the individual creativity is the origin of public innovation, it will be a decisive need of collaboration to foster individual creativity. While these new methods are not clearly defined and allow for different interpretations, they are widely understood as (a) a clear description of a process, (b) a new mindset for evaluating and doing things, or (c) a toolbox to use different instruments and techniques [38]. There are different methods in use, which all have a three-step approach in common. Step 1, analyzing; Step 2, ideation; Step 3, testing [19]. Around these methods and steps, there are several techniques (e.g., brainstorming, prototyping, etc.) in order to enhance creativity on the individual, group and organizational level.

It is important to understand the drivers and barriers in German local governments, as the mechanisms in public sector are different because "*…the absence of competition and profit motives creates different conditions for innovation in the public sector*" [36, p.4]. To understand the drivers and barriers of adopting and cultivating creativity in German local governments, it seems to be helpful to understand where these creative techniques and methods come from. Because it makes a difference if a work practice or method is rooted in a discipline or whether it is adopted to a domain, we will use an example of a popular creative problem-solving method. Using the example of design thinking illustrates that the idea of creative problem solving is a methodological approach that origins from product design and architecture [30]. Adopting design-oriented methods in the business sector went along with a human-centered approach where the user and user needs became focal points [38]. The most current stream of adopting design thinking is about social innovation [20]. In this line of argument, creativity is seen as key to innovation.

Against the theoretical background and initial practical work, a few questions remain unanswered: Which drivers and barriers determine the governmental use of creative methods like design thinking? What are the drivers and barriers when cultivating creativity in German local governments? Answering these questions help understand and further shape the adoption of creativity in the public sector.

To answer our research question, this work is structured as follows: First, we present an overview on creativity and the current state in German local governments. Second, we give an overview on the methodological approach. Third, as our research is an initial step, we present preliminary findings of our pre-study. Finally, this paper ends with discussing our findings and by providing an outlook for future research.

28.2 Related Work

Creativity

Creativity is a multifaceted cognitive phenomenon and has been studied in various disciplines, including psychology, sociology, organizational behavior research, Information Systems (IS), and the humanities [32]. In IS research, authors have discussed this topic since the early 90s, however, Couger [6] stated that it is still under-researched in the respective domain [32]. Since then, the research of creativity is a permanent stream of interest [17]. The common characterization of creativity is to create or produces something new, that had not existed before, or in other words, "creativity typically emerges from discovering new associations between previously disparate things" [24]. We define individual creativity as a prerequisite for innovation and want to contribute to existing knowledge by examining the individual conditions of creativity and ideation.

One model to understand the complexity of creativity is proposed by Rhodes [29] and it is called 4-Ps model. The model proposes different perspectives on creativity, namely the *process*, the *person*, the *product*, and the *press* or *environment* behind the phenomena of creativity. In contrast to other theories, the model provides a broad understanding and a holistic approach, that other theories such as the Cognitive Network Model (CNM), the Adaptive Control of Thought theory (ACT) and the Search of Associative Memory theory (SAM) did not offer at this point. After presenting the initial work by Rhodes, we will transfer these perspectives to the public sector, because this opens areas for action. We identify public sector specific features concerning the 4-Ps.

The perspective on the creative *person* shows that there are differences on the individual level [29]. It is important that the creative abilities on that level can be trained and learned and are not only determined by gens – which is a widely known mindset [6, 28]. This perspective opens opportunities for IS research by enhancing creativity through the use of technology or software [6]. Looking at public sector specific features, the employees in this sector are traditionally not trained in creative techniques. Whilst creative methods already reached the business world, employees in the public sector are not seen as designers or agile thinkers, because there was no need for that before. However, governments reach out for creative problem solving and innovation. There is a huge potential of enhancing creativity on the individual level by using software or stimulating creativity by public management.

The creative *process* is omnipresent in contemporary creative techniques like design thinking. It is about the process which can be taught, learned, and thus communicated [29]. In IS research, this perspective can value the opportunity to implement skill-enhancing support systems incorporating strategies and software tools [24]. Again, looking at this perspective from the public sector's point of view, skill-enhancing techniques, which are supported by strategies and software tools, seem to be worthwhile. Governments in the digital age are highly interconnected. Co-creation is one example of multi-sectoral and cross-juristical networks of collaboration [7]. Thus, people with different backgrounds are increasingly working together. Understanding common grounds and processes can help both individual with different background and diverse teams to collaborate. Moreover, at the organizational level, a shared understanding facilitates work routines. Because administrations have become diverse, interdisciplinary, and open-minded work settings need to be designed in order to enhance creative output.

The creative *product* is the outcome of the creative process, which leads to a novel and original idea. Thus, the idea can be seen as a created artefact, which can be a product, service, business-model, or even a strategy [4]. The outcome can be evaluated and tested, which is a good point of departure for IS research to evaluate and measure the creative *product*. Transferring this perspective to the public sector shows that the development of new services is a corner stone of e-government and digital government value creation [2, 22, 23]. Against this background, there are creative methods like service design thinking, which were adopted to and applied in the public sector [7, 34]. Another example are digital service teams, which were implemented to enhance the development of new services [22].

In addition, we can find different streams where *products* are present. For example, on the website https://open.gov.sg/ Singapore presents its work under the slogan "Build Technology for the Public Good" [40]. In other countries, such as Germany, this perspective manifests itself in policies, which implement the user- and customer-orientation as well as new public management approaches, and at the same time adopt perspectives from the private sector [31].

Business-models in the sense of public sector *products* also play a role. Through the development of smart cities and the co-creation between different sectors, there can emerge different opportunities concerning creativity towards business-models. One is the opportunity for public sector spin-offs or new public sector agency, where the understanding and creation of new business models takes place [11]. Another one is the need for understanding business models to shape policies and strategies that foster innovation and new business models to stimulate new industries as value for society [14]. Also, strategies do play a major role in public sector, e.g., smart city strategies. From traditional urban planning- and spatial strategies we know that the development of smart cities requires strategic work [25]. The transformation of governmental organizations needs these strategies to transform purposefully [12].

Finally, the creative *press* or *environment* describes the organizational influence of values and norms, which can support or suppress creativity in organizations [6]. Opportunities and challenges for IS research are various in this respect, because of the disperse use of technologies and related organizational policies. In the case of the public sector, creativity and the related norms and values of an open-minded work culture do differ from what a lot of traditional professions learned and what traditional skills such as optimization built on [37]. One example is how to deal with failure. While it is important not to make mistakes in core-processes in traditional environments, it is absolutely worthful to make mistakes and learn from them in a creative culture. The ability of ambidexterity is another important aspect to handle both core-processes and new ways of work. Because of the digital transformation, it is important to be efficient in core-processes and to frequently find new ways and solutions. The influence of the *press* or *environment* does also play a major role [1] by giving creative abilities space.

Exploring German Local Governments

In Germany, there are many municipalities and city administrations that run creativity projects and use creative methods. Now, we present some examples from German local governments, which are regarded as best practice examples, and have served as pioneers for other large projects. They might have a special appeal due to the size of the city or its regional character.

Office for unsolvable tasks. The Office for Unsolvable Tasks (German: "Amt für unlösbare Aufgaben") is an interdisciplinary team consisting of a theatre-maker, an architect, a music producer, and an urban developer, which came together during the PHASE XI project that has been initiated by the Cultural and Creative Industries Initiative of the German Federal Government and the Federal Competence Centre for Cultural and Creative Industries. The office develops creative solutions for bureaucratic processes. Topics from business, politics and society are examined from the perspective of eleven creative industries in a total of eight labs throughout Germany. Leonie Pichler, theatre director and member of the Office for Unresolvable Tasks, summarizes the central aim in providing answers on how to get humanity, an appealing language, appreciation, design, humor and identification into bureaucracy [101].

GovLab Arnsberg. A similar approach is the governance laboratory (GovLab) in Arnsberg. The initiative was founded in April 2018 in the district government of Arnsberg, which is a central authority in the state of North Rhine-Westphalia. The principles of the innovation lab will be transferred to the administration and agile methods will be used to make life easier for citizens, communities, and employees. The aim is to make administration as simple as possible. Some projects are submitted by core administration staff; others are the result of events organized by the lab. The projects always include diverse project teams. They have a workshop room as well as templates, method descriptions, prototyping software, and even chatbots [102, 103].

Dinslaken. The metropolitan region Rhine-Ruhr is one of the largest conurbations in Europe. Because the cities are becoming crowded as the population grows, questions of the reorganization and restructuring of areas and spaces in cities need to be tackled. Space as a resource plays a major role as one of five core themes of CREATIVE.NRW (Cluster of Cultural and Creative Industries in North Rhine-Westphalia). In 2005, the Lohberg mine was closed. In the following years, a design workshop entitled 'Perspectives for Dinslaken-Lohberg' was set up to collect the concerns, criticism and wishes of citizens and local actors. The project was about restructuring, reorganizing, and reusing space. Subsequently, several event-related citizens' workshops on structural planning were held. The results were incorporated into a structural plan. In 2009 and 2010, a framework was developed, which divides the area into a residential area, the core area 'Creative Quarter Lohberg' and a commercial area. A park and a foot and cycle path, the serve as a connection. These goals were achieved with multiple forms of citizen participation. In workshops with international experts and creative companies, a mission statement was developed. Furthermore, there is a debating platform for debating future topics. There are discussions on fundamental tasks of location development, aimed at experts as well as citizens. In addition, creative people from Dinslaken and the surrounding areas visit the event 'Idea meets market' organized in the form of a world café and used as an opportunity to exchange ideas. It dealt with questions like "How do young companies manage to successfully position themselves on the market?".

Munich. In 2018, representatives got involved in a three-day Design Sprint. The participating departments were the E-/Open-Government & Smart City unit, the Department of Social Affairs and the Department of Urban Planning and Building Regulations of the City of Munich. All of them brought questions to the table, which were then addressed with the help of moderators. A design sprint is about generating and validating ideas and solutions as quickly as possible. Approaches such as Design Thinking, Service Design or agile product development are used. A major advantage is that measurable and user-centered results are obtained within a very short time. Through a mixture of group and individual work and the deliberate use of time pressure as a creativity technique, Design Sprint teams are extremely productive. The administration in Munich used the Design Sprint as an inspiration to shorten lengthy processes with "comparatively little resources and time, to deal with questions openly and across departments, and to develop concrete, user-oriented solutions" [104]. The participants looked at questions from different perspectives and put themselves in the position of their users (citizens or colleagues). First insights were derived, and solution spaces were defined. Finally, prototypes were created and tested on users. The feedback enabled the participants to revise their solution approaches and to plan the next steps.

Heidelberg. The municipal administration of the city of Heidelberg is considered a best practice example for administrations in Germany when it comes to creative techniques. The city does a lot to make communication as transparent and simple as possible. There are committees, a staff newspaper, information events and one-on-one meetings with employees [105]. The resource of space is also put to new uses: The "office of the future was designed as a place of mutual appreciation" [106]. For example, the is an armchair with an integrated table. Raised rotary chairs are intended to enable conversations literally at eye level. This room concept has been tested by citizens and said to be a good idea during the long night of bureaucracy, another idea from Heidelberg. Since 2017, the administration opens from 8 to 11 pm to reach people who have to work during normal opening hours [107]. Somehow, Heidelberg resembles an up-to-date company. Citizens are regarded as customers to think and act in a solution-oriented manner and to be able to offer the best possible service. In areas such as design and digitization, the administration works with experts from the private sector, who are hired on a part-time or as freelancers. In this way, the administration becomes open to modern topics, methods and working methods. Some of the methods are team boards, the development of personas and design thinking. In addition, there is further training, a flexible pension program, and great efforts to be family friendly. Home office can be negotiated individually. Feedback discussions are held with all employees several times a year.

28.3 Methodological Approach

Research Design

Case study research. Since our research is intended to gain insights into government and its digital transformation, our study is highly explorative and specified to the governmental context. As the situation in public sector organizations is dynamic, because of e-government legislation and internal change and smart city transformation an explorative case study approach seemed promising [8].

Focus group approach. Doing focus groups as qualitative method is underestimated and its potential is not fully exhausted [27, 35]. In our case, interaction and the deep discussion on a topic based on personal experience is considered as valuable. Thus, we decided to conduct a focus group interview. The discussion helped make social dynamics, consensus, and conflicts observable. The participants empowered each other and brought broad insights to the table [35]. We were able to collect rich data in a short time – "*attitudes, feelings, beliefs, experiences, and reactions in a way that is not feasible using other field methods*" [35].

Case description. The participants were part of a larger project in which the municipalities of a district reconvene on a regular basis with the goal to develop a shared digitization strategy. Their professional background and training are multidisciplinary. The topics of the overall project are *building competencies* (workshops which are offered to the mayors, administrative boards and executives are directed), *developing strategy* (developing a digitization strategy), *implementing projects* (develop concrete, joint projects to initiate and accompany digitization projects), and *supporting activities* (activities to promote the networking of the individual actors in the district and to provide opportunities for further training). Currently, the competencies had been completed and the strategy had been developed. Projects are being assembled and the project implementing is taking place.

Data and Analysis

We conducted a focus group interview with employees from four different public sector organizations (n=4, all male) to identify drivers and barriers of a creativity in their domain. The sample of organizations obtained three municipalities (population 104.000/25.000/7.000) and one district (280.000), which includes the municipalities. The sample covered the most common classes of municipalities in Germany (*Kleinstadt* – small city up to 20.000 inhabitants, *Mittelstadt* – medium city up to 100.000 inhabitants, *Großstadt* – large city from 100.000 inhabitants) and thus gives a good starting point. The participants' positions within their organization include aspects of smart city or digital transformation. The focus group interview was held virtually with the Webex platform by Cisco.

The workshop was divided into three phases. First, the moderator gave an overview about creativity and about common stimuli and psychological factors (creativity as something you can learn). There are two kinds of enhancing individual creativity. Priming (unconscious) and stimuli (conscious) are hints to be more creative [26,32]. To understand the mechanisms, we used stimuli to introduce the concept in our study. Second, we conducted two ideation tasks. The first one happened without stimuli and the second one with stimuli. The visual stimulus (11 design heuristics/design principles – guidance for idea generation) was presented as text and icons (*see Table 84*). The second one was designed in a similar fashion, but now the participants had the same understanding of ideation. We choose ideation because it is core of creative problem-solving tasks. In the third phase, we discussed whether and how creativity could be helpful not only for doing ideation tasks in public administrations, but for a 'real' design or problem-solving task for governmental products, services, processes, strategies or even business-models in daily live, i.e., authentical problem-solving tasks. By presenting and discussing the results of phase 2 and discussing the questions of phase 3, we achieved an ongoing discussion encouraging the experts to think and reflect about their everyday practices and beyond. We collected the data with audio recording and transcription, prepared by one of the authors. Based on this data, we identified different themes presented in *Table 85*. Analyzing the data was performed by two of the authors in several iterative steps.

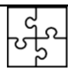
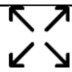
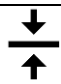
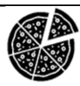
Heuristic/ principles	Description	Icon
Add features from nature	The object mimics natural features or helps to mimic natural features	
Attach product to user	The object is attached to something or helps something to be attached	
Change flexibility	The object helps to change flexibility or is flexible	
Contextualize	The object fits within a specific context	
Elevate or lower	The object can be used to lift or lower something or can be lifted or lowered	
Extend surface	The object can be used to extend the assumed size of something or can be extended	
Fold	The object can be used to fold something or can be folded	
Mirror or array	The object can be used to something because it is mirrored or arrayed along a central axis or pattern	
Reorient	The object can be used by being flipped (vertical/ horizontal) or help to flip something	
Repeat	The object can be used by being repeated or help to repeat something	
Separate parts	The object can be used by being separated or help to separate	

Table 84. Design Heuristics

28.4 **Findings**

In this chapter, we present our findings structured in four emerged themes. The quotations were translated into English with minor adjustments.

Theme	**Definition (provided by the authors)**
T1: Creative self-efficacy	The belief of being capable of producing creative ideas.
T2: Complexity and application	The barrier to transfer the principles of creative work into every-day work.
T3: Organizational structure	The belief that creative work is possible.
T4: Mindset	The belief that creative work is allowed and desired.

Table 85. Thematical Overview

Creativity and self-efficacy. These two concepts (T1) emerged when discussing the results of the two ideation tasks. The participants refined the common understanding of creativity as something which can be learned and practiced. Here, the participants reported what was helpful to produce more ideas and what was not helpful. *Complexity and application* as theme (T2) involved different aspects of the application of creativity and ideation in the setting of the public sector. This theme deals with aspects of transferring creativity in the context of public sector organizations. *Clearance* (T3) refers to aspects of the implementation in the respective organization and the daily business. This can be about resources (time, staff, etc.) or about constraints such as laws or rules. *Mindset* (T4) deals with cultural aspects in public sector organizations, such as openness towards new solutions, leadership or socio-cultural aspects and demographic variables.

Creative Self-efficacy

In the second phase we made the following core observations:

Self-efficacy. The presented visual stimuli of design heuristics enhanced the creative outcome (quantity of ideas) in three of four cases (quantity first task without stimuli / quantity second task with stimuli: 13/12, 15/17, 9/13, 7/12). One interviewee told us: *"I think it's basically already helpful. It was the external circumstances that maybe influenced it a little bit with me. But I think it's basically helpful."*

Creativity stimulation and support. The interviewees reported that the icons themselves were not sufficient for being creative and were only helpful in combination with the explanatory text. Dealing with the heuristics led to a higher cognitive load. One participant said: *"In addition, the heuristics were helpful, although they always give cause for reflection, which of course takes time and is not necessarily target-oriented."* And *"I honestly did not look at the icons at all, only at the text."*

Complexity and Application

Complexity. While the ideation task was abstract and restricted to a simple task, the context related aspects increased complexity. The complexity and the application of creative work method seems to be hard. One interviewee highlighted: *"However, I find it difficult ad hoc to link this to a concrete example."*

Application. However, the participants made some promising suggestions, where creative work methods could be applied. One idea was about designing processes. One employee told us: *"I believe that the topic of process management in general is not yet a major issue in many* *administrations. That's why there should be potential for creativity techniques in many areas, because I don't think that processes are really being tackled as much as they are with digital possibilities. How they could be repositioned now, and it depends on whether you are creative and look at your processes from a different perspective."* We know some examples of service design thinking and design thinking of processes. This has already been applied in some cases [22, 41] and seems to be interesting on a more general basis, too.

Organizational Structure

Organizational structure. The theme refers to the freedom of employees to try out new techniques and methods. In the public sector, we often face policies and alignments between state, province, district, and the municipalities. This leads to the view of a limited scope for design at the individual level. The theme *organizational structure* consists of three sub-themes: clear definitions, clear regulations, and perspective-taking.

Clear definitions. While the one participant reported one potential application of creative techniques in designing governmental processes, other participants reported some constraints. It was said that *"In my eyes, there are areas where this could take up more room and in others, processes are so clearly defined that this cannot offer so much help."*

Clear regulations. Regulations were reported as constraints. However, there is a potential field of action where they see a potential application – culture and tourism. One of the participants concluded: *"So if you look at certain specialist applications, for example in the Citizens' Office, where the processes are digitally supported, but where the procedures are already clearly regulated, the scope is not quite as great as when you say that you are doing something completely new for the […] museum, where everything is still open as to how culture can be communicated digitally in the future. There is a lot of room for manoeuvre and in other areas, because there are so many specifications regarding the procedures, you would have to find niches where it might be possible to provide support." "I believe that the areas that are less regulated, culture but also tourism, are definitely areas where this can work better than in the real estate cadaster or the environmental office, i.e., where the processes are generally very strongly regulated."*

Perspective-taking. We could also identify a driver for using creative techniques in the public sector. As every employee is also a citizen, it is hard to change the perspective when it is about designing new services, processes, business models or even strategies. *"I believe that everything that has a perspective on citizens simply has an additional perspective from which to look at it, and that creativity techniques can work well in these areas. Because then it has a kind of application and an additional external perspective. That creates space for creativity."* Creative techniques are reported as promising when taking the perspective of citizens in order to enhance user-centricity.

Mindset

The theme *mindset* deals with the attitude and the culture in government. The context-specific circumstances in government lead to some special aspects. For example, creative work can be hindered by the fact that one organization is just one of hundreds with similar problems. Why should they start to question existing solutions? *"Situations often have to follow laws that dictate what to do, but the laws usually dictate what has to be done, but not how it has to be done. The question is how to build something like this, how can it look like at all, and the whole issue of intermunicipal cooperation is always involved to some extent, so that people from the same specialist offices in other municipalities think about such processes. You have more people and resources to think about creativity techniques."* On the other hand, the same aspect has a positive stance. The high number of other municipalities that are open for cooperation and for the scaling of solutions, can be a driver.

Management in the sense of public value creation and public welfare is different to private sector with its commercial orientation. Employees in the public sector act in the role of a multi-stakeholder representative. This can be a fact when it comes to impede cultivating new work methods. *"We always have these resource problems. Budgetary security concept, lack of financial, time and personnel resources... You must sell these free spaces very well and then you must show how productive something is when we invest something. A start-up has a better chance of creating this kind of freedom, saying that we try something completely new, and we go crazy, and we do something and if it goes wrong, then it has gone wrong. That must reach us first. But we are dealing with tax money. For us, we don't think it's like saying, come on, let's experiment and let it run into the wall and then we'll look and say oh yes, too bad."*

Drivers and Barriers

In our study, we identified several entry points for different drivers and barriers to cultivate individual creativity in public sector. In this chapter we show our results and categorize them into *process*, *person*, *product*, and *press* or *environment.*

Category	Drivers and Barriers
Process	Applying creative methods is complex. A clear process helps. Methods like design thinking with a structured process can be a driver and help to foster individual creativity.

Person	Public sector employees are not trained to generate disruptive ideas or concepts. CSS or teaching strategies like design heuristics/principles help foster creative self-efficacy.
Product	Public sector employees act in the sense of public value. The product (e.g., a new digital service) needs to be defined and the task has to be clearly articulated in order to foster individual creativity. Also, the user-centricity (of the user who will use the product) should be part of the task.
Press	In an environment, where innovation does occur rather by chance, than systematically, encouraging a mindset that fosters creativity helps to increase individual creativity.

Table 86. Drivers and Barriers

28.5 Discussion

Our research and the preliminary findings are just a small first step on the route of understanding drivers and barriers of creative techniques and methods in local governments. However, the findings serve several implications for theory, and practice.

Our initial step contributes to theory by understanding what kind of stimuli can be helpful to support creativity. It thus contributes to the body of knowledge about Creativity Support Systems (CSS). Adapting the design heuristics to the context of the respective domain (i.e., the public sector) will help better apply them. Second, we seek to study the drivers and barriers of individuals when it comes to adopt new work methods. By understanding which drivers and barriers determine the adoption of creative problem-solving tasks, we contribute to the state of research in innovation management in public sector organizations. Based on the statements of the participants one can see that the employees in a government are in a dilemma situation. On the one hand, they manage tax money and have no task and only few opportunities to experiment. On the other hand, this does not lead to innovative solutions. It can be valuable for future research to see to find out to what extent the decisions of the employees regarding their working methods (e.g., willingness to experiment and take risks) are influenced by cognitive biases (e.g., projection bias: A projection bias or 'presentism' [10] occurs when a decision-maker projects the present into assumptions about the future [21]. This bias leads to decisions which neglect events that differ from the present, e.g., extreme events like pandemics). Moreover, uncertainty and complexity are not yet fully considered. Due to the complexity and uncertainty of social phenomena, it is not possible for employees to make purely rational decisions. Therefore, employees must rely on heuristics and run the risk of not making optimal decisions due to cognitive distortions. If the public sector is not able to experiment, social innovations will fail to arise and then to materialize. This provides a point of reference for research on bounded rationality.

The implications for practice are various. Our results represent different links to the use of creative techniques in governments. Employees assume that creative techniques application can be beneficial in the fields of action of tourism and culture. While we also show implications that creative techniques can be used more general when it is about processes design and taking the perspective of citizens. All barriers we identified can be a starting point by asking how to determine them. For instance, cooperation is an implication with practical relevance, by working together on problems governments share. Another implication for practice is the aspect to question the regulations and definitions. Some findings suggest that not every regulation and definition is a barrier. Maybe there can be more space to design new processes by implementing clear rules. We also expect that the introduction to design heuristics (e.g., via webinar, podcast, etc.) will lead to a higher creative self-efficacy. Public sector employees will trust their ability to find creative solutions after understanding that creative skills can be learned.

Besides our preliminary findings, our research has some weakness. The explorative qualitative interview is just a first and initial step. The sample size (n=4) is sufficient as a starting point; however, the findings are not to be understood in generalizing fashion. The project the participants were part of and consequently the common goals and shared perspective of the participants might have also limited our insights. Furthermore, there are limitations of focus groups such like biases due to group interaction and social desirability. As our investigation is designed just as a first step, there are several possibilities for further research. A semi-structured interview seems to be promising to validate our findings from different perspectives. Second, quantitative data (e.g., a survey) can help to understand how to cultivate creativity in a broader context. Third, a laboratory experiment can help understand the drivers and barriers on the individual level in detail.

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29. Paper 23: Design Thinking als Werkzeug für Co-Kreation und Co-Design

Title	**Design Thinking als Werkzeug für Co-Kreation und Co-Design – Ein Erfahrungsbericht in 5 Thesen** (**Design Thinking as a Tool for Co-Creation and Co-Design – An Experience Report in 5 Theses**)
Authors	Hans Christian Klein[1] Frederike Marie Oschinsky[1] Aida Stelter[1] Björn Niehaves[1] [1] University of Siegen, Siegen, Germany.
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Table 87. Fact Sheet Publication

Design Thinking als Werkzeug für Co-Kreation und Co-Design – Ein Erfahrungsbericht in 5 Thesen

Zusammenfassung. *Die digitale Transformation stellt deutsche Städte und Gemeinden vor große Herausforderungen. Dabei ist es wichtig, dass der Mensch mit seinen Bedürfnissen im Mittelpunkt der Gestaltung der zukünftigen Lebens- und Arbeitsräume steht. Im vorliegenden praxisorientierten Artikel wird aufgezeigt, wie der innovative Design Thinking-Ansatz zur digitalen Transformation öffentlicher Verwaltungen beitragen kann. Anhand des Fallbeispiels eines kommunalen Open Government Labors in Nordrhein-Westfalen, welches den „Kurort der Zukunft" gestalten möchte, können allgemeine Anregungen zur aktiven Teilhabe der Bürgerschaft und Stadtgesellschaft abgeleitet werden. Ferner werden spezielle Prinzipien für die Durchführung eines Ideen-Workshops diskutiert und mögliche Herausforderungen virtueller Formate beleuchtet. Der Beitrag schlussfolgert, dass der Design Thinking-Ansatz eine große Chance ist, den Wandel unserer Kommunen inklusiv, kollaborativ, agil zu gestalten und einen wertvollen Beitrag zu Stadtentwicklung zu liefern. Aufbauend auf unserem Anwendungsbeispiel wird insgesamt deutlich, wie und warum durch innovative Formate der Zusammenarbeit ein zusätzliches Potenzial der co-kreativen und co-produktiven Gestaltung der Städte und Gemeinden von morgen geschaffen werden kann. Das Gelernte kann schnell auf andere Fälle adaptiert und übertragen werden.*

Schlüsselwörter: *Smart City, Design Thinking, Verwaltungsinnovation, Co-Kreation, Co-Produktion, Digitale Transformation.*

Abstract. *The digital transformation is a major challenge for German cities and municipalities. It is becoming increasingly important to consider the citizens' needs and to account for their various interests when designing future living and working spaces. This practice-oriented article shows how the innovative design thinking approach can contribute to the digital transformation of public administrations. Based on the case study of a municipal Open Government Laboratory in North Rhine-Westphalia, which aims for designing the "health resort of the future" ["Kurort der Zukunft"], general suggestions for involving citizens and the urban society can be derived. Furthermore, distinct lessons learned for the implementation of an ideation workshop are discussed and possible challenges of virtual formats are highlighted. Our work concludes that the design thinking approach is a great opportunity to manage change in our municipalities more inclusive, collaborative, agile and to make a valuable contribution to urban as well as rural development. Building on our use case, it becomes clear how and why to use the potential for the co-creative and co-productive innovative formats of cooperation when designing the cities and communities of tomorrow. These insights can easily be adapted and transferred.*

Keywords: *Smart City, Design Thinking, Innovative Administration, Co-Creation, Co-Production, Digital Transformation.*

29.1 Einleitung

Bei der Gestaltung intelligenter, bürgernaher Städte und Gemeinden bieten kollaborative Innovationstrategien einen guten Ansatz für Inklusion und Partizipation (Torfing 2019). Sie versprechen, relevante Akteure mit unterschiedlichstem Hintergrund in Entscheidungs- und Entwicklungsprozesse einzubeziehen, um auf nutzerorientierte Weise Antworten auf komplexe Herausforderungen der öffentlichen Hand zu finden und mögliche Lösungsansätze frühzeitig zu legitimieren. Nicht zuletzt bieten die Formate eine Antwort auf die knappen Ressourcen in öffentlichen Verwaltungen (z. B. wegen schlechter Haushaltslagen, auf Grund von Nachwuchskräftemangel, wegen des demografischen Wandels) sowie die Möglichkeit, die Performanz und Transparenz der Dienstleistungen (Services) vor Ort zu erhöhen. Doch wie genau kann eine kollaborative Innovationsstrategie in Kommunen umgesetzt werden?

Der Ansatz des Design Thinking ist ein Werkzeug zur Gestaltung von innovativen Lösungen und dem Umgang mit komplexen Problemen (Brown 2008; Brown und Katz 2011), der zur Entwicklung neuer Ideen führen soll. Ziel sind Lösungen, die aus Anwendersicht (z. B. Perspektive der BürgerInnen) überzeugend sind. Seine Wurzeln hat das Design Thinking in der Produktentwicklung und Architektur. Heute wird es bei der Entwicklung von Produkten, Geschäftsmodellen, Strategien und – wie im vorliegenden Fall – Dienstleistungen angewendet (Brown 2008). Es ist eine vielschichtige Methode. Die leitenden Prinzipien, die die Haltung und Handlungen der Design Thinker formen, sind radikale Kollaboration, am Menschen orientiertes Handeln, sofortiges Demonstrieren, spielerisches Experimentieren, direkte Umsetzung, Klarheit und stetige Prozessorientierung. Diese Leitlinien helfen, schnell neue Perspektiven einzunehmen und nutzerorientierte Innovationen zu gestalten (Schmiedgen et al. 2016). Wie aber sieht Design Thinking konkret im öffentlichen Sektor aus?

In unserem Erfahrungsbericht möchten wir Ihnen Einblicke in unser Projekt „Open Government Lab: Designing Future – Kurorte der Zukunft“ (Bundesministeriums des Innern, für Bau und Heimat 2021) geben und darauf eingehen, wie die digitale Transformation gerade in ländlich geprägten Regionen gestaltet werden kann. In dem vom Bundesministerium des Inneren, für Bau und Heimat (BMI) geförderten Projekt nutzen wir die Ansätze des Design Thinking und das Prinzip eines Open Government in einem Verbund aus sieben Kurorten, diversen Klinikbetreibern und weiteren Partnern. Im Rahmen der Projektarbeit möchten wir die Potenziale des Design Thinking als

Kollaborationsformat der Smart City von morgen verstehen. Dies tun wir im vorliegenden konzeptionellen Beitrag, indem wir fünf Thesen zum Thema Design Thinking als innovatives Kollaborationsformat der Smart City illustrieren:

1. Design Thinking ist inklusiv: Wie mit Design Thinking ein Partizipationsformat für Kommunen entsteht

2. Design Thinking ist kollaborativ: Warum viele Perspektiven helfen, man dabei aber einiges beachten muss

3. Design Thinking verhilft agilem Arbeiten: Warum Design Thinking auf agilen Prinzipien beruht und wie man den spezifischen Anwenderkontext berücksichtigen kann

4. Design Thinking ist nicht nur Mittel zum Zweck: Warum Design Thinking auch ein gutes Change-Management-Werkzeug ist

5. Design Thinking kombiniert Planung und Freiheit: Warum Design Thinking zwar Offenheit für Überraschungen bieten muss, es aber keine ungewollten Überraschungen geben sollte

In dem folgenden Kapitel gehen wir näher auf das Konzept der innovativen Kollaboration ein und beschreiben das Open Government Lab „Designing Future – Kurorte der Zukunft“. In Kapitel drei teilen wir die „Lessons Learned“ und schließen in Kap. 4 mit einer Diskussion und einem Ausblick.

29.2 Bisherige Arbeiten und der Case

Innovative Kollaboration

Die digitale Transformation unserer Städte ist eine der wichtigsten Herausforderungen unserer Zeit (Portmann und Finger 2015; Gil et al. 2019). Auf der einen Seite stehen Themen wie Landflucht oder Urbanisierung. Auf der anderen Seite bieten der technologische Fortschritt und aufstrebende Innovationen neue Möglichkeiten diesen Herausforderungen zu begegnen. Während der digitale Transformationsprozess in großen Städten und Metropolen bereits seit Jahren auf der Agenda von Verwaltung und Stadtgesellschaft steht, besteht gerade in ländlichen Regionen noch Handlungsbedarf (Ruhlandt 2018). Das lässt sich unter anderem durch kontextuelle Faktoren, wie unterschiedliche Autonomiegrade der Verwaltungsebenen oder die Verfügbarkeit von

Wissen bei z. B. BürgernInnen (Ruhlandt 2018) erklären. Diese Faktoren sind bei Kommunen im ländlichen Raum geringer ausgeprägt als in großen Städten und Metropolen.

Informations- und Kommunikationstechnologien (IKT) sind der technologische Baustein von intelligenten Städten und Gemeinden (Smart Cities) (Andrushevich et al. 2015). Durch sie können sowohl die Qualität als auch Effizienz von städtischen Dienstleistungen verbessert werden. Gleichzeitig besteht bei zweckorientiertem Einsatz von IKT und bei einer gründlichen Risiko-Analyse die Möglichkeit, dass Kosten reduziert und Ungleichheit aufgehoben werden können (Yigitcanlar et al. 2018). Über die technologischen Neuerungen hinaus ist es wichtig, dass in Kommunen Formate für die kollaborative Zusammenarbeit zwischen Verwaltung, Bürgerschaft und Wirtschaft entstehen, um strategische Leitbilder zu erarbeiten und als greifbare Maßnahmen der Stadtentwicklung umzusetzen (Alawadhi et al. 2012). Die Öffnung des Verwaltungshandeln spielt bei der Kollaboration von Smart Cities eine wichtige Rolle (Bickmann et al. 2020; Hennen et al. 2020). Governance-Formate rahmen die Zusammenarbeit unterschiedlicher Interessengruppen (engl. Stakeholder), die gemeinsam Verantwortung für die digitalen Angebote der öffentlichen Hand übernehmen. Diese haben bereits seit den 1980er-Jahren Bestand und stehen für Transparenz, Effizienz und Legitimität (World Bank 1992). Mit den fort- schreitenden technologischen Möglichkeiten, wie dem Internet und der Präsenz der sozialen Medien, hat sich dann das Konzept des e-Government entwickelt. Dabei werden neue Services für die BürgerInnen möglich und gleichzeitig gibt es neue, teils digitale Austauschformate zwischen der Verwaltung und den BürgerInnen. Durch Letzteres konnten neue Arten der Partizipation umgesetzt werden (e-Participation) (Guenduez et al. 2017). Allerdings zeigen sich nur geringe Beteiligungsquoten (Zepic et al. 2017). Eine persönliche Ansprache oder ansprechende Themen fördern jedoch die Beteiligungsquoten (Zepic et al. 2017).

Der nächste logische Schritt in der Öffnung des Verwaltungshandelns ist es, über bisherige Formen der Partizipation hinauszugehen und noch direktere Formen der Kollaboration zu ermöglichen (Crosby et al. 2016; Torfing 2019). Das bedeutet, dass BürgerInnen nicht nur beteiligt werden, sondern diverse Stakeholder gemeinsam an komplexen kommunalen Fragstellungen arbeiten. Auf dieser radikalen Einbeziehung fußt die Idee des Open Government, welche aus den drei Bausteinen Transparenz, Beteiligung und Zusammenarbeit besteht (Lathrop und Ruma 2010). Der Baustein Transparenz kann beispielsweise mit der voranschreitenden Digitalisierung beschrieben werden. Dabei spielt die langfristige Stärkung ländlicher Regionen vor dem Hintergrund demografischer Herausforderungen, schlechter Erreichbarkeiten sowie der Wertschätzung dieser Regionen eine zentrolle Rolle. Der Baustein Beteiligung kann z. B. durch die Einbindung von unterschiedlichen Akteuren gestärkt werden. Durch den gemeinsamen Austausch und Diskussionen zwischen Lokalpolitik, Verwaltung und Zivilgesellschaft können die Vorteile und Möglichkeiten von Open Government genutzt werden, um dialogorientiertes Handeln im ländlichen Raum zu verankern. Der Baustein Zusammenarbeit kann z. B. durch den Aufbau eines gemeinsamen Netzwerks mit unterschiedlichen Akteuren, den Einsatz von Arbeitsgruppen, Barcamps, Digital Cafés gestaltet werden und soll mit Co-Kreation ein gemeinsames Verständnis schaffen (Schaper-Thoma 2021). Gerade der Baustein der Zusammenarbeit bietet großes Potenzial für die Stadtentwicklung, da es um die Gestaltung der zukünftigen Lebensrealitäten der BürgerInnen vor Ort geht (Poocharoen und Ting 2015; Lembcke et al. 2019). Oftmals müssen vielschichtige Probleme gelöst werden, bei denen es nicht nur die *eine* richtige Lösung gibt. Der traditionelle Führungsansatz (Top-Down) gerät an seine Grenzen, da diese Herausforderungen ohne Graswurzelbewegungen (Bottom-Up) nicht angemessen bearbeitet werden können.

Kollaborative Innovation ist ein strategischer Ansatz, der Antworten liefern kann und verspricht, den Baustein der Zusammenarbeit vor Ort mit Leben zu füllen. Pragmatisch und mit wenig Ressourcenaufwand entsteht die Chance, Themen zu bearbeiten, die ansonsten nicht hätten bearbeitet werden können (Torfing 2019). Austausch und Wissenstransfer werden erleichtert, wenn Lösungen für die Probleme vor Ort generiert werden und die Beteiligten gewillt sind, ihre Perspektiven und ihr Wissen zu teilen (Torfing 2019). Zusätzlich kann es gelingen, Empathie für unterschiedliche Stakeholder, Nutzergruppen oder BürgerInnen aufzubauen. Gerade in Zeiten, die von Wandel und Unsicherheiten geprägt sind, ist das ein großer Vorteil für eine nachhaltig befähigte Stadtgesellschaft, die aus ihrer Mitte heraus innovativ ist (Crosby et al. 2016).

Design Thinking im Open Government Labor

Design Thinking ist ein einschlägiges Instrument zur kundenorientierten Entwicklung von Lösungen (Cross 2001; Uebernickel et al. 2015; Liedtka et al. 2017; Lembcke et al. 2019). Lösungen sollen stärker an den Kundenproblemen orientiert sein als an der technischen Machbarkeit (Brown 2008). Es umfasst einen mehrschrittigen Prozess, der von der Problemdefinition, über die Zielgruppenanalyse, Lösungsentwicklung und

Prototypengestaltungen hin zum Testen der Ideen reicht (Schmiedgen et al. 2016). Die elementaren Dimensionen des Ansatzes sind die involvierten Personen, der genutzte Raum und eben jener mehrstufige Prozess (Uebernickel et al. 2015). Aufgrund ihrer hohen Relevanz möchten wir auf diese Dimensionen nun genauer eingehen.

Personen: *Design Thinker*: Der Design Thinker übernimmt die inhaltliche Verantwortung eines Projekts und ist inhaltlich mit den Problemstellungen des Projektes vertraut (Kimbell 2009). Er oder sie übernimmt die Projektkoordination sowie die Workshop- und Projektadministration. Außerdem kennt er oder sie die wichtigsten Stakeholder und räumlich-sozialen Gegebenheiten und ist folglich HauptansprechpartnerIn für die Teilnehmenden.
Design Thinking-Coach: Der Design Thinking-Coach übernimmt die methodische Verantwortung eines Workshops und ist dafür ausgebildet, mit komplexen und vielschichtigen Problemstellungen umzugehen. Er oder sie übernimmt inhaltlich objektiv die Gruppenbetreuung sowie Vorbereitung und Moderation in den Workshops.
Da das Design Thinking bestimmte Werte, Haltungen und Werkzeuge transportiert, ist er oder sie für die Methodik exzellent ausgebildet.
Workshop-Teilnehmende: Die Workshop-Teilnehmenden arbeiten gemeinsam unter Anleitung des Coaches an definierten Problemstellungen. Die Auswahl eines Themas kann je nach inhaltlicher Ausrichtung gestaltet werden. Eine ausgewogene Mischung der Gruppen ist förderlich, da jede neue Perspektive ein großes Potenzial mit sich bringt.

Raum: *Kreativraum*: Da Räumlichkeiten einen großen Einfluss auf die Art und Weise haben, wie wir zusammenarbeiten, sollte der Design Thinking-Raum idealerweise die kreativen Potenziale der Gruppe fördern. Er kann zur Abwicklung von Workshops dienen und sollte mit den notwendigen Möbeln ausgestatten sein (Uebernickel et al. 2015). Darüber hinaus ist es sinnvoll, dass dieser Raum an einem neutralen Ort ist, da es für die Workshops wichtig ist, alte Sachzwänge hinter sich zu lassen. So gelingt es einfacher, eine inspirierende Umgebung umzusetzen, die neue Ideen fördert.
Verstehensorte in Kommunen: Die Räume vor Ort sind von entscheidender Bedeutung. Das gilt insbesondere für die Phasen Verstehen und Beobachten, in denen ethnographische Methoden und Interviews durchgeführt werden. Die Verstehensorte helfen, die darauffolgenden Phasen auf ein gutes Fundament zu stellen. Die Design Thinker müssen

das Leben vor Ort schließlich verstehen und ein Gefühl für die jeweilige Kommune bekommen, um Fragestellungen nutzerorientiert bearbeiten zu können.

Prozess: Die Workshop-Struktur sieht sechs Phasen vor. Es handelt sich um einen dynamischen Zyklus mit teils iterativen Schleifen. Schwerpunkte werden je nach Bedarf gesetzt. Der Prozess lässt sich in zwei Hauptphasen unter- teilen, die Problemphase und die Lösungsphase. Diese bestehen wiederum jeweils aus je drei Schritten. Die Problemphase umfasst das Verstehen, Beobachten und Synthetisieren. Die Lösungsphase beinhaltet die Ideengenerierung, das Prototyping und das Testen der Ergebnisse oder Lösungen.
In allen Dimensionen spielen die bereits erwähnten Design Thinking-Prinzipien eine wichtige Rolle (Carlgren et al. 2016; Redlich et al. 2019). Die Art und Weise der Zusammenarbeit, während eines Design Thinking Workshops ist für viele, wenn auch nicht alle, MitarbeiterInnen in Verwaltungen neu und entspricht nicht dem, was die meisten VerwaltungsmitarbeiterInnen aus ihrem Alltag gewohnt sind.

29.3 Die fünf Thesen und unsere Erfahrungen im Use-Case

Open Government Lab „Designing Future – Kurorte der Zukunft“

Mit dem Projekt „Designing Future – Kurorte der Zukunft“ (Bundesministeriums des Innern, für Bau und Heimat 2021) entstehen deutschlandweit Open Government Labore, die die Öffnung der kommunalen Verwaltungen pilotieren. Dort will man gemeinsam an den Herausforderungen des digitalen Zeitalters und der Zukunftsfähigkeit der ländlich geprägten Kommunen arbeiten. Bürgernahe Anwendungen sollen erarbeitet werden und Co-Produktion und Co-Design in den Mittelpunkt rücken. Speziell in unserem Labor geht es um den „Kurort der Zukunft“. Der präventive Gesundheitstourismus bedient zum einen demografische Veränderungen und stellt zum anderen eine vielversprechende wirtschaftliche Erweiterung des kommunalen Portfolios dar. Neue Dienstleistungen und Angebote sollen die Lebens- und Arbeitsumgebung für BürgerInnen und BesucherInnen in Qualität und Quantität bedarfsgerecht und nachhaltig verbessern (siehe auch Geiger et al. 2020). In den Umgestaltungsprozess der Kurorte werden diverse Stakeholder einbezogen, etwa BürgerInnen, die Klinikbetreiber und deren Kooperationspartner, die heimischen ÄrztInnen, EinzelhändlerInnen, TourismuskoordinatorInnen und der Verwaltungs- vorstand. Bisher haben wir zwei von sechs Workshops durchgeführt. Dabei diente uns der theoretische Rahmen (Personen, Raum und Prozess) immer wieder als Hilfe, um das Projekt in all seiner Komplexität und Offenheit zu strukturieren und unsere Erfahrungen zu reflektieren.

Es geht um die Frage, wie der Kurort der Zukunft konkret aussehen kann und der thematische Schwerpunkt ist die Gestaltung von neuen digitalen Services und individualisierten Dienstleistungsangeboten für Kurgäste auf Basis von mobil erhobenen Gesundheitsdaten. Dazu arbeiten VertreterInnen aus Forschung und Praxis gemeinsam an unterschiedlichen Leitfragen und nutzen die Design Thinking Methode. Sieben Kommunen und acht Organisationen aus dem Bereich der Gesundheitsversorgung und Tourismusbranche sind an dem Projekt beteiligt. Das Projekt wird dabei durchgehend von einer Universität begleitet. Darüber hinaus sind weitere Forschungseinrichtungen in einzelnen Workshops dabei.

Im Rahmen des Forschungsprojekts haben wir uns für eine gestaltungsorientierte Herangehensweise und Methode entschieden. Entsprechend der in der Wirtschafts-informatik etablierten Methode Design Science Research (DSR) (Hevner et al. 2004) haben wir unser Vorgehen gestaltet, um die Zusammenarbeit vor Ort (als soziales Artefakt) (Lee et al. 2014) bestmöglich zu gestalten. Dabei haben wir uns an der Vorgehensweise nach Sonnenberg und vom Brocke (2012) orientiert, die eine wieder- holte Evaluation nach jeder Entwurfsaktivität vorschlagen. Die Entwurfsaktivitäten erfolgten in vier Schritten: 1) Problemidentifikation, 2) Design, 3) Konstruktion und 4) Nutzung. Jede der Aktivitäten wurde durch eine Evaluation beendet. Die Problemidentifikation (die Fragestellung nach dem Kurort der Zukunft – Evaluation I) haben wir mittels Literaturrecherche evaluiert. Den ersten Entwurf für unsere Zusammenarbeit haben wir in Zusammenarbeit mit einem erfahrenen Design Thinking-Coach evaluiert (Experten-Interview – Evaluation II). Den konkreten Entwurf für die Zusammenarbeit (Projektmanagement und Workshop-design – Evaluation III) haben wir in einem gemeinsamen Workshop mit dem erfahrenen Design Thinking-Coach reflektiert. Die letzte Evaluation (Evaluation IV) haben wir durchgeführt, indem wir unsere Planung in dem Open Government Lab umgesetzt haben. Die folgenden Lessons Learned sind nach den vier Evaluationsstufen und auf Grundlage der gesammelten Daten in unserem Projektkonsortium entstanden.

Design Thinking ist inklusiv: Wie mit Design Thinking einPartizipationsformat für Kommunen entsteht

Bürgerbeteiligung ist ein wichtiger Baustein bei der Öffnung unserer Verwaltungen im digitalen Transformationsprozess. Grundsätzlich kann das auf unterschiedliche Weise geschehen. Erstrebenswert sind die Zusammenarbeit und das gemeinsame kreative Problemlösen im Sinne von Co-Produktion und Co-Design. Der Design Thinking-Ansatz bietet hier einen guten Rahmen. Allerdings sind wir während der Vorbereitungen des ersten Workshops auf Herausforderungen gestoßen: In unserem Projekt geht es an einer Stelle konkret darum, neue digitale Services für Besucher in einem Kurort zu entwickeln. Eine potenzielle Nutzergruppe sind Kurgäste. An diesem Punkt wurde deutlich, wie schwierig die Beteiligung einiger Nutzergruppen ist, denn die Personen, die oft nach schweren Krankheitsverläufen psychischer oder physischer Natur zur Genesung in einem Kurort weilen, sind oft sehr belastet oder befangen. Während die aktive Mitarbeit dieser Nutzergruppe somit also herausfordernd ist, bietet der Design Thinking-Ansatz aber gleichzeitig eine große Chance, diese Personengruppe besser zu verstehen. Um ihre Bedürfnisse besser nachvollziehen zu können, haben wir explorative Interviews durchgeführt, die nicht direkt nach aktuellen Bedarfen fragen, sondern diese vielmehr durch empathisches, personen- zentriertes Nachfragen aufdecken (Steller 2021). Im Anschluss hat es uns geholfen, die Interviews aufzuarbeiten, indem wir sowohl die Bedürfnisse der NutzerInnen, als auch die vorliegenden Hindernisse identifiziert haben, die der Erfüllung des Bedürfnisses bisher im Wege stehen.

Lessons Learned 1 (LL1): Eine direkte Beteiligung von betroffenen Gruppen kann zu Einschränkungen im Lösungsraum führen. Deshalb lohnt sich die eingehende Untersuchung der Bedarfe potenzieller NutzerInnen bereits vor den Partizipationsworkshops.

Design Thinking ist kollaborativ: Warum viele Perspektiven helfen, man dabei aber einiges beachten muss

Offenheit und Transparenz sind notwendige Bedingungen der Open Government Labore und auf den ersten Blick scheint es, dass man daraus schlussfolgern sollte, möglichst viele und diverse Gruppen zusammenzustellen (Carlgren et al. 2016). Im Design Thinking lebt die Gruppe von der Dynamik und Diversität der Personen, die an einem Problem arbeiten. Allerdings lässt sich diese Annahme nicht ohne weiteres auf Kommunen übertragen. Die verschiedenen Stakeholder haben oft eine starke, normative Haltung und spezifisches, teils exklusives Wissen in Bezug auf ein zu lösendes Problem. In unserem Beispiel wird das anhand zweier Stakeholdergruppen deutlich. Zum einen gibt es die VerwaltungsmitarbeiterInnen, die einen Fachbereich vertreten. Mit ihrer Funktion sind

Verantwortungen und eine gewissermaßen politische Perspektive verbunden. Zum anderen gibt es gesundheitswirtschaftliche Experten auf dem Gebiet. Wasserkuren und therapeutische Behandlungsverfahren in Kurorten fußen auf das Wissen ausgewiesener Experten, was dazu führen kann, dass mögliche Lösungsräume außer Acht gelassen werden. Deshalb schlagen wir vor, ei- ne Differenzierung der potenziellen Stakeholder vorzunehmen. So wird ermöglicht, die Potenziale der Einbindung aller Stakeholder dezidiert zu nutzen. Dies ist uns gelungen, indem wir in den Workshops Inputs unterschiedlicher Stakeholder einplanen. Zum Beispiel haben beteiligte ProfessorInnen (als thematische Experten) aus den Fachrichtungen Informatik, Medizinische Informatik und Mikrosystementwurf sowie Tourismusmanagement und Marketing während der Workshops inhaltliche Impulse geliefert. Die fünf unterschiedlichen Klassen haben wir in einem Workshop (Evaluation 3) gemeinsam mit einem Coach identifiziert.

LL 2: Eine differenzierte Unterscheidung der beteiligten Stakeholder hilft die unterschiedlichen Perspektiven beteiligter AkteurInnen zu verstehen, wertzuschätzen und die Stakeholder entsprechend ihren Hintergründen einzubinden. Wir unterscheiden zwischen Projektteam, inhaltlichen Stakeholdern, thematischen ExpertInnen, NutzerInnen/BürgerInnen und rahmengebenden Stakeholdern. (Figure 29.1).

Design Thinking verhilft agilem Arbeiten: Warum Design Thinking auf agilen Prinzipien beruht, man den Kontext aber immer berücksichtigenmuss und wie man den spezifischen Anwenderkontext berücksichtigen kann

Kreative Problemlösungsstrategien erfordern es, in bestimmten Phasen verschiedene Denkmuster abzurufen (Steller 2017) und unterschiedliche Kreativitäts-Werkzeuge anzuwenden. Kreative Problemlösungsstrategien mit den dazugehörigen Arbeitsweisen gehören nicht zu dem grundlegenden Repertoire der meisten Berufsgruppen. Die ungeübte Auseinandersetzung und Anwendung von Design Thinking-Werkzeugen kann die Teilnehmenden eines Workshops überfordern. Idealerweise beginnt man zunächst mit Befähigungsworkshops. Da dies aufgrund zeitlicher und personeller Ressourcen häufig nicht als einzelner Termin möglich ist, planen wir in unseren Workshops keine klassischen Design Thinking-Dramaturgie bei der klassisch alle sechs Schritte auftauchen. Stattdessen können die inhaltlichen Phasen 1–3 im Vorfeld durch eine kleine Gruppe (z. B. Projektteam) bearbeitet werden. Der größere Beteiligungsworkshop aller Stakeholder ist dann als ein Ideation-Workshop konzipiert, bei dem es darum geht, eine möglichst große

Zahl an Ideen und Lösungen zu generieren. Die Phasen 5 und 6 werden dann wieder durch eine kleinere Gruppe (z. B. Projektteam in Verbindung mit thematischen ExpertInnen und inhaltlichen Stakeholdern) abgebildet. Jede Phase wird durch Erklärungen und Ausprobierzeiten eingeleitet (Figure 29.2).

Figure 29.1. Underscreening der Stakeholder

Figure 29.2. Phasen für die Durchführung eines kommunalen Befähigungsworkshops

LL 3: Design Thinking kann ungeübte Stakeholder überfordern und den zeitlichen Rahmen für einen Workshop sprengen. Es lohnt sich deshalb, bestimmte Phasen des Design Thinking im Vorfeld oder im Nachgang in kleineren Gruppen durchzuführen.

Design Thinking ist nicht nur Mittel zum Zweck: Warum Design Thinkingauch ein gutes *Change-Management*-Werkzeug ist

Design Thinking erscheint gegensätzlich zu gewohnten linearen Prozessen und den an Effektivität, Effizienz und Null-Fehler-Kultur orientierten Arbeitsweisen in Verwaltungen ohne Experimente und kreatives Problemlösen. So können wir gerade dort nicht einfach neue Arbeitsweisen etablieren und die alten Strukturen über Bord werfen. Trotzdem können die erlernten agilen Fähigkeiten und Denkweisen vorteilhaft sein. Aus unserer Sicht macht es deshalb Sinn, mit Bedacht Räume zur Befähigung und zum Experimentieren mit diesen neuen Arbeitsweisen in Kommunen zu schaffen. Neben dem Projekt der Open Government Labore selbst kann das Projekt „Experimentierräume in der agilen Verwaltung (AgilKom)“ dienen. Es zielt darauf ab, Veränderungsprozesse von öffentlichen Institutionen, die sich im Rahmen des digitalen Wandels der Arbeitswelt vollziehen, mit sozialen Innovationen zu verbinden. Es werden Labore eingerichtet, um innovative Lösungen im Handlungsfeld
„Lernen und Arbeiten“ zu erproben. Für die öffentliche Verwaltung werden Methoden der agilen Organisation genutzt, adaptiert und ausgeweitet. Die Ergebnisse der Erprobung

sollen Impulse und Best-Practice-Beispiele für Kommunen sowie für Bundes- und Landesbehörden liefern. Zuletzt werden jedoch nicht nur Projekte ins Leben gerufen, sondern auch anwendungsorientierte Räume geschaffen, so etwa der Dataport Experimentierraum in Hamburg. Er ist ein weiterer Ort zum Ausprobieren für die öffentliche Verwaltung und bietet eine Seminarfläche für Workshops, Vorträge oder andere Veranstaltungen. Der Experimentierraum entstand durch eine Kooperation mit dem Forschungs- und Transferzentrum Digital Reality der HAW Hamburg. Auch in anderen Anwendungsfeldern wurde Design Thinking neu eingeführt und die Bedeutung des entsprechenden Mindsets hervorgehoben. Auch in dem speziellen Fall von industrienahen Dienstleistungen für kleine und mittlere Unternehmen konnte der Design Thinking-Ansatz erfolgreich angepasst und genutzt werden, jedoch wurde das Mindset als wichtiger Aspekt identifiziert (Redlich et al. 2019). In unserem Projekt konnten wir feststellen, dass die Teilnehmenden in unseren Workshops sehr positiv auf neue Werte und Haltungen reagiert haben. Sie fördern die Offenheit für Veränderungen und begleiten den teilweise drastisch einschneidenden Prozess der Digitalisierung in öffentlichen Verwaltungen. Dies bestätigen auch aktuelle Entwicklungen und Angebote führender Ausbildungsanbieter (siehe z. B. Hasso-Plattner-Institut Academy GmbH 2021). Die Arbeit mit Design Thinking kann tiefgreifende Effekte für eine Organisation haben und ihre Entwicklung positiv beeinflussen. Design Thinking kann beispielsweise neues Interesse an komplexen Herausforderungen wecken (Selbstwirksamkeit), die kreativen und sozialen Kompetenzen der Mitarbeitenden schulen (Empathie), die Arbeitskultur der mitwirkenden Teams verbessern (Wir-Gefühl) und einen Raum für menschliche Faktoren und Bedürfnisse schaffen (Vertrauen). Durch ein tiefes Verständnis der bevorstehenden Herausforderung und ein starkes Wir-Gefühl beim Lösen der damit einhergehenden Probleme, wird die Freude bei der Arbeit hochgehalten. Darüber hinaus bietet Design Thinking viele Ansätze und Methoden an, um gemeinsam Entscheidungen zu treffen, Verantwortung für Herausforderungen zu übernehmen und damit in eine moderne Führungsrolle zu wachsen.

LL 4: Neben der inhaltlichen Arbeit an komplexen und vielschichtigen Problemen ist Design Thinking ein vielversprechendes Change-Management-Werkzeug.

Design Thinking kombiniert Planung und Freiheit: Warum Design Thinking zwar Offenheit für Überraschung bieten muss, es aber keineungewollten Überraschungen geben sollte

Offenheit ist ein Muss, um die bestmöglichen Lösungen für neue Services im Kurort der Zukunft zu erarbeiten. Freiheit heißt hier allerdings nicht, dass wir keine Struktur verfolgen, an dem wir das Projekt ausrichten. Wir haben deshalb die Frage nach dem Kurort der Zukunft auf weitere Unterfragen hinunter gebrochen und arbeiten mit einem kontrollierten, wenn auch agilen Projektplan. Im Laufe des Projekts führen wir sechs Workshops durch. In jedem der Workshops wird eine Frage bearbeitet, die sich von der übergeordneten Frage nach dem Kurort der Zukunft ableitet. So zum Beispiel die Frage: „Wie können sich Akteure aus dem Gesundheits- und Tourismusbereich bei der Gestaltung des Kurorts der Zukunft gegenseitig unterstützen?“ Die Erkenntnisse des Workshops werden anschließend von dem Projektteam in Bezug auf die Frage nach dem Kurort der Zukunft reflektiert. So erhalten wir uns zu jedem Zeitpunkt die Übersicht bei gleichzeitiger Entscheidungsfreiheit über folgende Themen. Wir bleiben offen gegenüber neuen Themen und Impulsen, haben aber gleichzeitig alle Fäden in der Hand, das Projekt zu organisieren und zu monitoren. Jede neue Unterfragestellung wird in einem einzelnen Workshop bearbeitet, womit wir gute Erfahrungen in Bezug auf unser Projekt gemacht haben. Dabei startet man bereits vor dem Workshop mit Interviews, tätigt Beobachtungen oder sichtet Dokumente. Im Anschluss an jeden Workshop folgt die Reflektionsphase in der die Ergebnisse hinsichtlich der übergeordneten Frage aufbereitet werden (Figure 29.3).

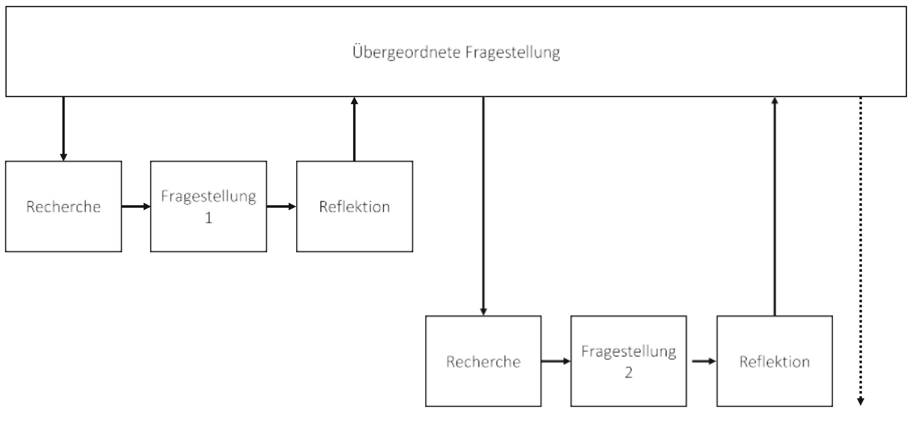

Figure 29.3. Übergeordnete und untergeordnete Fragestellungen zur Projektstruktur

LL 5: Eine offene und agile Arbeitsweise benötigt eine kontrollierte Struktur, die ein geordnetes Projektmanagement ermöglicht.

29.4 Diskussion und Ausblick

Neue kollaborative Innovationsstrategien ermöglichen die Öffnung des Verwaltungshandelns eines Open Government. Sie unterstützen es auf der einen Seite, die geringen Ressourcen der öffentlichen Verwaltung bestmöglich einzusetzen, um inklusiv an Fragen des digitalen Zeitalters zu arbeiten und gleichzeitig neuartige Partizipationsformate zu etablieren, um den konkreten Herausforderungen vor Ort zu begegnen.

Doch wie diese innovative Kollaborationsstrategien tatsächlich umzusetzen sind, um unsere Städte und Gemeinden in zukunftsfähige, intelligente Lebens- und Arbeitsorte zu verwandeln, blieb bislang im Dunkeln. Gerade klassische Beteiligungsformate stoßen schließlich an ihre Grenzen, wenn es darum geht, nutzerzentriertneue Dienstleitungen oder Angebote zu entwickeln. Komplexe und vielschichtigeFragestellungen lassen sich mit bekannten Beteiligungsformaten nur schwer lösen.

Design Thinking bietet hier einen vielversprechenden Ansatz. Gleichzeitig wirft er viele Fragen auf, auf die wir Antworten bieten möchten und teils auch neue Fragen identifizieren. In einem laufenden Forschungsprojekt konnten wir lernen, was es etwa bei der Übertragung von dem Privaten auf den öffentlichen Sektor zu beachten gilt und haben in diesem Beitrag folglich einen Versuch unternommen, unsere Lessons Learned praxisorientiert vorzustellen. Grundsätzlich haben wir die Erfahrung gemacht, dass es schwierig ist, das Konzept Design Thinking, wie es heute vermarktet und im privaten Sektor angewendet wird, eins zu eins auf den öffentlichen Sektor zu übertragen. Dabei können wir empfehlen, den Versuch zu starten, auf Grundlage der Design Thinking Prinzipien seinen eigenen Weg mit der Methode zu gestalten. Mit Design Thinking gibt es nicht den einen richtigen Weg zu innovativer Kollaboration. Für jede Organisation wird dieser anders aussehen.

Bisher konnten wir zwei von sechs Workshops durchführen. Während wir einige Iterationsschleifen bei der Gestaltung dieser beiden Workshops durchlaufen haben, gilt es in den verbleibenden Workshops die Erkenntnisse auf einer weiteren Ebene zu hinterfragen und iterieren. Außerdem stellen wir uns die Frage, inwiefern ein klassischer Design Thinking Workshop unterteilt werden und durch unterschiedliche Stakeholder bearbeitet werden kann, ohne, dass die Mehrwerte von Design Thinking noch erhalten bleiben. Das theoretische Rahmengerüst (Personen, Raum und Prozess) hat sich für uns als gutes Werkzeug erwiesen, unsere Arbeiten und Gestaltungsprinzipien zu erarbeiten und reflektieren. Diese Struktur kann bei weiteren Versuchen, Design Thinking in Verwaltung

zu etablieren hilfreich sein. Aber auch diese Struktur gilt es in der weiteren Arbeit zu hinterfragen und eventuell weiterzuentwickeln.
Design Thinking hat sich in unserem Projekt als gutes Werkzeug erwiesen, um innovativ und kollaborativ an kommunalen Fragestellungen im Sinne von Open Government und mit Bezug auf die Gestaltung digitaler Services (individualisierte Dienstleistungsangebote für Kurgäste auf Basis von mobil erhobenen Gesundheitsdaten) zu arbeiten. Wir konnten einige theoretische Annahmen, die sich aus bisherigen Arbeiten und der Literatur ergeben hatten, überarbeiten, differenzieren oder erweitern. Gleichzeitig bestätigte sich unsere Erwartung, dass sich Design Thinking für die Umsetzung innovativer Kollaborationsstrategien in Kommunen eignet, sofern die Begebenheit des öffentlichen Sektors und die projektspezifischen Voraussetzungen einzelner Fragestellungen berücksichtigt werden. Allen Voran geht die Befähigung der Mitarbeitenden, die Offenheit gegenüber Fehlern und agilen Denkweisen und die kompetente Begleitung durch ausgewiesene Design Thinking Coaches. Diese Fertigkeiten und Fähigkeiten müssen, können und werden in den Verwaltungen der Zukunft etabliert werden. Und wie genau – das geschieht nutzerorientiert.

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29.5 Literatur

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30. Paper 24: Does one Creative Tool Fit All?

Title	**Does one Creative Tool Fit All? Initial Evidence on Creativity Support Systems and Wikipedia-based Stimuli**
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Table 88. Fact Sheet Publication

Does one Creative Tool Fit All? Initial Evidence on Creativity Support Systems and Wikipedia-based Stimuli

Abstract. *Creativity is important to all kind of organizations because creative capacity can help tackle complex challenges and navigate through the ambiguity of wicked problems. In Information Systems (IS) research, this topic is addressed by studies on creativity support systems (CSS). One promising approach is to provide (context related-) stimuli to individuals to inspire new and useful ideas. The relatedness of a stimuli, which means the degree to which a stimulus is related to a topic (i.e., to the creative task), is a vital characteristic. We investigated in the relationship between Wikipedia-based searching results (computational relatedness) and individual cognition (individual relatedness). Our initial findings show that there can be differences between individuals based on demographic variables. We further suggest a laboratory experiment to contribute to a CSS that takes individual relatedness and thus custom-fit stimuli into account.*

Keywords: *Creativity Support Systems, Creativity, Relatedness, Wikipedia.*

30.1 Introduction

Creativity is vital in today's digital world because creative capacity can help organizations and companies tackle complex challenges and navigate through the ambiguity of wicked problems (Müller-Wienbergen, Müller, Seidel and Becker, 2011). Creative advantages are sustainable in the sense that they cannot easily be copied by competitors and help exploit new business options. In that line, it is argued that creativity is one of the most important human capabilities of the future (IBM, 2010; Powers, 2018).

In Information Systems (IS) research, this topic is addressed by studies on creativity support systems (CSS), which are tools that can enhance creative output of individuals or groups (Müller-Wienbergen et al., 2011; Althuizen and Reichel, 2016). There are several approaches to enhance creativity (Elam and Mead, 1990; Minas and Dennis, 2019; Wang and Nickerson, 2019) and a promising one is to provide (context related-) stimuli to individuals to inspire new and useful ideas (Wang and Nickerson, 2019).

The relatedness of stimuli, which means the degree to which a stimulus is related to a topic (i.e., to the creative task), is a vital characteristic (Santanen, Briggs and Vreede, 2004; Wang and Nickerson, 2019). Based on findings related to the Cognitive Network Model (CNM), the Adaptive Control of Thought theory (ACT) and the Search of Associative Memory theory (SAM), we derive that remote stimuli indeed help enhance creativity, because "creativity typically emerges from discovering new associations between previously disparate things" (Müller-Wienbergen et al., 2011, p. 719). Current empirical findings show that exposure to closely related stimuli leads to more ideas and more useful ideas. In specific, "(…) stimulus relatedness is positively related to idea quantity and idea usefulness" (Wang and Nickerson, 2019, p. 2). So, based on literature and empirical evidence, we expect that the relatedness of stimuli affects creative output.

Previous literature already has emphasized personal characteristics (e.g., experience or knowledge) and their link to creative output (e.g., Briggs and Reinig, 2010). One aspect is that cognition is highly individual. For instance, the concept of *CSS* might be connected to the discipline of *information systems* for someone who has domain knowledge. The concept *iPhone* might be connected to *steve jobs* for someone who knows the company *apple*. People who have an *iPhone*, but do not have information about the company *apple*, will have probably experience a greater non-relatedness between the two concepts. However, in a lot of recent studies, *individual relatedness* is mainly neglected. Against this background, we define *individual relatedness* as an inherent cognitive structure of concepts by an individual and expect custom-fit stimuli to enhance creative output more than stimuli ignoring the aspect of *individual relatedness*. With our research, we want to make a first step towards addressing this research gap. To reach our aim, we will investigate the relationship between Wikipedia-based searching results (*computational relatedness)* and individual cognition (*individual relatedness*). We define *computational relatedness* as computational extracted concept structure. While both structures draw on human memory, *computational relatedness* builds on the relatedness, which is often cumulatively defined by several people who share their knowledge about a concept and relate it to other concepts. As highlighted, *individual relatedness* builds on one's own experiences. In the following, we give an overview of related work. Afterwards, we propose a research model to understand the implications of the relatedness of stimuli. We further illustrate the first results of our preliminary investigation (pre-study). The paper closes with a research agenda and outlook.

30.2 Related Work

Cognitive Processes of Creativity

Based on classical cognitive science research, the cognitive network model (CNM) seeks to explain ideation. There are two modes in human memory (Baddeley, 1997), which are the working memory (WM) and the long term memory (LTM). The WM only has the capacity to store information for a limited amount of time, while the LTM stores individuals' experiences and knowledge in the long run (Santanen et al., 2004; Nijstad and Stroebe, 2006). For the sake of better access to knowledge stored in LTM, knowledge is organized in groups, which we call frames (Minsky, 1975). Frames and entities of frames are linked to each other. The CNM refers "to these bundles as frames and assume[s] that the frame, rather than the discrete items within each frame, is the basic unit of knowledge that we store and manipulate in our memory" (Santanen, Briggs and de Vreede, 1999, p. 490). Once activated, frames often automatically activate linked frames (Santanen et al., 2004; Nijstad and Stroebe, 2006), which then builds a network of frames, representing our knowledge and experience (Santanen et al., 1999). According to Collins and Loftus (1975), frames can be part of more than one entity. The links and the strength of the links between them are variable. Thus, not all information stored in LTM is equally well accessible.

The cognitive process of ideation in a creative process is a two-step process (Nijstad and Stroebe, 2006). First, knowledge is activated in the WM and loaded from the LTM. Second, we find a combination or a processing of different frames in the WM to generate new ideas (Nijstad and Stroebe, 2006). This two-step process is iterative. For example, new ideas can influence knowledge activation. Looking at the characteristics of new ideas, Mednick (1962) said that the combination of two unrelated frames leads to new ideas. Thus, a greater variation and the combinations of frames may increase the likelihood that a new idea is produced (Santanen et al., 2004). Notably, people often fail to explore the solution space and only activate bounded or familiar frames (Santanen et al., 2004). However, "the creativity of a solution is a function of the degree to which frames that were previously distant from one another become saliently associated in the context of problem-solving" (Santanen et al. 1999, p. 491).

Additionally, there are two other well-cited theories, which can help to understand the implication of stimuli: the SAM theory (Raaijmakers and Shiffrin, 1981) and the ACT theory (Anderson et al., 2004). The SAM theory states that once the WM contains a task-related frame (e.g., hotel promotion) and once a stimulus word (e.g., cooking) is presented, this frame will be loaded from the LTM to the WM. Both frames (i.e., the task and stimuli frame) are used as search cues in LTM to identify useful other frames. The search is likely to identify closely related and highly connected frames. In the next phase, the identified frames are evaluated. If they seem to be useful for ideation, they will be progressed in the WM. If they do not seem appropriate, the cues will be used for the next search. According to ACT theory, the second useful theory, a steady level of activation ensures searching for fitting frames. External stimuli can enhance this process. A stimuli word will automatically activate other frames based on the strength of their relatedness. The automatic activation of frames based on the strength of their relatedness is the main aspect of the ACT theory (Wang and Nickerson, 2019).

Relatedness and Effects of Stimuli

Remote stimuli have a positive effect on creativity (Chan et al., 2011; Chiu and Shu, 2012). For example, they decrease a narrow focus and fixation during the ideation session (Wang and Nickerson, 2019). Likewise, literature shows that people who are exposed to novel or paradigm-modifying ideas tend to create highly creative ideas themselves (Wang and Nickerson, 2019). However, there are many studies that challenge these findings. For instance, also moderately distant stimuli can help create useful ideas (Fu et al., 2013). So, based on theory we can derive that a stimulus can be close, moderately close, remote, or unrelated to an initial ideation task. Relatedness can affect creative outcome (Wang and Nickerson, 2019).

We relate to Wang and Nickerson (2019), by noticing three limitations which also lead the way for our research. The first limitation is that relatedness has different definitions (e.g., in one study, remote stimuli are closely related, while in another study, they are moderately related). This causes inconsistency. Second, the differentiation between unrelated and remote stimuli is infrequent. This results in different empirical results. Third, the selection and collection of stimuli for experimental studies is usually done 'by hand' and is very vulnerable to biases and errors. This is not beneficial for any scientific setting and not beneficial for further research in the sense that it is not replicable.

Besides these gaps, which are addressed in our research, to the best of our knowledge, there is no study that considered individual factors such as experience/age, domain knowledge, gender, etc., in conjunction with computational use/search of stimuli. The gap is particularly important to investigate as the use of computers offers enormous potential (e.g., artificial intelligence and knowledge graphs).

30.3 Research Model

Adopting related work, the relatedness of stimuli has to consider the individual cognition (Briggs and Reinig, 2010). Because knowledge and experience are so individual, we have to consider that also the link between a stimulus and the activated knowledge of a person is highly individual. That means that the definition of relatedness defined on the base of semantic structures such as a knowledge graph (1st, 2nd, 3rd, etc. order) can be different from a highly individual cognitive network.

Also, the strength of the relatedness has to consider the individual level (Raaijmakers and Shiffrin, 1981; Anderson et al., 2004). For instance, a variation in strength can be how often links are used and activated. If someone is used to a certain link, it is highly likely that this link will automatically be activated in ideation sessions. Another example is the time when a link was activated. If it was a long time ago, it would not be likely to be activated. The boundary between the WM and the LTM plays a key role in this context. If links are not used for a long period, they are not only far away about its content; they can become remote or quite unrelated although they might have been related before because of timing.

Both dimensions of individual relatedness (i.e., relatedness itself, strength of relatedness) do moderate the effect of stimuli on cognitive persistence and cognitive flexibility through cognitive load and WM capacity (WMC) (Wang and Nickerson, 2019). WMC moderates the effect between stimuli and cognitive flexibility and cognitive persistence. Cognitive flexibility is defined as "the ease with which people can switch to a different approach or consider a different perspective" and cognitive persistence as "the possibility of achieving creative ideas, insights, and problem solutions through hard work, the systematic and effortful exploration of possibilities, and in-depth exploration of only a few categories or perspectives" (Nijstad et al., 2010). It is noteworthy that especially cognitive persistence is affected by the WMC, because cognitive persistence (i.e., the systematic and effortful approach to creativity) needs cognitive effort (Baas et al., 2013). In turn, WMC is affected by cognitive load (Nijstad, De Dreu, Rietzschel and Baas, 2010). Thus, reducing the cognitive load by designing an optimal fit between the computational relatedness (i.e., close, moderately close, remote, or unrelated; Wang and Nickerson, 2019) and the actual cognitive relatedness (*individual relatedness*), can enhance the effect of stimuli on creative output. In sum, we expect that considering individual factors (e.g., age, gender, experience/knowledge) when implementing stimuli in a CSS can achieve a better fit between the *computational relatedness* and *individual relatedness*. This can reduce cognitive load and finally enhance the WMC for the creative task, which in turn leads to a higher creative output. Figure 30.1 illustrates the overall research model.

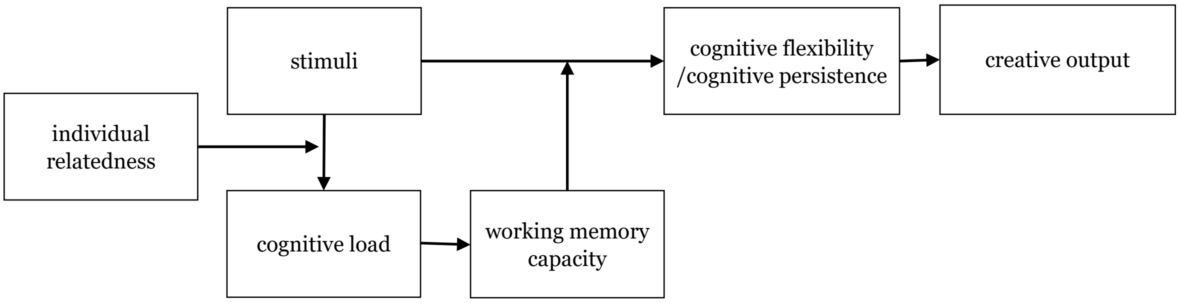

Figure 30.1. Overall Research Model

30.4 Pre-Study

Wang and Nickerson (2019) validated the use of a Wikipedia-based approach for automatically finding stimuli (*computational approach*), which opened the door for further developing CSS. While literature on CSS in IS research is rich and various (Wang and Nickerson, 2017), the understanding of the relation between cognitive structures and computational searching approaches (e.g., Wikipedia or other knowledge graphs) is not sufficiently understood for deriving design items, which could be validated. A better understanding of this relationship will inform future research.

To make a first step towards an individualized CSS, we want to investigate and understand the differences between the relatedness in Wikipedia and the rated relatedness on an individual cognitive level. A first attempt towards that direction is to examine three concepts where we expected to be different between groups. (1) The concept *iPhone*, because we expect differences on the basis of experience with technology. (2) The concept *breastfeeding*, because we expect differences on the basis of gender. (3) The concept *tree*, as a concept that is more universally valid.

Experimental Pre-Study

We followed the data collection approach proposed by Wang and Nickerson (2019), who suggested finding concepts that are spreading out from an initial concept through hypertext linkages. These are labeled as 1st, 2nd, and 3rd degree concepts. Returning to the previously mentioned example *iPhone*, we would receive iPad as a 1st degree concept as it is a hyperlink and in the text of Wikipedia page of iPhone. Similarly, Bluetooth (as a hyperlink and in the text of Wikipedia page of iPad) would be a 2nd degree concept and packet switching a 3rd degree concept (as a hyperlink and in the text of Wikipedia page of Bluetooth). We wrote a Node.js web scraping script to recursively identify the terms. While collecting, the script counted every term's respective hyperlink on their Wikipedia page in order to rank them. As Wang and Nickerson (2019) suggest, we only included the 30 top-ranked concepts for every iteration to reduce the runtime and receive more well-known concepts. All duplicates were removed. Figure 30.2 illustrates the resulting structure.

Additionally, we implemented a function to search for random Wikipedia books (http://en.wikipedia.org/wiki/Special:Random/Book) to collect a totally unrelated concept for every combination. Overall, we selected three basic terms: *tree*, *iPhone*, and *breastfeeding*. We expect that *tree* could represent a concept well known to everyone, while *iPhone* and *breastfeeding* could result in different ratings across demographic variables. To evaluate the relatedness between a concept and its related concepts, we adopted the relatedness measurement by Wang and Nickerson (2019). Relatedness is measured on a scale ranging from 1 to 7 (1 being totally unrelated, 7 being highly related). For each of the basic concepts, we then randomly selected two combinations from our resulting structure.

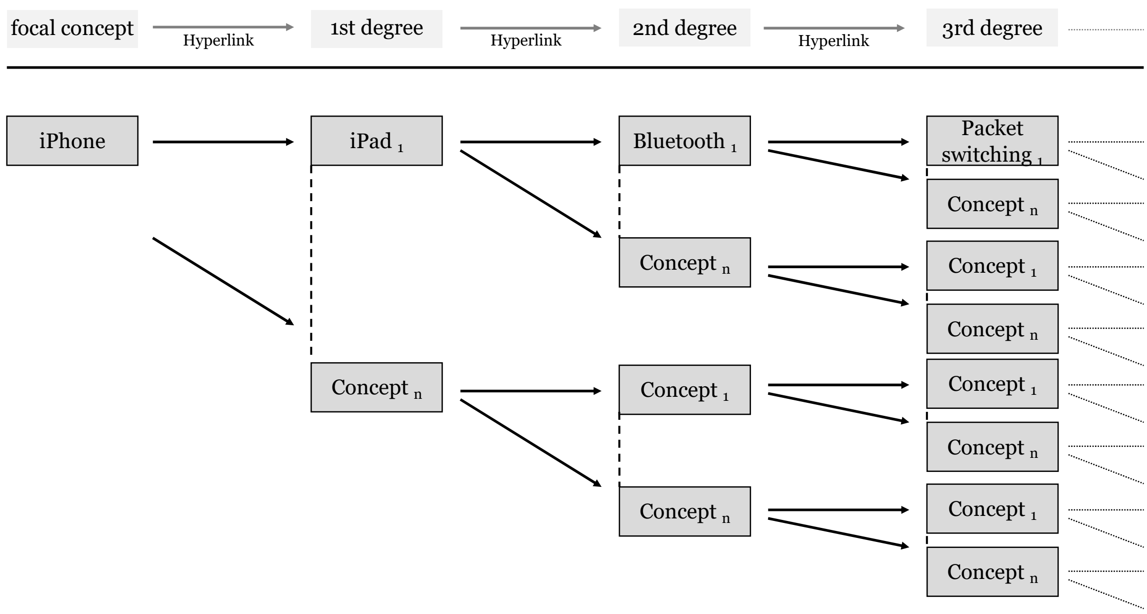

Figure 30.2. Structure of Scraping Results

To investigate the relatedness of the crawled Wikipedia concepts, we conducted an online questionnaire. We acquired 167 subjects from Amazon Mechanical Turk to evaluate the relatedness. The maximum time on task was set to 10 minutes. Each worker was offered and paid one US dollar for completing the task. On average, these participants were 35.9

years old (SD = 11.7 years) and spent 240 seconds on the survey (SD = 108 seconds). 29.3 percent of the participants were female, 67.7 percent were male, and the remaining 3 percent did not specify their gender.

First, our results confirm the findings of Wang and Nickerson (2019). Regarding the concepts *iPhone*, *breastfeeding*, and *tree*, all participants generally validated the order of concepts of Wikipedia. Exemplary, 1st degree concepts are closer related to *iPhone* (Mean = 4.89 SD = 1.8) while 2nd, 3rd degree, and random concepts are less and less related (in this order, Mean = 4.26, SD = 2.02; Mean = 3.81 SD = 1.9; Mean = 3.76 SD = 1.96). Based on a one-way analysis of variance (ANOVA), the relatedness differs significantly across groups ($F(3,980) = 18.29$, $p < 0.001$). Due to the statistically significant results, we carried out post hoc comparison analyses using Tukey's honestly significant difference (HSD) test to further scrutinize the differences between the groups. The post hoc Tukey tests show that the 1st degree concepts, 2nd degree concepts, and 3rd degree concepts differ significantly at $p < .001$; 3rd degree concepts and random concepts were not significantly different. We also carried out these procedures for the other concepts.

However, we expected varying results for demographic groups. For example, it is assumable that women have another relationship to the concept of *breastfeeding*. To evaluate this expectation, a two-way ANOVA was carried out on relatedness by gender and order. There was a statistically significant interaction between the effects of gender and order on relatedness [$F(3, 3721)=5.037$, $p = 0.002$]. Tukey's HSD post hoc tests were carried out. While females and males do not differ in the rating of relatedness of the 1st degree and 3rd degree concept, they differ significantly at $p=0.004$ in the rating of the 2nd degree concept and at $p=0.04$ in the rating of the random concept. Furthermore, when considering the term *iPhone*, it is assumable that IT users who rate themselves as competent are more likely to better evaluate the relatedness of concepts regarding the concept *iPhone*. To evaluate, a two-way ANOVA was carried out on relatedness by IT skills (ordinal scale: beginner, competent user, expert) and order. However, there was no statistically significant interaction between the effects of IT skills and order on relatedness [$F(6, 3484)=1.235$, $p = 0.277$]. Finally, we expected that there would not be a difference for a general term like *tree* across demographic variables. Exemplarily, we tested whether there are differences based on gender. To do so, a two-way ANOVA was carried out on relatedness by gender and order. There was a statistically significant interaction between the effects of gender and order on relatedness [$F(3, 3630)=6.251$, $p < 0.001$]. Further, Tukey's HSD post hoc tests showed that females and males do not differ in the rating of relatedness of the 1st, 2nd, and 3rd degree concept, but they differ significantly at $p<0.001$ at the random concept. Figure 30.3 shows the results of the posthoc comparisons.

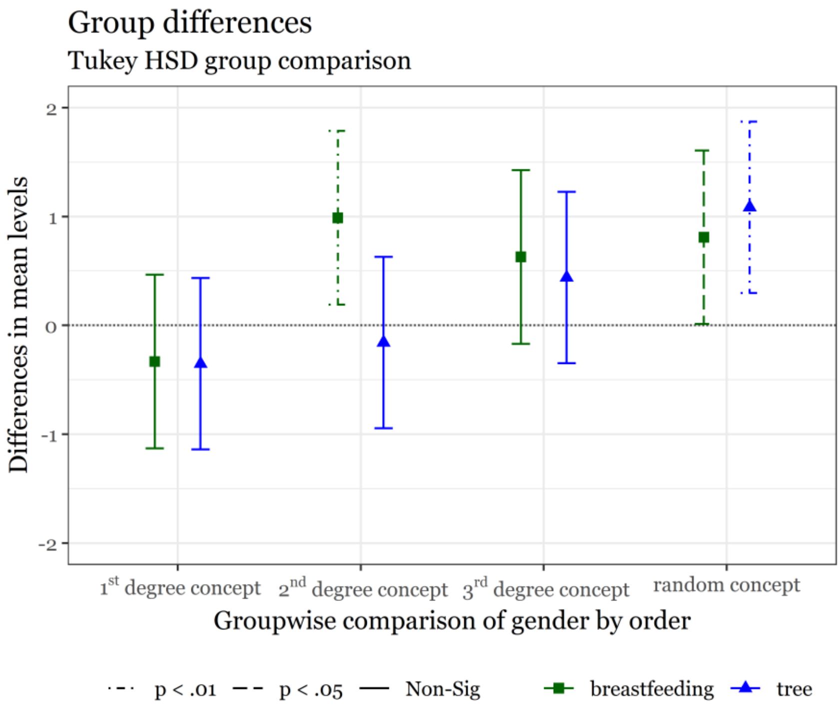

Figure 30.3. Groupwise Differences

Findings and Discussion of the Pre-Study

First, our findings highlight that future research can consider the limitations of previous research. In fact, it is important to view relatedness as a continuum and that people generally recognize the difference between remote and unrelated stimuli. Furthermore, our research shows that the relatedness of Wikipedia concepts generally applies to the results of Wang and Nickerson (2019). However, considering demographic variables, our results show that the relatedness of concepts can vary across different groups. Specifically, we demonstrate that not only specific concepts like *breastfeeding* (and their related concepts) but also general concepts like *tree* (and their related concepts) differ in their rating of relatedness across demographic variables. This suggests that the linked structure of Wikipedia concepts does not always reflect the individuals' cognitive networks.

30.5 Research Agenda and Outlook

As our research is intended for design, it seeks to derive design implications that help construct a CSS in the long run (Gregor, 2006; Niehaves and Ortbach, 2016). Our research is a step towards providing “theory-driven design guidelines and prescriptions for IS design, and the generation of hypotheses that are testable” (Walls, Widermeyer and El Sawy, 2004, p. 54). When it comes to the kernel theory, we follow Nijstad et al. (2010), who defined cognitive flexibility and persistence. Creative insights, ideas or solutions are achieved through “flexible switching among categories, approaches and sets” (Nijstad et al., 2010).

Keeping our initial findings in mind, we plan to conduct an experiment to gain further insights. We will assign 80 participants to two conditions in a within-subjects design: stimuli text (Wikipedia-based), individualized stimuli text (validated stimuli). Based on our initial findings, we will validate the stimuli before the laboratory experiment. Foundation for the validation will be a similar procedure to the pre-study. This way, we ensure that the custom-fit stimuli achieve the desired effect. IS students from our local university will be recruited for the study in exchange for course credit. During the experiment, we use creative tasks that have been used in previous IS literature (Dennis, Minas and Bhagwatwar, 2013; Bhagwatwar, Massey and Dennis, 2017; Minas and Dennis, 2019). Each participant will work on each task, for 15 minutes each on three consecutive days. The order of the tasks is set at random. The first one (“tourism task”) is phrased as “Please generate as many ideas as you can to increase the number of tourists that visit the state of <State Anonymized for Peer Review>. Please consider tourists from inside the state who visit other parts of the state, as well as tourists from other parts of <Country Anonymized for Peer Review> and those from other countries”. The second task (“pollution task”) is phrased as “Please generate as many ideas as you can that will reduce pollution. Please consider ideas to reduce air pollution, water pollution, and ground pollution (e.g., garbage and landfills)”. As a third task, the participants read: “Please generate as many ideas as you can that will allow elderly people to stay in their homes. Please consider elderly people in need of physical, mental, and monetary assistance”. After each task, they read: “Try to generate as many ideas as possible. All ideas are welcome, no matter how silly or unusual they seem.” Participants will be tested in a laboratory with twenty computer workplaces in groups of ten to twenty persons. Necessary additional features due to the Corona pandemic will be considered, and distances will be kept at all times. The participants will obtain informed consent in which we explain that we are interested in their ideas for different areas over the course of the study.

Afterward, we ask them to read the instructions on the computer screen and to provide sociodemographic information (e.g., age, gender, whether they have a job in the mentioned area). Next, whiteboards will open, and participants receive an explanation of how the software works. After they have pressed the “Start“-button, the first task begins. After they have completed the first task, the experiment for day one ends. At the next day, the experiment continues with the respective following task. At the last day, participants fill out the last task, are thanked, debriefed, and receive course credit. *Creative output* is measured with the variable’s quantity of ideas and quantity of creative ideas. *Quantity of ideas* is measured in line with previous research (Minas and Dennis, 2019), as the number of unique ideas, without assessing quality. A master list of unique ideas of all participants will be created by one rater. Based on this list, this rater and a second rater will count the ideas independently. Subsequently, inter-rater-reliability will be calculated by the number of ideas on which both raters agreed divided by the total number of ideas and the final score will be calculated by the mean of both raters. *Quantity of creative ideas* will be measured by counting the number of creative ideas using the procedure of Dean et al. (2006) and Minas and Dennis (2019). For this, two independent raters will rate the ideas regarding novelty, workability, and relevance. Each is rated on a four-point scale, with higher values reflecting higher fit to the subdimension. Cronbach’s alpha will be calculated as a measure of inter-rater reliability (Minas and Dennis, 2019). We will use one-way repeated measures ANOVAs using the afex package in R (Singmann, Bolker, Westfall and Aust, 2015), followed up by planned contrasts. If necessary, to assess mediation effects, we will use the mediation package.

It is our goal to contribute to the development of an efficient CSS in the long run. Our ultimate vision is an ontology-based system that analyzes the user and task as automatically as possible and provides appropriate stimuli. After the proposed experiment, we try to investigate not only other stimuli, but also stimuli based on more established sources, such as a knowledge graphs based on an ontology.

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31. Paper 25: Inspiring Ambient Technology

Title	**MUSE – Towards a Concept of Inspiring Ambient Technology Driven by Artificial Intelligence**
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Table 89. Fact Sheet Publication

MUSE – Towards a Concept of Inspiring Ambient Technology Driven by Artificial Intelligence

Abstract. *Creativity is of increasing importance to all kind of organizations. Moreover, Creativity Support Systems (CSS) have a long history in Information Systems (IS) research. However, findings are various and not overwhelming. In this research-in-progress paper, we want to contribute to existing literature by using a design-oriented approach to start the route towards a concept of a CSS with inspiring ambient technology driven by AI and to propose further steps on how to evaluate the derived design variants (i.e., restrictive, and expansive examples, texts and pictures). The justification knowledge is based on the Cognitive Network Model (CNM) and the Dual Pathway Approach to Creativity. Our work shows how to build the AI-driven CSS and how to evaluate the system in a two-step approach. The first part of the evaluation will be a qualitative ex ante evaluation to inform the subsequent post ante laboratory experiment.*

Keywords: *Creativity Support System, Creativity, Artificial Intelligence, Dual Pathway to Creativity, Cognitive Network Model of Creativity.*

31.1 Introduction

Creativity is of increasing importance to all kind of organizations; be it a large traditional mechanical engineering group that has to rethink its product range; be it a medium-sized family business after a change of management with the will to re-organize work processes; be it a small start-up that puts its employees at the center of its business, but at the same time wants to build up a reputation for its innovative ability. Innovation often succeeds after creativity helped solve wicked problems, which are more and more obvious in today's complex business environment (Schmiedgen et al. 2016). Against this background, creative capacity can help companies that strive for sustainability and future viability to tackle pressing challenges. Creative settings (e.g., design thinking workshops) are necessary and surpass individually occurring ideation, because team creativity by far beats the individual (Buchanan 1992; Nijstad and Stroebe 2006; Paulus and Brown 2007; Santanen et al. 2004). For designing such creative settings, we have to understand the various situational and dispositional variables that can affect the quantity and quality of the creative output (Nijstad et al. 2010).

Artificial intelligence (AI) is increasingly present as more and more organizations use it for decision making and optimization. Thereby, AI tremendously affects the way we work (Fink et al., 2010). In this respect, literature identified two different paradigms about the relation between humans and AI. AI can be human level (McCarthy 2007), or work symbiotically with humans to enhance their inherent abilities (Licklider 1960). The second paradigm points to the fact that AI assists, guides, challenges, supports, and inspires human (e.g., artist and designers; see *Künstliche Intelligenz Als Kreative Muse | Roman Lipski & Florian Dohmann | UBX18* 2018), which will be the focal point of our analyses.

Inspiration stands as the opposite of fixation, which is one of the five different pillars of neuro-creativity (among priming, associations, inhibition, and incubation). To apply neurobiological principles to the complex and multifaceted concept of creativity is considered as promising (Onarheim and Friis-Olivarius 2013), as preventing fixation was shown to be doable when we "use clues or hints in the environment" (Smith and Linsey 2011). One specification of this approach is the exposure of examples as stimuli (Agogu et al. 2011), which was also shown in neuroimaging studies (Fink et al. 2010). As research revealed which examples can encourage fixation or inspiration (Agogu et al., 2011; Howard, Maier, Ponarheim and Friis-Olivarius, 2013), we expect an IT artefact that presents inspirational examples can help groups in creative workshops to become or to stay inspired (i.e., preventing fixation), which will, among other things, create better outcome, encourages the participants, and saves time.

Summing up, the aim of this research-in-progress paper is to start from a design-oriented approach to start the route towards a concept of an inspiring ambient technology (communication media (i.e. screens) that are integrated into the architecture or furniture in the according rooms (e.g. workshop rooms) in order to assist with the task (i.e. inspire)) driven by AI and to propose further steps on how we will evaluate the derived design variants in a laboratory experimental setting. With our research, we seek to answer the following two research questions:

RQ1: *Do inspiring examples provided by an AI as visual stimuli help be more creative – and if so, how?*

RQ2: *Based on our findings, how can we design inspirational AI-driven creativity support systems (CSS) to help designers to produce more creative ideas through adaptive ambient technology?*

By answering these research questions, we seek to contribute both to theory, practice, and design.

31.2 Theoretical Background

Creativity in the light of the Cognitive Network Model. The Cognitive Network Model (CNM) is a theoretical model that seeks to explain ideation episodes in a creative process based on classic cognitive science research. The model differentiates two modes in memory (Baddeley 1997): the working memory (WM) and the long-term memory (LTM). The first has the capacity to store information for a limited time, whereas the second stores experiences and knowledge on a long-term basis (Nijstad and Stroebe 2006; Santanen et al. 2004). Bringing forth knowledge from the LTM is resource-consuming, so 'rules of thumb' are organized in different groups to make them easier to access. These groups are called 'frames' (Nijstad and Stroebe 2006; Santanen et al. 2004). One feature of frames is that they are directly linked to each other and oftentimes automatically activate linked ones, when being activated themselves (ibid.). Moreover, the content of the frames (i.e., its items) can be part of more than one frame (Collins and Loftus 1975), which results in the fact that the links and the strengths of those links can vary across frames.

Like the modes in memory, the cognitive process of ideation can be differentiated in two steps (Nijstad and Stroebe 2006): the activation knowledge and the combination of knowledge. Idea generation relies on the two modes in memory (i.e., WM, LTM) by (step 1) loading information from the LTM, activating it in the WM, and (step 2) by processing various frames in the WM to generate new ideas (Nijstad and Stroebe 2006). The combination of unrelated frames is considered a promising pillar for generating more creative output (Mednick 1962). During this process, the creative thinker iteratively makes new connections between items and applies existing frames to new domains. Because it is not easy to discover different frames, and to combine them in a meaningful way (Santanen et al. 2004), supporting this process by technological means may offer great advantages.

Technology can help humans in the creative process by providing context-specific stimuli on how to combine two unrelated frames (Santanen et al. 2004). As literature tells us, this can be achieved by activating unrelated frames in the LTM and by making them accessible in the WM. The provision of context-specific external stimuli via technology is possible to happen in a way, the individual cannot influence (Santanen et al. 2004) and thus automatically and free instead of deliberately and constrained. Therefore, creative processes supported by information systems can on the one hand avoid 'fixation' and on the other hand assist switching between frames, which in the end inhibits inertia (Santanen et al. 2004). We pursue this insight further and concentrate on CSS in the following.

CSS are information systems that support individuals or groups in being creative (Seidel et al. 2010). On the one hand, CSS have been a part of IS research for a long period of time (Couger et al. 1993; Nevo et al. 2009). On the other hand, they are currently under discourse (Althuizen and Reichel 2016; Minas and Dennis 2019; Sassenberg et al. 2017). Literature shows that there are three ways to support creativity by CSS (Müller and Ulrich 2013; Müller-Wienbergen et al. 2011). The most common approach is to provide task-specific information as stimuli (i.e., CSS as stimuli provider) (Müller-Wienbergen et al. 2011). The second approach is to provide help to structure the creative process (i.e., CSS as process guide) (Couger et al. 1993). The third approach is to use the system to prime individuals (i.e., CSS as priming instrument) (Minas and Dennis 2019). To the best of our knowledge, there is no CSS that is designed to support a group of people in ideation phase by ambient technology (AI).

Creativity in the light of the Dual Pathway Model. When studying creativity, it is important to note that there are two different ways to come up with new ideas, namely flexibility and persistence (De Dreu et al. 2008; Nijstad et al. 2010; Paulus and Brown 2007). The flexibility pathway can be seen as generating a great number of different ideas. Producing many original responses stand for a creative search process in the breath of various categories. On the contrary, persistence can be viewed as generating multiple ideas within a single category and as search process in depth in one category. Following Nijstad et al. (2010) we define the two pathways: Cognitive flexibility is "the ease with which people can switch to a different approach or consider a different perspective" and cognitive persistence is "the degree of sustained and focused task-directed cognitive effort". The number of categories can be looked at as an indicator for the used pathway (De Dreu et al. 2008). Interestingly, the choice of the pathway can be influenced (Minas and Dennis 2019). Looking closer at flexibility, we see that creative insights, ideas or problem solutions are achieved through "flexible switching among categories, approaches and sets" (Nijstad et al. 2010). People find remote associations as a source of inspiration and a "broad attentional focus and switch flexible between approaches" (Nijstad et al. 2010). New connections between distant frames can help to generate new ideas (Simonton 2018), however, resulting in the probable production of a lot of unusual and useless ideas. Being persist then means to spend hard work, cognitive control and effort into creative ideas, insights, or problem solutions. Only few categories are explored. The process does not directly lead to original ideas but needs many resources to prevent irrelevant thoughts (Dreisbach and Goschke

2004). Thus, cognitive psychology emphasizes that flexibility and persistence are a tradeoff (Dreisbach and Goschke 2004; Nijstad et al. 2010). Both pathways seem to be negatively related, however, people can switch between the two (Leber et al. 2008). In the case of creative problem solving and ideation, people may use both modes (Nijstad et al. 2010), so in sum, both pathways can lead to inspiration, while preventing fixation. Both pathways will lead to more creative ideas. Depending on personality traits or the task one pathway is easier to activate than the other. However, to prevent fixation, it does not matter which pathway is activated. Both pathways, although or because they can be negatively related, do lead to creative ideas.

31.3 Research Design and Methodology

Towards an integrated research model. The core component of our model is the integrated information system architecture for an AI-driven CSS. As our research is intended for design, it seeks to derive design implications that help construct and build the technological artifact (e.g., methods, techniques, and principles of form and function) (Gregor 2006). We focus on the design principles of form and function of an AI-driven CSS to foster inspiration and prevent fixation. For reaching our aim, we will consider two main perspectives on the artifact, namely to 'theorize prescriptively for artifact construction' (i.e., interior mode) and 'theorize about artifacts in use' (i.e., exterior mode) (Gregor 2009). By doing so, our research is a first step towards providing "theory-driven design guidelines and prescriptions for IS design, and the generation of hypotheses that are testable" (Walls et al. 2004, p. 54). At this stage, our research is of an explanatory fashion, because it "prescribes principles that relate requirements to an incomplete description of an object" (Baskerville and Pries-Heje 2010, p. 273).

Research design. Looking at the process of our research, we must focus on two core activities, namely theory and artifact *building* (step 1) and *evaluation* (step 2) (Peffers et al. 2007; Simon 1967). *Building* implies that we need a framework for our research, which is built on theoretical work and does deliver a set of distinct theory components (Baskerville and Pries-Heje 2010). In our case, it is the Cognitive Network Model and the Dual Pathway Model. This theoretical background delivers the kernel theory (Walls et al. 1992) and our justification knowledge (Gregor and Jones 2007) *(Outcome A, see 'Theoretical Background')*. Consequently, we defined general requirements (Baskerville and Pries-Heje 2010) that a system needs to replicate and support creativity *(Outcome B)*. In the next step, we defined initial principles of our design. They are "command variables" (Voigt 2014), which help create or change objects for a desired future situation (Simon 1967) *(Outcome C)*. Based on these components, we then presented our inspiring AI-driven CSS as an expository instantiation (Gregor and Jones 2007) *(Outcome D)*. Coming to *evaluation*, design science's core element is the evaluation of design artifact and theory (Hevner et al. 2004). We see our inspiring AI-driven CSS as a fruitful way to evaluate the given theories. Using prototype instantiation as artifacts to evaluate theories is common approach in verification and refinement (Ngai et al. 2009). Thus, and to be more precise, we differentiate two steps in our evaluation, namely the ex ante evaluation *(Outcome E)* and ex post evaluation *(Outcome F)*. The first means receiving qualitative feedback (e.g., Becker et al. 2011), where "the artifact is evaluated on the basis of its design specifications alone" (Pries-Heje and Baskerville 2008, p.2) to thereupon implement improvements. The second is meant to conduct a quantitative evaluation, e.g., an experiment.

31.4 Initial Findings and Further Research

General Requirements (Outcome B). Based on related work (i.e., the kernel theory (Gregor and Jones 2007; Walls et al. 1992)) we derive requirements for an AI-driven CSS.

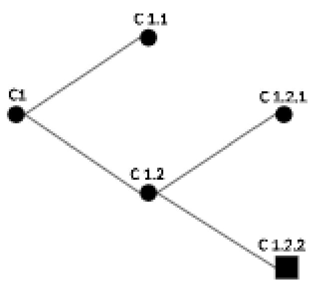
(1) support connections between the LTM and the WM: "This suggests that external stimuli provided to problem solvers may act as fresh entry points into one's cognitive network" (Santanen et al. 1999). Although the LTM contains a huge potential for creative solutions, people often rely on habitual ideas and narrow solution space and do not connect unrelated frames after loading them into their WM.

(2) support iterations: Whichever pathway (i.e., flexibility or persistent) is activated, an iterative approach will lead to more ideas, as new ideas will activate new associations and thus lead to more ideas and so forth (Santanen et al. 1999). In other words, "activation of successive frames spreads through our memory causing the activation of yet other frames (Collins and Loftus 1975)".

(3) activate unrelated frames: CNM "indicates the creativity of a solution is a function of the degree to which frames that were previously distant from one another become saliently associated in the context of problem solving" (Santanen et al. 1999).

Design Principles (Outcome C). To avoid fixation or "functional fixedness" (Howard et al. 2013; see for examples Duncker 1945; Maier 1931) in the form of unconscious blocking, which is quite familiar in disciplines like design (Jansson and Smith 1991), we have to encourage the exploration of the solution space during creative tasks. Studies have shown that examples can help to enhance creativity (Fink et al. 2010), because they can function as cognitive stimulation (see also Agogu et al. 2011; Howard et al. 2013).

One way to approach the integration of examples is the C-K-theory, because it helps to differentiate the examples between restrictive examples and expansive examples. Moreover, it delivers a useful framework to explain how designers create concepts. As designing itself can be described as an exploration of different spaces, namely the knowledge space and concept space, the idea of having a knowledge space can be transferred to our related work about the LTM, which we know as important for saving knowledge and experience. Moreover, the concept space can be seen as an image of the WM, where different mental content is processed and combined. Of course, this is only an initial approach, and not an exhaustive or problem-free comparison, but it helps to connect the theoretical flows. A figurative example has been given by Hatchuel et al. (2011). The figure below shows the concept space. The exploration of the concept space is like spinning a web of variations and alternative concepts, which differ from another in different ways. The basic concept is an exemplary shopping cart, and the following example illustrates the concept space exploration.



(1) C1 is a shopping cart
(2) C1.1 is a four wheeled shopping cart
(3) C1.2 is a three wheeled shopping cart
(4) C1.2.1 is a three wheeled shopping cart with advertising panel
(5) C1.2.2 is three wheeled shopping cart with display panel not provided by supermarkets yet

Figure 31.1. Expansive and Restrictive Examples

To deepen the understanding of how restrictive and expansive examples differ, Figure 31.1 also illustrates what is specified and termed as partition in the literature. As every dot or rectangle is a different partition, we see three restrictive partitions illustrated as dots being "propositions that further specify a concept in a routine or already known way" (Howard et al. 2013). In addition, we see one expansive partition being "propositions that further specify a concept or the product by adding an original element" (Howard et al. 2013). Empirical evidence showed that restrictive examples can cause fixation, while expansive examples can help to explore the concept space (Agogu et al. 2011; Hatchuel et al. 2011; Howard et al. 2013). Based on these insights, we can derive several design principles:

DP1: *The system must present content build on what the participants talk about.*

DP2: *The system must create/present expansive examples or "original elements" (Howard et al. 2013) as inspiring stimuli.*

DP3: *The system must visualize examples and show different sets of examples without causing too much mental effort for the users.*

Instantiation (Outcome D). We develop an initial information systems architecture to provide a first step into an ambient technology system, which is able to implement the design principles. It consists of three general principles (i.e., Information Input, Information Processing, and Information Output). Figure 31.2 summarizes the funftionality and architecture of the ambient technology.

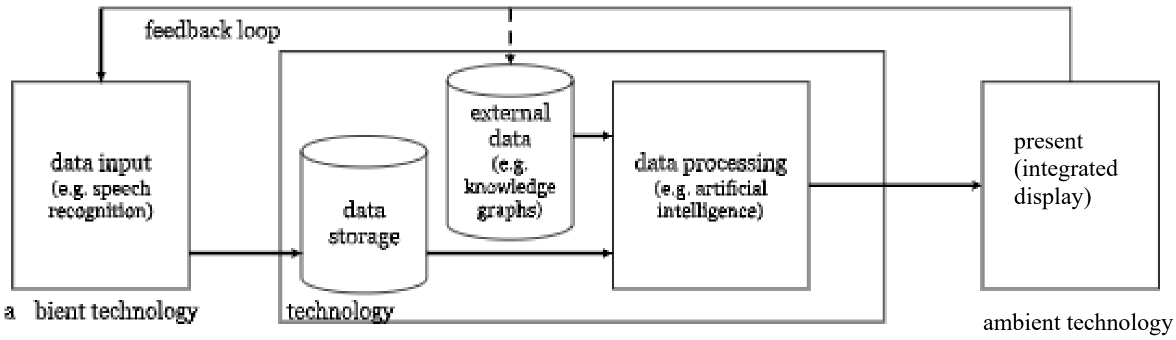


Figure 31.2. Ambient Technology AI-Driven CSS

Evaluation (Outcome E,F). As mentioned above, we evaluate our artifact in two ways. First, we will conduct interviews with design thinking experts on the derived design specifications of the prototype to specify them further (ex ante evaluation; *Outcome E*). The interviews will be semi-structured and last approximately 30 minutes. Participants will be invited from a pool of interested people by our department and will be rewarded with an expense of 25 Euro per interview. Second, after we have updated the prototype accordingly, we plan to conduct an experiment to test our inspiring AI-driven ambient technology (ex post evaluation; *Outcome F)*. To do so, we generate four prototypes. Hence, the between-subject design will be 2 (example type: restrictive examples vs. expansive examples) x 2 (output type: picture output vs. text output). Again, the participants will be invited by our department and will be rewarded with an expense of 25 Euro. They will be randomly assigned to the conditions. Beforehand, our sample size will be calculated with G*Power. The exact procedure of the experiments is currently being coordinated with experts and is to be pre-tested twice before execution.

The creative output of the participants is measured with the variables 'quantity of ideas' and 'quantity of ideas'. Quantity of ideas is measured in line with previous research (Minas and Dennis 2019), as number of unique ideas without assessing quality. A list of ideas of all participants will be created by one rater. Based on this list, the rater and a second rater count the ideas independently. Subsequently, inter-rater-reliability will be calculated by the number of ideas on which both raters agree, divided by the total number of ideas. The final score will be calculated by the mean of both raters. Quantity of ideas will be measured by counting the number of ideas using the procedure of Dean et al. (2006) and Minas and Dennis (2019). Two independent raters will evaluate novelty, workability, and relevance. Whereas novelty consists of the subdimensions originality and paradigm relatedness, workability consists of acceptability and implementability, and relevance of applicability and effectiveness. Each subdimension is rated on a four-point scale, with higher values reflecting higher fit to the subdimension. Cronbach's alpha will be calculated as measure of inter-rater reliability in line with previous research (Minas and Dennis 2019). Finally, overall flexibility will be calculated by the number of topic categories (De Dreu et al. 2008). Using the list, which includes all unique ideas (see above), categories will be counted using the same procedure as for quantity, only with the raters identifying unique categories instead of counting ideas. Persistence will be calculated by dividing the quantity of ideas of one individual by the number of categories that an individual used.

To assess whether our derived design principles hold, we will use independent samples t-tests using the afex package in R. Additionally, to assess occurring mediation effects, we will use the mediation package.

Figure 31.3 summarizes our research model. We expect that the exposure of expansive or restrictive examples will influence the pathway to creativity (i.e., cognitive flexibility, cognitive persistence) and thus will have an effect on creative output, which is measured with ‘quantity of ideas’ and ‘quantity of ideas’. We also expect that the way of visualization (text or picture, see also DP 3) will also influence the pathway to creativity and thus these two design variants are considered.

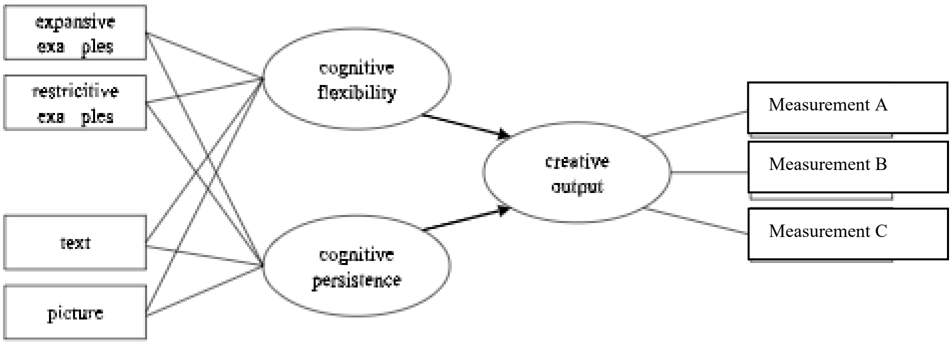


Figure 31.3. Research Model

Outlook. With our research, we plan to show how examples can enhance creative output using ambient technology in form of an AI-driven CSS. We want to illustrate how expansive and restrictive examples (provided as text and picture) will influence the pathway to creativity and the final creative output to further develop theory. Likewise, the relevance for practice will be to develop a system which is capable to enhance individuals’ and groups’ creative output in creative settings and the workplace. Research will benefit from our findings by getting insights from the interaction of humans and machines concerning the phenomenon of creativity and by further clarifying the various results in research on CSS which showed discrepancies of theory and latest experimental findings (Wang and Nickerson 2019).

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32. Paper 26: Beyond the Obvious

Title	**Beyond the Obvious – Towards a Creativity Support System using AI-driven Inspiration**
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Table 90. Fact Sheet Publication

Beyond the Obvious – Towards a Creativity Support System using AI-driven Inspiration

Abstract. *In our digital age creativity is important to all kind of organizations. In Information Systems (IS) research Creativity Support Systems (CSS) have a long history. However, findings are various and not overwhelming. In this emergent research forum-paper, we want to contribute to existing literature of CSS and cognitive science by using a design-oriented approach to develop a roadmap to a concept of a CSS using AI and different design variants and propose further steps on how to evaluate the derived design variants (i.e., continuum from highly realistic representations to abstract representation of visual stimuli). The kernel theory is based on the Cognitive Network Model (CNM) and the fixation literature. Our work shows how to build the CSS and how to evaluate the system in a two-step approach. The first part of the evaluation will be a qualitative ex ante evaluation to inform the subsequent post ante laboratory experiment.*

Keywords: *Creativity Support System, Creativity, Artificial Intelligence, Cognitive Network Model, Fixation.*

32.1 Introduction

In our digital age, in which creative output and forward-looking innovations are increasingly important, the generation of ideas is becoming more and more relevant for management. Creativity is important for business, because it helps in problem solving and decision making (Seidel, Müller-Wienbergen and Becker, 2010; Perry-Smith and Mannucci, 2017; Seeber, Vreede, Maier and Weber, 2017) to create competitive advantage in complex business environments (Schmiedgen, Rhinow and Köppen, 2016). If individuals are mentally blocked and the creation of new or useful ideas does not work, literature speaks of fixation or functional fixedness (Cardoso and Badke-Schaub, 2011). Fixation is problematic for creative capacity (Cardoso and Badke-Schaub, 2011) on all levels of an organization (Stempfle, 2011). We define fixation as "the inability to overcome a bias in the representation of a situation by transferring knowledge from prior experience in an inappropriate manner" (Dong and Sarkar, 2011). According to Dong and Sarkar (2011) the source of fixation can be the individuals' meta-representation. Humans develop three different abilities to represent the real world (primary representation, secondary representation, and meta-representation) (Perner, 1991). This ability can help people to see solutions that are beyond the mere semantic meanings of a given situation. One approach to prevent fixation is to "use clues or hints in the environment" (stimuli) as inspiration or source for new ideas (Smith and Linsey, 2011). We want to contribute to this understanding from a theoretical perspective on technology-supported creative processes in IS research and from a practical perspective on how to design creativity support systems (CSS) for making tomorrow's businesses more competitive. An innovative approach to design technology is the implementation of artificial intelligence (AI). This new technology becomes omnipresent and tremendously affects the way we work and decide (Fink et al., 2010). When it comes to how AI can be designed in interrelation with us human-beings, two different paradigms are depicted in literature. The first paradigm assumes that AI is developed on a human level (McCarthy, 2007). The second paradigm understands the relation to be a man-computer symbiosis designed to enhance human intelligence by helping and guiding (Licklider, 1960). In this respect, AI as tool for individualizing stimuli can help to challenge, support, and inspire employees during ideation episodes. In our work, we want to understand how inspiring stimuli provided by an AI can help employees to be more creative. In specific, our concept of an inspirational AI is based on the principle of abstracting. In this context, we ask the following research question: Can an inspirational AI-driven approach be conceptualized with implementing stimuli based on the principles of meta-representations – and if so, how? For reaching our objective, we follow an explanatory design-oriented research approach, which allows us to then propose further research on how to evaluate design variants of AI-driven CSS.

32.2 Related Work and Theory

Creativity Support Systems

CSS are information systems that help individuals or groups being creative (Seidel et al., 2010). The discussion about this group of systems in IS research has both a long history (Elam and Mead, 1990; MacCrimmon and Wagner, 1991; Couger, Higgins and McIntyre, 1993; Nevo, Nevo and Ein-Dor, 2009) and is under current debate (Althuizen and Reichel, 2016; Sassenberg, Moskowitz, Fetterman and Kessler, 2017; Minas and Dennis, 2019). Considering current studies, we see that there are three ways to support creativity with technology which are well understood (Müller-Wienbergen, Müller, Seidel and Becker, 2011; Müller and Ulrich, 2013). First, the system can offer task-specific information as stimuli and act as a stimuli provider (Müller-Wienbergen et al., 2011). Second, the system can structure the creative process and act as a process guide (Elam and Mead, 1990; Couger et al., 1993). Third, the system can offer stimuli and act as priming tool (Minas and Dennis, 2019). Note, however, there is yet no CSS, which can support creativity and decrease fixation with using AI.

Theoretical Background

The Cognitive Network Model (CNM) is a theoretical model to explain ideation episodes during a creative process. It is based on classic cognitive science research and differentiates two modes for storing memory (Baddeley, 1997). On the one hand, the WM stores information for a limited amount of time but makes them directly accessible. On the other hand, the LTM stores experiences and knowledge for a vast amount of time (Santanen, Briggs and Vreede, 2004; Nijstad and Stroebe, 2006) and organizes them into different ‘groups’ (i.e., frames) to make them easily accessible, if needed (Collins and Loftus, 1975). By doing this, the content of the frames (i.e., the item) is not directly accessible, but has to be loaded in the WM to be processed. The frames are directly linked, so that an activated frame often automatically activates connected ones (Santanen et al., 2004; Nijstad and Stroebe, 2006). Moreover, the frames’ items can be part of more than one frame. Keeping in mind the CNM, ideation episodes can be considered a fitting example of close connection between the WM and the LTM (Nijstad and Stroebe, 2006). Ideas cannot be generated without loading knowledge into the WM. Moreover, in the ideation episode, it is necessary to iteratively combine existing frames and to make new connections between stored frames and new ones (Nijstad and Stroebe, 2006). Combining unrelated frames can be an initial starting point for new ideas (Mednick, 1962), because it increases the likelihood that a new idea is produced (Santanen et al., 2004).

Perner’s model discusses the different representational abilities of humans by linking them with the cognitive development of representational abilities (Perner, 1991): i.e., primary representation, secondary representation, and meta-representation. Primary representation means a direct semantic relation to the world, where individuals only represent what they see. Secondary representation stands for individuals being able to represent the real world in another way as they see (Dong and Sarkar, 2011), e.g., a playing child taking a banana as a mobile phone. Finally, meta-representation is the capacity to represent a representation or in other words “a representation of the representational relation between a referent (the represented) and its model (that which represents) (Perner, 1991)” (Dong and Sarkar, 2011, p. 150). People tend to interpret someone’s thought about something and link someone’s thoughts and believes to the person, but not to anything they see in the real world. They understand that representation they have in their minds have an interpretation (Perner, 1991). Abstract art is a fitting example of meta-representation because it symbolizes an individual thinker thinking about someone else's representation of something and because it is an abstract conceptual way of visualizing. To visualize the different representational abilities, we present an example of Maier's study on functional fixation (Maier, 1931). In this study, subjects are placed in a room with two cords hanging from the ceiling. The task is to reach both cords at the same time and to tie them together, however, the cords are placed in a way that it is not possible to outstretch arms and reach both without help. Thus, several object such as pliers are also placed in the room. One possible solution is to use the pliers as weight for a pendulum and to complete the task this way. Nevertheless, most subjects are not able to come up with this solution. In this context, primary representation was found when the subjects see the pliers as pliers with the typical purpose and thus is not able to tie the cords. Secondary representation helps the subject to see cords as weight. Finally, meta-representation helps understand the phenomenon of inspiration and fixation and to tie the cords together. In summary, Maier's study shows the potential of meta-representations as inspiration source. Connecting the approaches by Fink et al. (2010) and Perner (1991), we recall the insight that the source of fixation can be the individuals' meta-representation (Dong and Sarkar, 2011), namely, that certain individuals are not able to build or easily build secondary representations in their minds. As the underlying relations between the representations are only based on the purpose (Dong and Sarkar, 2011), external stimuli can cause fixation instead of inspiration, because the individuals might overlook what the object could possibly be instead of only considering it real-world purpose. Thus, they only focus on its given properties and benefits instead of interpreting. This challenge grows even more significant when the represented properties of the object are highly realistic instead of generic (DeLoache, 2000; Uttal et al., 2009). We take up these findings and understand the different levels of representation to derive design implications.

32.3 Research Design and Outlook

As this research is intended for design, in the end, we aim at constructing an artifact and give prescriptions how to design an AI-driven CSS (e.g., methods, techniques, principles of form and function) (Gregor, 2006). By doing this, we will consider two main perspectives on IT artifact: first, the interior mode to "theorize prescriptively for artifact construction"; and second, the exterior mode to "theorize about artifacts in use" (Gregor, 2009). Our research seeks to help "provide theory-driven design guidelines and prescriptions for IS design, and the generation of hypotheses that are testable" (Walls, Widermeyer and El Sawy, 2004, p. 54). In this respect, it focusses on the explanatory design principles of form and function (Niehaves and Ortbach, 2016) of an AI-driven CSS to foster inspiration and prevent fixation. The design decisions of our inspiring AI-driven CSS should continuously be informed by evaluation, but in the first phase, it will be explanatory, because it "prescribes principles that relate requirements to an incomplete description of an object" (Baskerville and Pries-Heje, 2010, p. 273). Looking of the process of our research, it will consist of two core activities, namely theory and artifact building and evaluation (Peffers, Tuunanen, Rothenberger and Chatterjee, 2007) and following the procedure according to Becker et al. (2011).

The solid theoretical background delivers kernel theory and acts as a justification for our knowledge (Gregor and Jones, 2007) (Outcome A, see `Theoretical Background`). Based on 'Related Work and Theory' (i.e., the kernel theory and justification knowledge (Gregor and Jones 2007) we derive the following general requirements and design principles (Baskerville and Pries-Heje, 2010) that the CSS needs to replicate and support. *General Requirements (Outcome B):* (1) The system must support iterative combination of frames. (2) The system must activate secondary representation and meta-representation. (3) Overall Requirement: The system must help the participants to interpret the given stimuli and objects (e.g., by asking "What else could the object be?"). Based on this insight, we define the core principles of our design, or in other word, the "command variables" (Voigt, 2014). These variables will help create objects for developing a desired future situation. *General Components and Design Principles (Outcome C):* Design Principle 1; the system must deliver stimuli, which are more generic rather than detailed and realistic. Design Principle 2; the system must deliver stimuli, which make relations between different objects visible. Based on the components, we present our inspiring AI-driven CSS as an expository instantiation (Gregor and Jones, 2007). *Instantiation (Outcome D):* According to Andolina et al. (2015) our system uses speech recognition to identify keywords (microphone, google implementation of the HTML5 Web Speech API) and delivers keywords on a display, which are related to the identified concept. In our case we visualize the keywords with a real-time google picture search. The images are revised with different design of AI algorithms (e.g., DeepDream, ArtBreeder or DeepArt).

After the preliminary building phase, the evaluation phase begins. As a core element is the evaluation of artifact and theory (Hevner, March, Park and Ram, 2004), using prototype instantiations as artifacts to evaluate design theories is common approach to verification and refinement (Brohman et al., 2009; Ngai, Poon, Suk and Ng, 2009). In our case, it means to differentiate two steps in evaluation phase: the ex-ante evaluation (Outcome E) and ex-post evaluation (Outcome F). The ex-ante evaluation means to receive qualitative feedback (e.g., see (Becker, Heide, Breuker and Voigt, 2011), where "the artifact is evaluated on the basis of its design specifications alone" (Pries-Heje and Baskerville, 2008) p.2. Based on this evaluation, it will be possible to implement improvements and to change attributes of the artifact and go back to any point of the building phase. In this first step (ex ante) we will follow the explorative focus group approach according to Mueller et al. (2019). The empirical data generation procedure presents a five-step approach (i.e., ideation, focused exploration, synopsis, design extraction, theory construction). We utilize this data to inform next steps in our iterative procedure. The ex-post evaluation stands for a quantitative evaluation (e.g., a laboratory experiment), which enables us to test hypothesis. When using different levels of abstraction in an AI-driven CSS, this evaluation will encourage us and future researchers to further think about the relations between the objects of the artifacts (e.g., whether they randomly appear or not). We generate different prototypes to test different AI algorithm designs (continuum from realistic to abstract) which will be tested in a 2x2 setting. Participants will get instructed to a creative problem-solving task. Creative output will be measured according to Dean et al. (2006).

With our research, we plan to show how the type of representation in a CSS can be used to make secondary representation and thus inspiration possible. Practical relevance lies in the insights of how to design a CSS. Research will benefit by creating insights of sources in fixation and inspiration. Through a machine learning-approach it would be able to learn which algorithms to decrease fixation and foster inspiration.

32.4 References

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Epilog

In addition to this thesis, other papers are submitted (not listed) and accepted (listed below).

Schäfer, C., Stelter, A., Zeuge, A., Oschinsky, F. M., Niehaves, B. (forthcoming). AR- und Holografie-gestütztes Netzwerken als Alternative zu den traditionellen Netzwerken vor Ort – ein multiperspektivischer Einblick. In: HMD Praxis der Wirtschaftsinformatik. (accepted)
Oschinsky, F. M., Stelter, A., Kaping, C., Niehaves, B. (2021). Kompetenzoffensive Bad Berleburg Digital (KOBoLD), NEGZ-Studie Nr. 14. Nationales E-Government Kompetenzzentrums, Berlin. (published)
Niehaves, B., Oschinsky, F. (2021): Unsicherheiten in Chancen verwandeln, in: innovative Verwaltung, Ausgabe 3/2021, S. 31-33. (published)
Oschinsky, F. M., Niehaves, B., Riedl, R., Wriesnegger, S., Mueller-Putz, G. R. (2020). Mind wandering while using technology as a promising future NeuroIS research area. Presented at: Practice Development Workshop on NeuroIS: Status, Enduring Themes, and Future Directions at the Forty-First International Conference on Information Systems (ICIS 2020), Hyderabad, India. (accepted)
Oschinsky, F. M. (2020). Mind Wandering While Using Technology. Presented at: Coding on the Brain Workshop der Hawaii International Conference on System Sciences (HICSS-53), Maui, Hawaii, United States. (accepted)
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Oschinsky, F. M. (2019) Allowing for Divergent Thinking and Creativity at Work. A Research Proposal on the Future of Work. Presented at: 8th pre-ICIS workshop on the Changing Nature of Work (CNoW 2019), Munich, Germany. (accepted)
Oschinsky, F. M., Klesel, M. (2019). Mind Wandering in Information Technology Use: Some Fundamental Questions. Presented at: NeuroIS Training Course, Vienna, Austria. (accepted)
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Table 91: Overview of Additional Research Manuscripts

Everything great that ever happened in this world happened first in somebody's imagination.' Astrid Lindgren, 1958