Digital Transformation of Work:

On the Role of Transformation Governance, Digital Leadership, and Future Technology Management

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List of Abbreviations and Acronyms

3D	Three-Dimensional
AIS	Association of Information Systems
AMCIS	American Conference on Information Systems
CAD	Computer Aided Design
CEO	Chief Executive Officer
DSR	Design Science Research
ECIS	European Conference on Information Systems
HMD	Head-Mounted Display
ICIS	International Conference on Information Systems
IJIM	International Journal of Information Management
IS	Information Systems
IT	Information Technology
IT-K	Information Technology Knowledge
PACIS	Pacific Asia Conference on Information Systems
PVT	Process Virtualization Theory
RQ	Research Question
SME	Small and Medium sized Enterprises
VR	Virtual Reality

Part A

OVERVIEW

"Will reality be augmented or virtual or some hybrid of the two?
In any case, reality will no longer be the only game in town."

— Ced Kurtz

1 Introduction

1.1 Digital Transformation of Work

With the digital transformation of work, special challenges arise for organizations (Hanelt et al., 2021). External pressure by crisis, competitors, customers, or suppliers is forcing established organizations to digitally transform their products and processes. One promising approach for organizations to face the digital transformation is the application of innovative technologies that enable new ways of process design and optimization. Virtual Reality (VR) is an exemplary, innovative technology, which enables a new and experience-based way of user participation to establish digital transformation through VR in organizations. Organizations should have the appropriate and necessary governance structures in place to achieve this. Small and medium-sized enterprises (SMEs) face particular organizational and governance challenges and, therefore, are given special consideration here: Due to limited resources, SMEs are forced to find a compatible path through digital transformation. In contrast to large companies, there is a lack of specialists for individual topics; in SMEs, generalists are needed for cross-cutting topics, such as digital transformation (Bacon & Hoque, 2005). This dissertation is dedicated to precisely this compatible path through the digital transformation of work with a spotlight on SMEs.

As many organizational processes cross organizational boundaries, a coordination between organizations is becoming more and more important. Working in hybrid value chains as a boundary-crossing way of work has an impact on how business activities work, which also applies to the forms of organization themselves (Leimeister & Glauner, 2008). Constant change and technological advancement are accelerating the increasing complexity of our economy, presenting many with unprecedented challenges (ElMaraghy et al., 2012; Kagermann, 2015). Within hybrid value chains, product-related services are a key element. Services include, for instance, assembly work, maintenance work, inspections, and the repair of machines and industrial plants. Especially, customer-specific requirements for highly individualized solutions can often no longer be met by manufacturers themselves. In addition, today's products have a high degree of specialization, which can only be offered in cooperation with multiple stakeholders along the entire value chain. If players in hybrid value chains are excluded, the risk potential increases because not all perspectives are taken into account (Weigel et al., 2022).

When it comes to digital transformation in organizations, it is also assumed that the Chief Executive Officer (CEO) has a crucial role to fulfill (Venkatraman, 1994). Research shows that a lack of digital competence can be compensated by suitable Information Technology (IT) leadership structures (Weigel, Heger, et al., 2020). The CEO's responsibility is to develop leadership structures, which result in IT-related decision-making or in the ability to delegate responsibilities to individuals who have a higher level of digital competence. The relationship between the CEO's digital competencies, on the one hand, and a suitable IT leadership structure, on the other hand, has been little researched to date, but it offers enormous potential for shaping the digital transformation.

Beside the CEO, so-called influencers also have the power to convince and influence people (Enke & Borchers, 2019). Well-known from a social media perspective (e.g., Instagram, YouTube, or Facebook) where influencer influence the user's decision, for example, to buy a certain product (Brown & Hayes, 2008), influencer in the organizational context aim to accompany and influence the organization on the path to a successfully digital transformation. For organizations, the influencer concept is not yet represented in the field of Information Systems (IS) research. In a qualitative study of 2021, it was shown that the influencer concept can be applied to digital transformation processes of organizations (Weigel, Zeuge, & Sauter, 2021). Influencers provide CEO and IT governance structures with the necessary foundation for user participation in the digital transformation of work.

Like nearly all other research in the 2020 to 2022 period, this dissertation was written against the background of the global pandemic (COVID-19). COVID-19 changed the world we used to live in (Soto-Acosta, 2020; von Gaudecker et al., 2020). Companies were forced to close or, if compatible with work, turn to virtual work as employees fell ill or were at risk of falling ill (Netz et al., 2022). As a result, the pandemic laid the foundation for rethinking many aspects of people's lives. For organizations and employees, the use of digital communication channels was increased, and location-independent working becomes more and more commonplace (von Gaudecker et al., 2020). Although, before COVID-19, a multitude of digitization projects were initiated, started, and carried out (Oztemel & Gursev, 2020), the pandemic acted as a booster for digital transformation. With the advent of COVID-19, digital transformation of work had to be done faster, to be able to continue the work, adapted to the new circumstances. For various organizations, it became necessary at short to perform both digitally, the actual work and the collaboration with colleagues.

Fostering team cohesion is a particular challenge for leaders of virtual teams, not only but especially during the pandemic (Lilian, 2014; Malhotra et al., 2007). Team cohesion refers to a team member's sense of belonging to a team and the moral understanding associated with the team membership (Bollen & Hoyle, 1990). Team-building measures, such as company excursions, lunches, or after-work drinks, are associated in the IS literature with positive effects on team cohesion, which also has a positive impact on motivation, cooperation, and team performance (Bajaj & Russel, 2008; Kwak et al., 2019; Yang et al., 2015). However, strengthening the sense of belonging when cooperating digitally is a particular challenge for virtual leaders (Lilian, 2014). Virtual teams are organized in a decentralized manner and lack spontaneous opportunities for communication and interaction (Morrison-Smith & Ruiz, 2020). Therefore, previous approaches cannot be implemented in virtual teams in the same way. New and innovative approaches are needed to improve the sense of cohesion for virtual teams.

COVID-19 and its associated work from home policies and contact restrictions pose new challenges for organizations, teams, leaders, and employees equally (Zeuge et al., 2021). The pandemic has led to an even more rapid increase in the use of collaboration technologies due to the changing manner of daily work (Soto-Acosta, 2020). Digital collaboration describes the collaborative process, in which team members interact and communicate mainly in a digital manner (Fan et al., 2012; Hossain & Wigand, 2006). In this process, IT is a key component for the success of digital collaboration (Majchrzak et al., 2005). The development of VR technologies and VR content offers new opportunities to support digital collaboration (Hatzipanayioti et al., 2019; Mütterlein et al., 2018).

Besides a collaboration enrichment, VR also leads to rethinking hybrid value chains. For instance, the maintenance of industrial machinery is not carried out by the manufacturer but by external service providers at the customer’s site (Sundin et al., 2009). As a result, the experience gained from the external service provider’s maintenance process cannot be incorporated into the manufacturer’s future development processes because this feedback is missing. In this sense, there is an opportunity to better align organizations involved in the same value chain. Alignment between two organizations and how technology can be used to demonstrate external alignment still remain to be researched.

In the digital transformation of work, VR holds a promising place to explore the transmission of tacit knowledge (Faust, 2007; Weigel, Sauter, et al., 2021). VR technologies are expected to foster the development of tacit knowledge, e.g., by simulating work processes with specific challenges or by simulating collaboration in VR (McQueen, 1999). The transfer of tacit knowledge requires approaches and technologies, beyond simple information exchange. Tacit knowledge primarily involves experiences that provide new perspectives (Flavell, 1992). For tacit knowledge transfer in organizations, the use of VR can offer special potentials and create new opportunities (Y. Li et al., 2019). While the use of IT for explicit knowledge transfer is comparatively easy to handle, the transfer of tacit knowledge requires different approaches and solutions (Weigel, Sauter, et al., 2021). Successful transfer of tacit knowledge helps maintain competitive advantage and contributes significantly to the sustainable development of organizations (Afolayan, 2020). Also previous approaches relate to organizational structures and requirements of the organizational environment (Afolayan, 2020).

1.2 Theoretical and Practical Case Description

Work processes outside the organization's value chain are rarely known and are integrated into the organization's value chain to a limited extent (Leimeister & Glauner, 2008). Therefor the innovation potential (technical and social) cannot be fully exploited. Looking at the assembly and maintenance of cranes, processes are associated with potential hazards (Neitzel et al., 2001), such as great heights of crane systems or unpleasant weather conditions during outdoor maintenance work (Weigel et al., 2022). Hazards like these make it difficult to fully experience working on and around a crane without service technician experience (Weigel, Zeuge, Baumgart, et al., 2021). However, knowledge that is gained during assembly and maintenance is necessary to optimize crane assembly and maintenance processes during the planning and CAD design of cranes and its parts (Weigel et al., 2022). Although maintenance processes are evaluated in the respective service organization, a feedback and an evaluation of the experience of the service technicians often do not take place. If designers are able to evaluate designs in advance with regard to assembly and maintenance, they can improve the conditions for both, the assembly process (e.g., assembly sequences, notes on the positioning of add-on parts) and the maintenance process (e.g., accessibility of wear parts). Evaluating a crane and its design is often connected with difficulties, since cranes are serviced at high altitudes or under other hazardous conditions, which makes it necessary for service staff to receive special training. Since the situation cannot be experienced by design engineers, they can put themselves in the position of the service technicians to a limited extent only. In addition, the actual wear and failure behavior of components and their maintenance is exclusively known at the required level of detail by the service technicians. One possible solution to this is to make the assembly and maintenance situation tangible through VR simulation, especially for employees who are not primarily involved in the assembly and maintenance processes. VR as an immersive technology offers the possibility to experience assembly and service processes virtually and, thus, to be able to comprehend them oneself (Weigel, Hoffmann, et al., 2020). Figure 1.1 provides an overview of the case, showing the challenges of organizational boundaries and the importance of considering the users of the VR simulation.

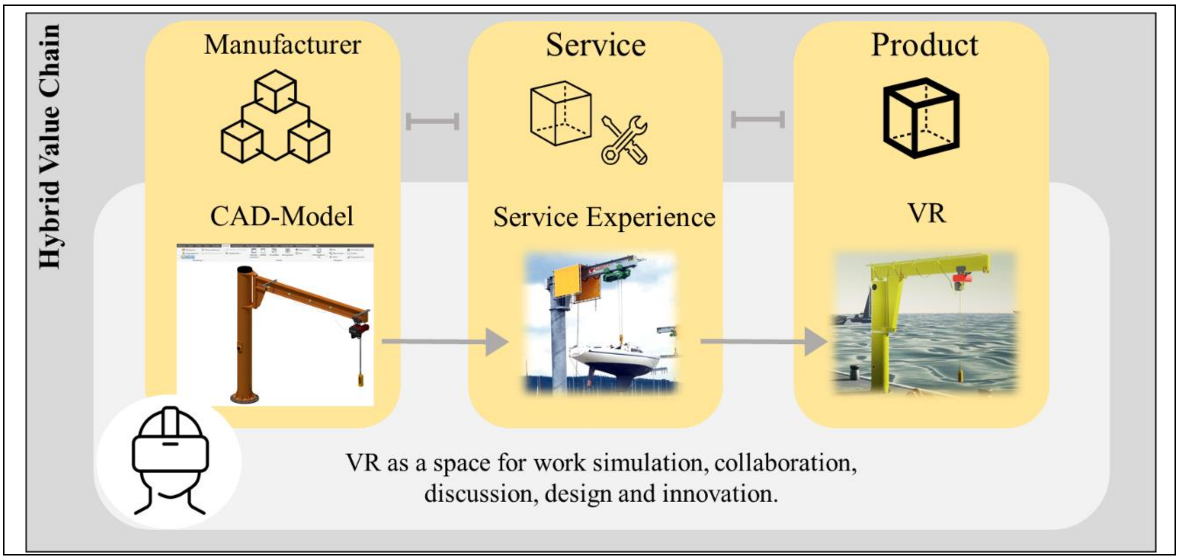


Figure 1.1 Case Overview

1.3 Research Questions

Many questions surrounding the digital transformation of work are still unanswered. This dissertation aims to help answer some of these questions. Therefore, the focus is deliberately on the governance structures of organizations, individual strategies and leadership, and opportunities through technology management. To this end, the following research questions (RQs) are formulated and subsequently answered in this paper-based cumulative dissertation.

RQ1: Which governance structures does an organization need to shape the digital transformation of work?

RQ2: Which strategies and leadership styles of individuals favor the digital transformation of work?

RQ3: What are the benefits of future technology management regarding the digital transformation of work?

1.4 Thesis Structure

This dissertation draws on several studies that serve the context of the RQ to be addressed and is divided into two parts: Part A and Part B (see Figure 1.2). Part A provides an overview of all studies related to the proposed RQs. Part B contains all the studies in this dissertation and includes 15 publications that appeared, were accepted, or are under review in journals, such as WORK – A Journal of Prevention, Assessment & Rehabilitation, Virtual Reality (VIRE) or International Journal of Information Management (IJIM). 12 conference publications were published at the International Conference on Information Systems (ICIS), the European Conference on Information Systems (ECIS), the American Conference on Information Systems (AMCIS), the Pacific Asia Conference on Information Systems (PACIS), the New Future of Work Virtual Conference, and the International Crane Conference.

All studies are presented in Table 1.1. The studies are listed in chronological order. The content of the studies listed in this paper has not been changed. However, to ensure consistency of headings, tables, and figures, these have been reformatted in Part B (Klesel, 2019; Lemmer, 2021). The studies in Part B were developed and published at different points in time (from 2016 to 2022). Consequently, these studies differ in terms of terminology and word choice [e.g., digitalization (Jahn et al., 2016) is synonymous with digital transformation (Weigel, Zeuge, & Sauter, 2021)]. Similarly, the papers differ in their choice of language with respect to American or British English. This is due to the fact that conferences and journals have different requirements and the studies in this dissertation were not changed in this regard. Furthermore, the citation style differs in the studies in Part B, which is also due to the specifications of the publications. In order to present the work as published here in this dissertation, this has not been changed.

#	Citation	VHB[a]	IF[b]
P1	Jahn, K., Klesel, M., Lemmer, K., Weigel, A., Niehaves, B. (2016). Individual Boundary Management: An Empirical Investigation on Technology-Related Tactics, *Proceedings of the 20th Pacific Asia Conference on Information Systems (PACIS)*, Chiayi, Taiwan (published)	C	

#	Citation	VHB[a]	IF[b]
P2	Roeding, K., Jahn, K., Weigel, A., Niehaves, B. (2019). Individualized Design: The Role of Individual Boundary Preferences on Technology Acceptance and Work-Life Conflict. *Proceedings of the 23rd Pacific Asia Conference on Information Systems (PACIS)*, Xi'an, China (published research in progress)	C	
P3	Weigel, A., Heger, O., Hoffmann, J., Roeding, K. (2020). CEOs of SMEs: How IT-Governance compensates the Lack of Digital Competencies. *Proceedings of the 28th European Conference on Information Systems (ECIS)*, An Online AIS Conference (published)	B	
P4	Weigel, A., Hoffmann, J., Klesel, M. (2020) Can Virtual Realities reduce the Gap between Organizations? Insights from a Case Study on the Potential of VR-Supported Perspective Taking. *Proceedings of the 28th European Conference on Information Systems (ECIS)*, An Online AIS Conference (published)	B	
P5	Weigel, A. (2020) A Design Journey: Towards a Virtual Reality Simulation and Training Application. *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)	(-)	
P6	Zeuge, A., Oschinsky, F., Weigel A., Schlechtinger M., Niehaves, B. (2020). Leading Virtual Teams – A Literature Review. *Proceedings of the New Future of Work,* An Online Conference (published)	(-)	
P7	Weigel, A., Zeuge, A. Sauter, L. (2021). Influencers of Digital Transformation: A New Concept of User Participation in IS Projects. *Proceedings of the 29th European Conference on Information Systems (ECIS)*, An Online AIS Conference (published)	B	
P8	Zeuge, A., Schaefer, C., Weigel A., Niehaves, B. (2021). Happy Together - How can Virtual Leaders Foster Team Cohesion? *Proceedings of the 27th Americas Conference on Information Systems (AMCIS)*, An Online AIS Conference (published)	D	

#	Citation	VHB[a]	IF[b]
P9	Weigel, A., Sauter, L., Niehaves, B. (2021) More Than You Know - An Investigation of VR to Support Tacit Knowledge Transfer within Organisations. *Proceedings of the 25th Pacific Asia Conference on Information Systems (PACIS),* An Online AIS Conference (published)	C	
P10	Weigel, A., Zeuge A., Baumgart T., Niehaves, B. (2021) Bittersweet VR Collaboration: Necessary and Sufficient Conditions for Collaboration in VR. *Proceedings of the 42nd International on Information Systems (ICIS),* Austin, Texas (published)	A	
P11	Weigel, A., Sauter L. (2022) Crane Assembly and Service Processes meet Virtual Reality. *30. Internationale Kranfachtagung*, Magdeburg, Germany (published)	(-)	
P12	Weigel, A., Baumgart, T. L., Zeuge, A., Sauter, L., Niehaves, B., Huchler, N., Heinlein, M., Wittal, R., & Staiger, B. (2022). Competence Transfer in Virtual Realities (VR): Can VR Bring Products and Services Together? *WORK - A Journal of Prevention, Assessment & Rehabilitation*, 72(4), 1727–1743 (published)	(-)	1,803
P13	Zeuge, A., Weigel A., Schaefer, C., Niehaves, B. (2022). The "New Normal" of Virtual Team Cohesion – a Qualitative Study to Investigate the Impact of COVID-19. *Proceedings of the 28th Americas Conference on Information Systems (AMCIS)*, Minneapolis, USA (published)	D	
P14	Zeuge, A., Schaefer, C., Weigel A., Eckhardt, A., Niehaves, B. Crisis-driven Digital Transformation as a Trigger for Process Virtualization: Fulfilling Knowledge Work Process Requirements for Remote Work. *International Journal of Information Management* (under review / 2nd round)	C	18,958
P15	Weigel, A., Baumgart, T., Niehaves, B. Keep an Eye on CAD in VR: Toward a Theory of Behavior Change. *Virtual Reality* (under review / 1st round)	(-)	5.471

[a] VHB-JOURQUAL3 (https://vhbonline.org/vhb4you/vhb-jourqual/vhb-jourqual-3)
[b] IF (Impact Factor) according to the Journal Citation Reports released in 2021 or in 2022

Table 1.1 Overview of Studies

In Part B, the research studies listed in Table 1.1 are organized according to their research topics and the overarching RQs. Figure 1.2 shows the structure of Part B, which consists of three main parts corresponding to the RQs. The first subsection shows studies related to RQ1 (P11, P3, P7). The second subsection offers insights into strategies and shows which leadership styles of individuals favor the digital transformation of work (RQ2). Studies P1, P2, P6, P8, P13, and P14 in particular have contributed to this. The third subsection addresses the benefits that digital transformation of work can bring through future technology management (RQ3). The implementation process of digital transformation is thereby described by providing concepts (P5 and P12) and usable technologies (P4, P9, P10, and P15).

Overall, the research in this dissertation contributes to different levels and sectors of analysis. The contributions in Part B, I *Transformation Governance*, focus on organizational frameworks and related changes, while the contributions in Part B, II *Digital Leadership*, focus on the analysis of individual ones. The contributions in Part B, III *Future Technology Management*, deal with technology-related aspects.

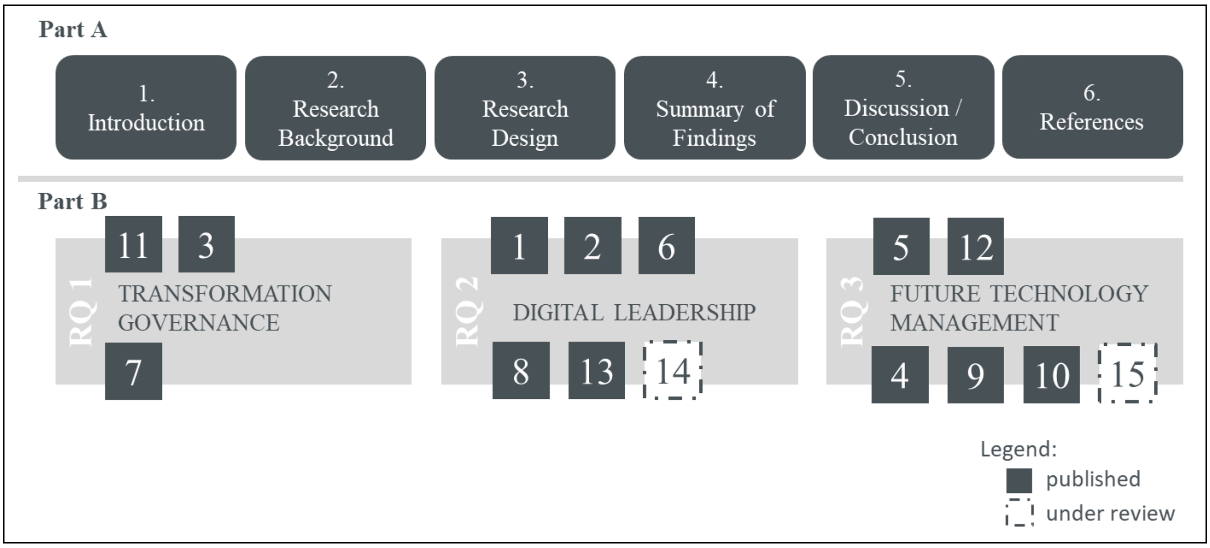


Figure 1.2 Dissertation Structure

2 Research Background

2.1 IT Business Alignment

For organizations, the key benefits of IT governance are the strategic alignment of business and IT, clarity of accountability and responsibility, and improved stakeholder engagement

(Wilkin et al., 2016). While IT business alignment between organizations is becoming increasingly important, it has not been a focus of research so far. A possible reason for that in practice is the difficulty to perform IT business alignment between organizations when, for instance, machines are serviced at high altitudes or under other hazardous conditions (Weigel et al., 2022). Thus, maintenance staff has to be specially trained to deal with such circumstances (e.g., altitudes, weather conditions). Allowing employees who are not involved in service processes to experience and evaluate these circumstances safely in a virtual environment indicates a possible solution (Weigel et al., 2022). The technology-supported perspective taking has already been identified as a way to strengthen IT business alignment (Weigel, Hoffmann, et al., 2020). The combination of IT business alignment across organizational boundaries and the possibility of using IT as a potential enabler for technology-supported perspective taking has not yet been considered in IS. In particular, technologies, such as VR, offer the opportunity to simulate perspective taking (Jestice, 2016).

2.2 Perspective Taking

Perspective taking originally derives from psychology (Underwood & Moore, 1982). It describes an attempt to enable a person to adopt the perspective of another person (Boland Jr & Tenkasi, 1995). In the literature, perspective taking is often described as reflecting on one's perspective (Brugger, 2002). Perspective taking can be seen in terms of customer and benefit focus, which has a positive effect on the creation of new products (Salomo et al., 2003). In the context of services, the ability to take the perspective of another individual (in this case the customer) also has a positive effect on helpfulness (Axtell et al., 2007). VR offers great potential for teaching skills and processes. Objects and even individual process steps can be represented in a high level of detail (Weigel et al., 2022). Research on the use of VR in the context of technology-supported perspective taking is nonetheless limited (Weigel, Hoffmann, et al., 2020).

Successful and, most importantly, tangible perspective taking is accompanied by several challenges that a virtual environment can face (Weigel, 2020). The different knowledge communities are often unable to recognize that they are starting from different knowledge and different cognitive frames of reference. As a result, they are unable to present their perspectives or adopt different perspectives, which drastically limits the possibilities for successful knowledge sharing (Weigel, Sauter, et al., 2021). Different departments, such as Sales, Construction, IT, and Service, focus on different parts of the overall process. Employees not only ignore each other's activities and fail to discuss their respective priorities, but they completely overlook each other's concerns and tend not to recognize their complexity (Boland Jr & Tenkasi, 1995). VR simulations can start at these points and offer the possibility to take over the perspective of the other person (X. Pan & Hamilton, 2018). In this way, an employee can experience the actual work simulated and, consequently, be sensitized to the respective other perspective (Weigel, Hoffmann, et al., 2020).

2.3 User Participation

The literature confirms that user participation has a positive influence on the success of an IT project (Bano & Zowghi, 2013). It has been shown that there is a positive relationship between user participation and user satisfaction in system development (Kujala, 2003; Mckeen & Guimaraes, 1997) and that user participation can increase system quality (Boland, 1978; Lin & Shao, 2000). The literature also confirms that user participation increases system acceptance (Bachore & Zhou, 2009) and can lead to a more realistic expectation of the system's capabilities (Kujala, 2003). Moreover, user participation has been shown to create a sense of ownership of IT systems, reduce user resistance, and increase user engagement (Lynne, 1983). In addition, literature shows that user participation reduces the time of technology implementation (Bachore & Zhou, 2009). General processes must also be considered; in times of digital transformation, the vitalization of processes also plays a role. For this purpose, the process visualization theory (PVT) was developed, which addresses the virtualizability of processes (Overby, 2008).

As part of an IT project team (Wu & Wang, 2007), key users represent the business units involved, have domain knowledge in their areas, and have extensive software knowledge (Maas et al., 2016; M.-Z. Pan & Mao, 2013). In contrast, end users are the intended users of the IT system (Aggarwal et al., 2015). Their knowledge is limited to the part of the system they need for their work (Wu & Wang, 2007). Key users spread external knowledge within the organization. As representatives of the business units, the prerequisite for the success of the IT system is the acceptance by the key users (Weigel, Zeuge, & Sauter, 2021). They also have to provide the business knowledge required for system configuration and support the business unit leaders in making important system decisions. These are the prerequisites for effective knowledge exchange (e.g., between suppliers, consultants, and consumers from different organisations). Equally important are the effects of exchanges between leaders and their employees. Positive relationships between leaders and their followers are confirmed to have a positive impact on the performance of virtual teams (Goh & Wasko, 2012).

2.4 Hybrid Value Chains

Hybrid business models and the associated changes in work organizations pose major challenges for organizations (Berkovich et al., 2009). Initially, however, hybrid value creation means that industrial products and services are offered by one or more companies bundled in cooperation (Leimeister & Glauner, 2008). Current solutions are aimed at improving the integration of all value creation partners. Approaches to collaborative development of business models and processes are often the exception. However, it can be observed that tangible and intangible services are usually developed separately. In other words, services are only added to the existing value creation process of organizations “alongside the product” (Weigel & Sauter, 2022).

In hybrid value chains, the alignment of corporate strategy is particularly important (Schmidt & Budinich, 2008). Often, hybrid value chains involve multiple organizations (Santos et al., 2015). Due to their organizational nature, they pursue different objectives and strategies (Leimeister & Glauner, 2008). Successful collaboration in hybrid value chains is characterized by the fact that the different organizations pursue similar objectives (Weigel, Hoffmann, et al., 2020). Organizations have already known this alignment of organizational objectives in the field of IT and the actual business: this is called IT business alignment (Reich & Benbasat, 1996). Alignment of the IT business is also becoming increasingly important in hybrid value chains between organizations, and this is where alignment should take place (Ryan et al., 2013; Weigel, Hoffmann, et al., 2020).

2.5 Transfer of Tacit Knowledge

The transfer of tacit knowledge is of particular importance for organizational development and constantly presents organizations with new challenges (Seidler-de Alwis & Hartmann, 2008). In their daily work, employees regularly draw on their tacit knowledge unconsciously (Leonard & Sensiper, 1998). The challenge in sharing tacit knowledge is that employees are not able to fully communicate and share it. Polanyi (1966) describes the fundamental nature of tacit knowledge with the phrase “It is immeasurably rich in things we know and cannot tell.” (Polanyi, 1966, p. 13). Therefore, Tacit knowledge is context-specific, personal, practical, and procedural, and is especially needed when solutions to emerging problems have to be found (Afolayan, 2020; Ambrosini & Bowman, 2001).

The consequences of lacking transfer of tacit knowledge across organizational boundaries need to be highlighted. Here, organizations are to be considered that are linked by a value chain but are organizationally separate (Weigel, Hoffmann, et al., 2020). The employees of the manufacturing organization produce a product, which they never will have to maintain or repair. Furthermore, they receive little to no feedback on the problems that occur during maintenance and repair. Since it is not possible for the design engineers to experience the maintenance and assembly scenarios due to time and safety constraints, they lack the experiential knowledge that they could generate in problematic maintenance and assembly situations (Weigel, Sauter, et al., 2021).

2.6 Current State of Development and Use of VR Technologies

VR technologies have evolved steadily in recent years and their costs have decreased significantly. Basically, there are two types of VR technologies: non-immersive VR and immersive VR (Mills & Noyes, 1999). Non-immersive VR involves a three-dimensional (3D) visualization on desktop displays where the user can interact exclusively with mouse and keyboard (Weigel, Zeuge, Baumgart, et al., 2021). By wearing a Head-Mounted Display (HMD) for an immersive VR and being completely surrounded by the virtual world (Jahn et al., 2018), VR supports the reinvention of many business processes, services, and industries, as strategies can first be tested in the virtual environment (Mueller et al., 2011). There is already a high level of motivation in organizations to use VR in the future to support various work processes. Steffen et al. (2019) investigate the motives for VR use. VR was not evaluated as a game or as a pure entertainment option, but each interviewee saw meaningful areas of application for the respective industry. This indicates that organizations are willing to use VR if it can cover areas that cannot be covered with current technologies and processes (Steffen et al., 2019).

3 Research Design

3.1 Overview

This dissertation includes five major methodological approaches: qualitative research, literature and concept reviews, quantitative research, case studies, and multimethod studies. The methodology used was determined based on the proposed RQs. The strengths of the methodologies were used to answer the identified RQs accordingly. Table 3.1 provides an overview of the research methodology and the underlying data sets used to fit the objective of each research article.

RQ	#	Objective and Method	Data Set	Reference
	P11	A qualitative study using grounded theory methods was conducted to investigate the organizational requirements of crane assembly and service processes in VR simulations.	Qualitative, semi-structured interviews, 12 interviewees	(Weigel & Sauter, 2022)
I	P3	Using grounded theory methods, a qualitative study was conducted to investigate the influence of CEOs' competencies on the digital transformation of SMEs and to analyze IT governance structures.	Qualitative, semi-structured interviews, 20 interviewees	(Weigel, Heger, et al., 2020)
	P7	Qualitative research was conducted using open coding methods. Deviations from the key user concept known from the literature were identified. The similarities and differences were explored in the interviews, and it became clear that a new concept of user participation was found.	Qualitative, semi-structured interviews, 11 interviewees (5 individual interviews and 3 focus group interviews)	(Weigel, Zeuge, & Sauter, 2021)
	P1	Grounded theory methods were used to examine the IT-related demarcation tactics individuals use to satisfy their preferences for integrating or separating personal and professional lives.	Qualitative, semi-structured interviews, 15 interviewees	(Jahn et al., 2016)
	P2	A 2 x 2 experiment with an online survey extended the theory of IT-related boundary tactics by revealing which design options may be beneficial along different work-life boundary preferences.	Quantitative, experiment, suggested 128 participants	(Roeding et al., 2019)
II	P6	A literature search was conducted narratively. The research was conducted by five independent researchers with the objective of representing the broadest possible spectrum of IS understanding of leading virtual teams.	Narrative literature review	(Zeuge et al., 2020)
	P8	Using grounded theory methods, an exploratory approach was taken to gain insight into the importance of fostering team cohesion in virtual teams from the perspective of team members and leaders.	Qualitative, semi-structured interviews, 40 interviewees from 24 organizations	(Zeuge et al., 2021)
	P13	A qualitative study that examines the impact of COVID-19 and explains how it affects virtual team cohesion during work, breaks, and after work.	Qualitative, semi-structured interviews, 26 interviewees	(Zeuge et al., 2022)

RQ	#	Objective and Method	Data Set	Reference
II	P14	With quantitative perspectives of virtualization through the COVID-19 pandemic based on PVT, it was shown how IT properties can meet the requirements of knowledge work processes in remote environments, and two new IT properties (presence, situational awareness) were outlined.	Qualitative, semi-structured interviews, 40 interviewees	(Zeuge et al., under review)
III	P5	A design science research (DSR) approach was implemented with the objective of applying the developed software to a broad class of related problems. Finally, the underlying processes were evaluated to gain insights into the design of a VR system.	DSR case study	(Weigel, 2020)
	P12	A design science-based, empirical approach to improving the use of VR in SMEs. Here, the interorganizational knowledge exchange on the conscious use of VR technology as a work interruption was evaluated regarding occupational health and safety issues.	Qualitative, semi-structured interviews, 60 interviewees, DSR VR experiments	(Weigel et al., 2022)
	P4	A case study was conducted with eleven employees from two organizations that are linked in a value chain (manufacturer / service partner). The results provide insight into how virtual realities can be designed to reduce the gap between organizations.	Qualitative case study, semi-structured interviews 11 interviewees	(Weigel, Hoffmann, et al., 2020)
	P9	The research methodology corresponds to an embedded single case design. Perspective taking, social interaction, and cognitive absorption were qualitatively identified as potentials for the transfer of tacit knowledge in 12 experiments. Based on these potentials, a research model was developed to represent the relationships between each construct.	Qualitative case study with a VR experiment, semi-structured interviews, 12 interviewees	(Weigel, Sauter, et al., 2021)
	P10	A multi-user VR experiment was conducted, and participants were interviewed individually as well as in focus groups about their collaboration behavior. The conditions that influence the intention to collaborate in VR environments were investigated.	Qualitative VR experiment, semi-structured interviews, 20 interviewees	(Weigel, Zeuge, Baumgart, et al., 2021)
	P15	Based on dual process theory, a research model was developed by adding environmental congruence and perspective taking to investigate if different manifestations of VR influence design decision behavior.	Quantitative, experiment, 97 participants	(Weigel et al., under review)

Table 3.1 Overview of Research Methodology and Data Sets

3.2 Qualitative Studies

This dissertation uses qualitative research methods (Table 3.2 and 3.3) to analyze new phenomena and concepts and develop new theories (Rowlands, 2005). In this context, qualitative methods, such as grounded theory methods (adapted open coding and bottom-up coding), were applied (Corbin & Strauss, 1990, 2014; Glaser & Strauss, 1967, 2017). Additionally, the qualitative content analysis according to Mayring (1994) was used (Mayring, 1994; Mayring & Fenzl, 2014).

In this work, Grounded Theory methods (P1, P3, P7, P8, P10, P11, and P13) was used to explore the phenomena for which there is no solid and well-established theory in previous research (Timmermans & Tavory, 2012). Methods of Glaser and Strauss (1967), Corbin and Strauss (1990), and Gioia et al. (2013) were used to apply methods of Grounded Theory. In relation to the use of individual information services (P1), the competencies of CEOs regarding digital transformation processes (P3), the elicitation of new user participation opportunities (P7), the identification of best practices of team cohesion, the highlighting of necessary and sufficient conditions for collaboration in VR (P10), the identification of IT governance requirements for crane assembly and service processes in VR (P11), and the description of the change of cohesion measures through COVID-19 (P13) as well as the application of Grounded Theory enabled the identification of new concepts.

Maying's qualitative content analysis is a structured method for evaluating, e.g., interview data (Mayring, 1994). In terms of content analysis, the evaluation process is characterized by a rule-guided, fixed procedure. In this research (P14), qualitative content analysis was used to capture the performance of PVT and the requirements for process virtualization that are not yet captured.

Tables 3.2 and 3.3 provide an overview of the qualitative studies presented in this paper.

	P1 (Jahn et al., 2016)	**P3** (Weigel, Heger, et al., 2020)	**P7** (Weigel, Zeuge, & Sauter, 2021)	**P8** (Zeuge et al., 2021)
Primary objective	Description of IT-related boundary tactics	Exploring the CEO's influence on the digital transformation of SMEs	Exploring new opportunities for user participation	Gaining insights that are important for promoting team cohesion in virtual teams
Technique for analysis	Grounded Theory methods	Grounded Theory methods	Grounded Theory methods	Grounded Theory methods
Data	15 interviews	20 interviews	11 interviews (5 individual and 3 focus group)	40 interviews
Main contribution	Definition of individual IT-related boundary tactics regarding mobile devices	6 IT governance strategies were identified depending on the characteristics of the CEO	Influencer as a new concept of user engagement was explored and defined	Overview of measures and procedures for virtual leaders to strengthen team cohesion

Table 3.2 Overview of Qualitative Studies (1/2)

	P10 (Weigel, Zeuge, Baumgart, et al., 2021)	**P11** (Weigel & Sauter, 2022)	**P13** (Zeuge et al., 2022)	**P14** (Zeuge et al., under review)
Primary objective	Exploring collaboration in VR	Research of requirements for crane assembly and service processes in VR	Exploring the impact of COVID-19 on virtual team cohesion	Examine how crisis-driven digital transformation has enabled PVT to meet workflow requirements
Technique for analysis	Grounded Theory methods	Grounded Theory methods	Grounded Theory methods	Qualitative Content Analysis
Data	20 interviews	12 interviews	26 interviews	40 interviews
Main contribution	Identify conditions that can be differentiated into necessary and sufficient conditions for collaboration in VR	5 IT governance requirements for crane assembly and service processes in VR were identified	Explain how team cohesion measures have changed on the job, during breaks, and after work as a result of the pandemic	Conceptual extension of established process virtualization to meet requirements in work processes through new IT characteristics

Table 3.3 Overview of Qualitative Studies (2/2)

3.3 Literature and Concept Reviews

A common method of exploring areas of research that the researchers have not yet explored themselves is to review previous research findings through a literature review (Vom Brocke et al., 2009, 2015; Webster & Watson, 2002). Previous literature is first reviewed and then analyzed to formulate new RQs and distinguish new research ideas from previous research. In this dissertation, a narrative literature review (P6) was conducted to present as broad a spectrum of IS understanding of virtual team leadership as possible.

In addition, DSR (Niehaves & Ortbach, 2016; Peffers et al., 2007) was conducted. The study (P5) follows the six phases of the DSR methodology for IS research (Peffers et al., 2007) to demonstrate practical relevance using an existing research project.

The literature & concept reviews are described in Table 3.4.

	P5 (Weigel, 2020)	**P6** (Zeuge et al., 2020)
Primary objective	Compatibility of prior scientific knowledge and practical experience	Collecting previous understanding
Type of review	Narrative concept review	Narrative literature review
Fundamental theory	DSR	Virtual team leadership
Considered outlets	Project documentations	Popular databases, such as Google Scholar, Web of Science, Scopus, and PUBMED
Analysis	The scientific understanding of the DSR was discussed and applied to an exemplary project. For this purpose, the project documentation was used as the basis for the analysis	The results were summarized by five researchers in a joint workshop who discussed and prioritized the literature. These findings were then discussed and reflected upon in workshops with practitioners
Main contribution	Overview of DSR phases based on a VR project	Overview of virtual team leadership in IS

Table 3.4 Overview of Literature and Concept Reviews

3.4 Quantitative Studies

The quantitative studies in this dissertation aim to test the hypotheses of two proposed research models (Chan, 2000). In two studies (P2 and P15), firstly, structural equation modeling and secondly, multiple-linear regression analysis were used to analyze the effects (Büchel & Friston, 1997). In the studies, data collection was conducted in a laboratory experiment. In this experimental research, theoretical dependencies and cause-effect relationships are to be explained. For this purpose, a between-subjects design and a within-subjects design were chosen. The between-subjects design is chosen when different participants test different conditions (Keren & Raaijmakers, 1988). This results in participants being exposed to only a single manipulation at a time, while other participants receive individually different manipulations. In this case, the difference between participant groups is explored. In the within-subjects design, participants undergo all conditions, so they are exposed to multiple manipulations (Keren & Raaijmakers, 1988).

A comparison of the quantitative studies in this dissertation can be found in Table 3.5.

	P2 (Roeding et al., 2019)	**P15** (Weigel et al., under review)
Primary objective	Hypothesis testing	Hypothesis testing
Technique for analysis	Structural equation modeling	Multiple linear-regression analysis
Data collection	Laboratory between-subjects experiment	Laboratory within-subjects experiment
Data points	128	97
Main contribution	Development of a construct for IT-related boundary tactics, which can be used to measure impact on perceived usefulness and work-life conflict	Development and test of a research model on promoting behavioral change / decision quality in VR

Table 3.5 Overview of Quantitative Studies

3.5 Case Studies

Case studies are often based on multiple-source data or research data related to multiple cases (Yin, 2009, 2012, 2017). Depending on the context, a distinction is made between a single case study and a multiple case study (Gustafsson, 2017). The advantages of a multiple case study consist in the data analyzed within each situation and across situations (Stake, 2013). Several different cases are examined to understand the contrast between cases and can provide important influences on the literature through them (Gustafsson, 2017).

Single case studies have the advantage that they are not as costly and time-consuming as multiple case studies (Gustafsson, 2017). Furthermore, single case studies are better suited for building a qualitative theory due to additional and better theory maintenance. A single case study also provides a better understanding of the topic being studied. Other advantages are that single case studies can comprehensively describe the presence of a phenomenon and that conducting a single case study may be more useful when studying one person or a group of people. Using a single case study also allows the author to question old theoretical relationships and explore new ones (Yin, 2009, 2012, 2017).

A comparison of the case studies in this dissertation can be found in Table 3.6.

	P4 (Weigel, Hoffmann, et al., 2020)	**P9** (Weigel, Sauter, et al., 2021)
Primary objective	Research on how VR helps to narrow the gap between organizations	Investigation into the potential of VR to fill a gap in previous research on the transfer of tacit knowledge
Case study type	Embedded single case design	Embedded single case design
Data	11 interviews	12 interviews
Main contribution	Insights on how VR can be designed to reduce the gap between organizations	5 hypotheses in a coherent research model to support the transfer of tacit knowledge in VR

Table 3.6 Overview of Case Studies

3.6 Multi-Method Qualitative Study

In this dissertation, a study (P12) was conducted using a multi-method approach that integrates different approaches (Chamberlain et al., 2011). The objective of this study was to ensure the most comprehensive perspective on the research findings. P12 follows a DSR approach (Gregor & Hevner, 2013; Niehaves & Ortbach, 2016; Peffers et al., 2007). First, existing processes were analyzed, and existing best practices were examined. Next, technical options for implementing a VR environment were explored. This resulted in concrete requirements for a VR demonstrator and the data to be collected. A concept was then developed that hypothesizes how a VR environment should be structured to address the approaches to be researched. Four iterations were then conducted. A total of 60 participants were exposed to an experimental VR environment. Data was analyzed using both Grounded Theory methods (Corbin & Strauss, 1990, 2014; Glaser & Strauss, 1967, 2017) and Qualitative Content Analysis (Mayring, 1994; Mayring & Fenzl, 2014).

Table 3.7 provides an overview of the multi-method study.

	P12 (Weigel et al., 2022)
Primary objective	To what extent is VR a promising technology to improve workflows and enable transparency between different departments and organizations
Technique for analysis	Design science-driven empirical approach, Grounded Theory methods & Qualitative Content Analysis
Data	60 interviews in 4 iterations
Main contribution	Improvements in work processes achieved through VR, which allow early consideration of design issues that are particularly relevant to safety and, thus, provide for more occupational safety and health protection

Table 3.7 Overview of Multi-Method Qualitative Study

4 Summary of Findings

4.1 Transformation Governance

To answer RQ1 *(Which governance structures does an organization need to shape the digital transformation of work?),* insights have been gained into which transformational governance requirements are beneficial for the successful implementation of assembly and maintenance processes in VR (Weigel & Sauter, 2022). The five dimensions identified as prerequisites for the successful implementation of assembly and maintenance processes in VR have been summarized (Table 4.1).

Dimensions	**Example in VR**
Strategic Alignment	A common objective to optimize the hybrid value chain through VR simulation must be in place.
Resource Management	The investment in VR, on the one hand, the development of the software, on the other hand, the time then to be spent in VR, must contribute to optimization.
Risk Management	Processes and associated risks must be mapped transparently through VR, including the associated risk of oversimplification in VR.
Value Delivery	The VR simulation must promise added value for the organization or the hybrid value chain.
Performance Measurement	The VR simulation must be followed by a measurable optimization of the real work processes.

Table 4.1 IT Governance Requirements for Crane Assembly and Service Processes in VR

(Source: Weigel & Sauter, 2022)

It has become apparent that not the explicit IT competence on the part of the CEOs is decisive for the success of the digital transformation but rather knowledge of the fundamental interrelationships between hardware and software and error-free and secure IT communication. Similarly, it has become apparent that CEOs' roles in IT projects vary widely. This is related to their individual experiences in IT management and their respective ambitions and visions regarding digital transformation. External IT knowledge (IT-K) is often brought in by service providers or research institutions, while access to internal IT-K depends on the qualifications of the organization's employees. CEOs and employees depend on external and internal stimuli. The willingness to engage in lifelong learning as well as open-mindedness and self-criticism were rated as priorities by the interviewees in this context (Table 4.1).

Leader		Organization		Explanation / Definition
IT-C	**IT-E**	**IT-K**	**IT-GS**	
Low	No	Internal	Weaker structured corporate relationships	These leaders do not see their role as a digital actor, but as a driving force in digital transformation. With these impulses, the respective experts have a high degree of personal responsibility. It is therefore essential to avoid hierarchic structures, but rather to create network structures.
Low	No	External	Learning structures	Especially the smallest organizations can be confronted with the problem that neither the leader nor an employee has a high level of IT knowledge. Here it is necessary to fall back on external knowledge. However, one should use this knowledge to build up one's own knowledge in these areas.
Medium	No	Internal	Structures of trust between business leaders and IT	If leaders recognize the value of digital transformation for their organization, but are not an expert themselves, it is advisable to build up a strong trust structure to internal experts. The potential change of digital transformation can be profound.
Medium	Yes	Internal / External	Structures of nearness, adaptations, and mediators	The leaders know from their experience how to develop their employees and how to guide them through the digital transformation. Digitization is understood holistically, and digital transformation can lead to changes in the organization. The leaders are more likely to act as mediators.
Medium	Yes	No	Strong structures of distance and resistances	The leaders act as "lone fighters" in the field of digital transformation of SMEs. The organizations are characterized by strongly hierarchical structures. The employees are at most involved in operational activities.
High	Yes	Internal	Everyone has to adapt	A field of tension can arise when the leader and the CIO each have very high IT competencies. Networked, cooperative structures are recommended here.

Table 4.2 Excerpt from the Overview of IT Competencies and IT Governance Types

(Source: Weigel, Heger, et al., 2020)

If it is internal or external IT-K, is the subject of transformative governance and thus plays an important role in the digital transformation of work (Table 4.2). It can be concluded that in the case of internal IT-K, the integration of this knowledge in the form of user participation is important (P3). User participation in digital transformation is often associated with key users. However, the concept of key users refers to software know-how rather than expertise in the field of digital transformation (Wu & Wang, 2007). Therefore, this dissertation proposes a new concept for user participation. The influencer concept can be understood as an extension of the key user concept (P7). Influencers have become a decisive factor for digital transformation projects (P7). Table 4.3 compares the key points of the influencer concept with those of the key user concept. The differences between both concepts have been highlighted in terms of focus, role, motivation, communication, function, direction, and objective.

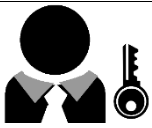
Concepts	Key-user	Influencer
		
Focus	Software implementation	Process transformation
Role	In the project and the daily business	Mainly in the daily business
Motivation	Extrinsic	Intrinsic
Communication	Request / Response	Publish
Function	Represents professional interests	Promotion of the transformation
Direction	Top-down	Bottom-up
Objective	Sustainability of the software	Sustainability of the process

Table 4.3 Comparison of Key-User Concept vs. Influencer Concept

(Source: Weigel, Zeuge, & Sauter, 2021)

In summary, key users are responsible for the software. In addition, they train other end users and are experts for the respective software. The key users are interested in further development and adaptation of the software. In contrast, influencers are responsible for the business process. For them, the focus is on improvement through the selected software. If they find that the changes do not achieve the desired effects, they question decisions that have already been made. This leads to high sustainability of the processes, but also puts the project continuity at risk. Ultimately, the study (P7) shows that influencers can be crucial to the success of the digital transformation of work.

4.2 Digital Leadership

For RQ2 (*Which strategies and which leadership styles of individuals favor the digital transformation of work?*), the findings show the importance of individual concepts, leadership styles, and strategies, which are explained below.

As a first step, the individual communication behavior of digital leaders in times of digital transformation is considered in relation to work. Individual IT-related boundary tactics (P1) were conceptualized. The domains of private and work life can be communicatively integrated, separated, or partially integrated or separated through the individual use of IS. Mobile technologies often blur boundaries so that work and private lives cannot be fully separated. To this end, six specific individual IT-related boundary tactics and three preferences (integration, separation, or mediation) for managing the communicative boundaries between work and private life are identified (P1).

Figure 4.1 provides an overview of the six identified IT-related individual tactics for dealing with a person's boundary preferences.

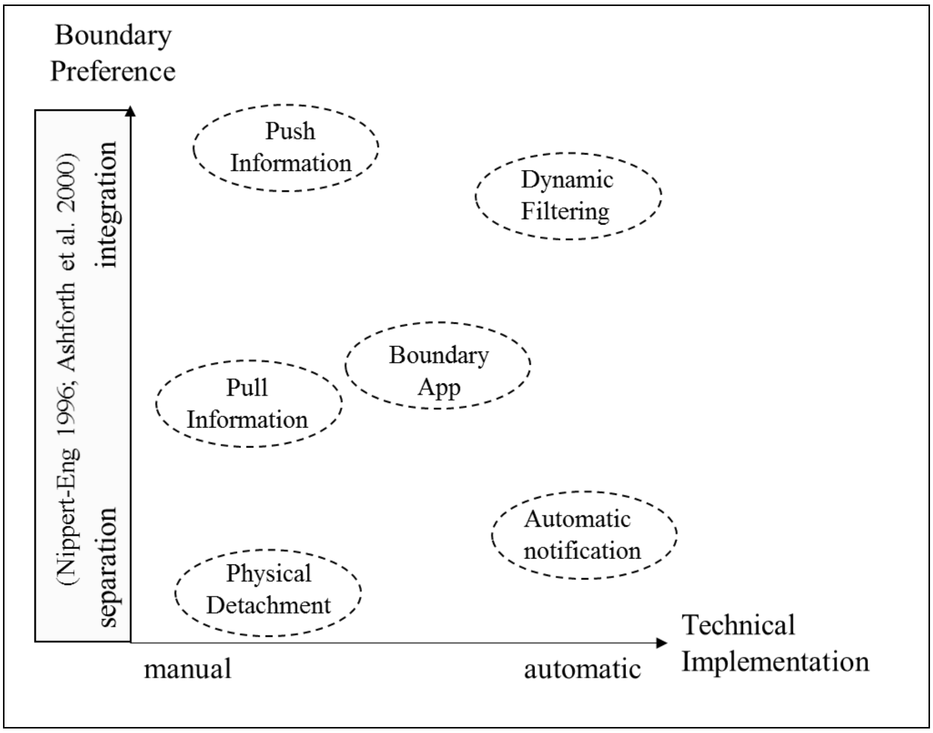


Figure 4.1 IT-Related Boundary Tactics

(Source: Jahn et al., 2016)

In addition to individual boundary preferences, the communication behavior of the leader is a key to accepting the technology and avoiding a work-life conflict (P2). To this end, a research model was designed (Figure 4.2).

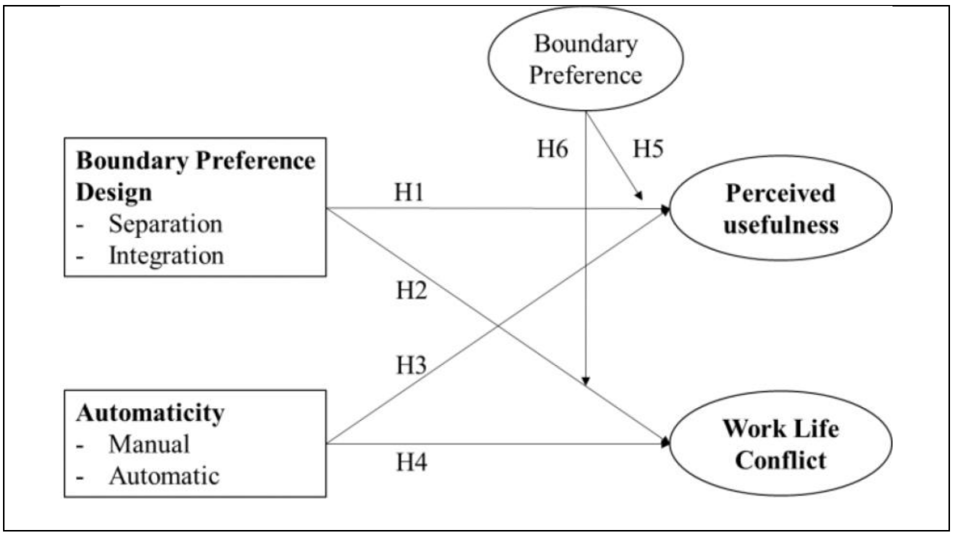


Figure 4.2 Research Model for the Influence of Boundary Preference Design

(Source: Roeding et al., 2019)

Based on this individual communication behavior, however, it is also possible to identify general points in leadership behavior that promise positive effects. The literature review (P6) has shown the importance of leadership in the virtual world both, in the future and in times of the pandemic. It is the leaders' competence that shows their employees how to make the transition from on-site work to a digital workplace. The transition has a higher chance of success if they act as role models and try to support team members as much as possible.

Fostering team cohesion for both, the team and the leader, is becoming increasingly important in the digital world (Larson & DeChurch, 2020; Yang et al., 2015). Strengthening team cohesion is an important individual task for virtual leaders to ensure team success. To this end, P8 examined various measures and "best practices" for maintaining team cohesion both, "on the job" and "off the job" / during breaks. It can be concluded that one of the most important tasks of virtual leaders is to create time for content and personal exchange within the team (P8). However, many traditional, i.e., non-digital, measures to strengthen team cohesion can also be transferred to the virtual environment. Table 4.4 shows the identified "best practices" and some exemplary measures for promoting virtual team cohesion.

Measures			Examples
On-the-job	Exchange	Substantive exchange	Regular virtual meetings Bilateral exchange
		Interpersonal exchange	Care calls Instant personal exchange
	Communication	Communication patterns	Unambiguous communication Transfer physical communication patterns to virtual
		Technical communication	Turn camera on Avoidance of digital wallpaper
	Team interaction	Team-Team	Availability in core hours Keeping agreements
		Leadership-Team	Celebrating achievements Merchandise by post
Off-the-job	Break Times	Socializing	Virtual coffee roulette Permanent virtual break room
		Sport	Virtual yoga class Virtual office gymnastic
	After-work	Sport event	Virtual run Virtual challenges
		Virtual game night	Virtual escape rooms Virtual online games
		Virtual round table	Virtual drink tasting and cooking Virtual concerts

Table 4.4 Excerpt Overview of Selected Best Practices

(Source: Zeuge et al., 2021)

However, these best practices on how to realize cohesion “on-the-job” and “off-the-job” must also be considered in the transformation brought about by COVID-19. One of the biggest challenges associated with the pandemic is dealing with feelings of social isolation. Here, research shows that COVID-19 has had and continues to have a significant impact on virtual team cohesion. Study P13 examines the “new normal” of cohesion in virtual teams, i.e., how measures of cohesion in virtual teams changed during times of the pandemic (P8). It was possible to shed light on how these measures changed during work, breaks, and after work (Figure 4.3).

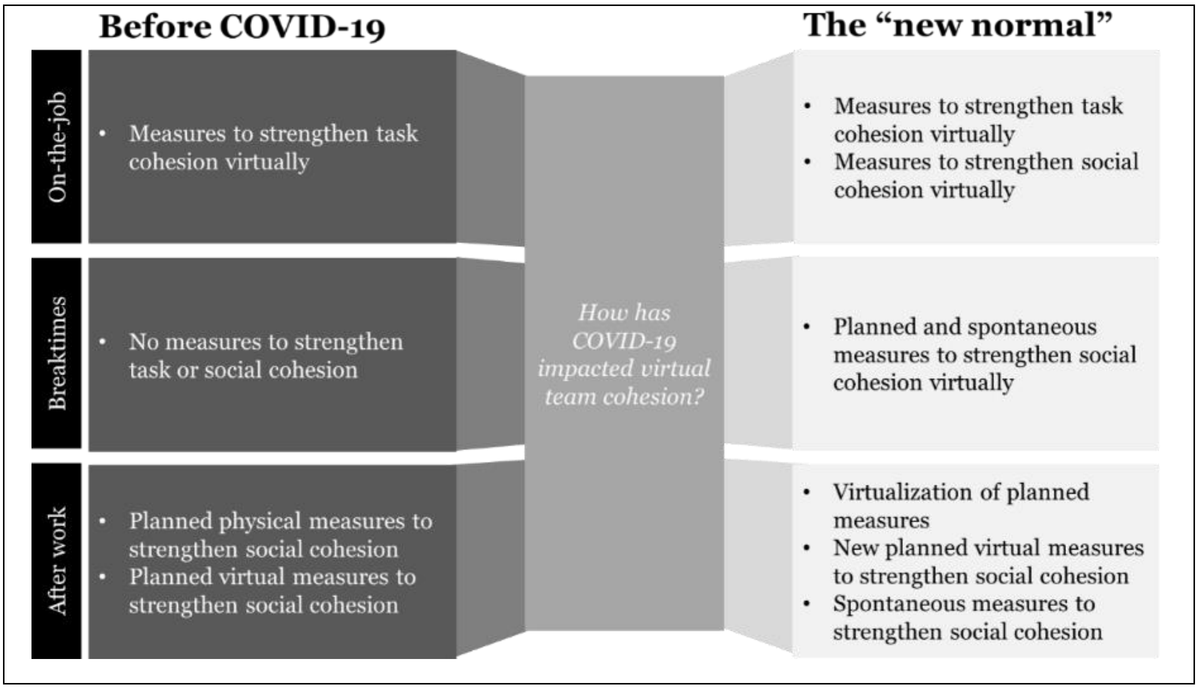


Figure 4.3 The Impact of COVID-19 on Virtual Team Cohesion

(Source: Zeuge et al., 2022)

In addition to team cohesion, it is also important to consider the overall change in work due to COVID-19 (Bartsch et al., 2020). Prior to the pandemic, many knowledge work processes were performed from an office. However, due to the pandemic and the associated lockdowns, employees were forced to virtualize their work and to work remotely. What seemed unthinkable before the pandemic has become possible due to the pressure of the pandemic. However, the requirements for knowledge work processes have remained the same, while the same work output has been expected and has had to be achieved. Therefore, it is unclear how a crisis-driven digital transformation has helped to meet these requirements (P14). From the theoretical perspective of PVT, it could be shown that COVID-19 has led to a revised perspective on PVT in a way that virtualized knowledge work processes have become a requirement. Furthermore, the requirements for knowledge work processes in remote work environments could be confirmed during COVID-19 and two new IT characteristics (social presence, situational awareness) were discovered (Figure 4.4).

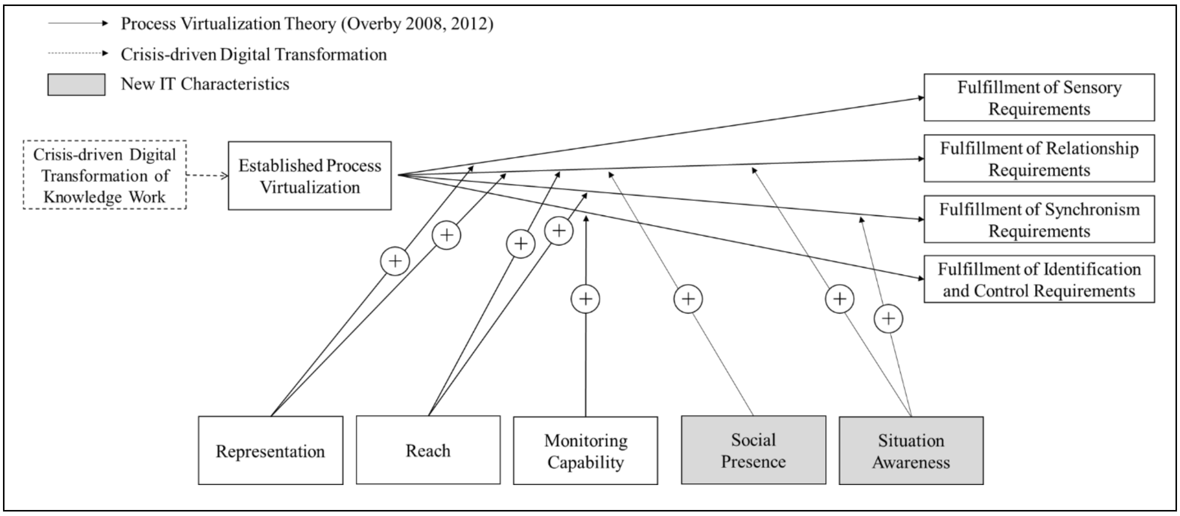


Figure 4.4 An Expanded Crisis-Driven Revisited Perspective on PVT

(Source: Zeuge et al., under review)

4.3 Future Technology Management

To answer RQ3 *(What benefits can the digital transformation of work address through future technology management?),* insights have been gained into which technology adds potential and actual value to the digital transformation of work. During the digital transformation of work, the virtual and real worlds increasingly merge, and products and services are equally affected by this process (P12). Accordingly, it is necessary for products and services (e.g., design and maintenance processes) to be coordinated (P5). For this purpose, the required competencies on the part of both designers and service providers have to be identified and jointly developed. Two studies deal with the development process of an interactive VR demonstrator for teaching competencies about hybrid value chains (design- and maintenance-related processes) (P12).

In the research process both, theoretical and practical elements, were mapped in the VR demonstrator to promote knowledge transfer along hybrid value chains (P5). To define the VR demonstrator in more detail, the relevant requirements and workflows of the employees were first determined on an empiric basis. Subsequently, the organizational development of competencies will be analyzed. Supporting employees in their competence development in the best possible way using VR and transferring this support into operational practice, is one attempt of the RQ's response (Figure 4.5).

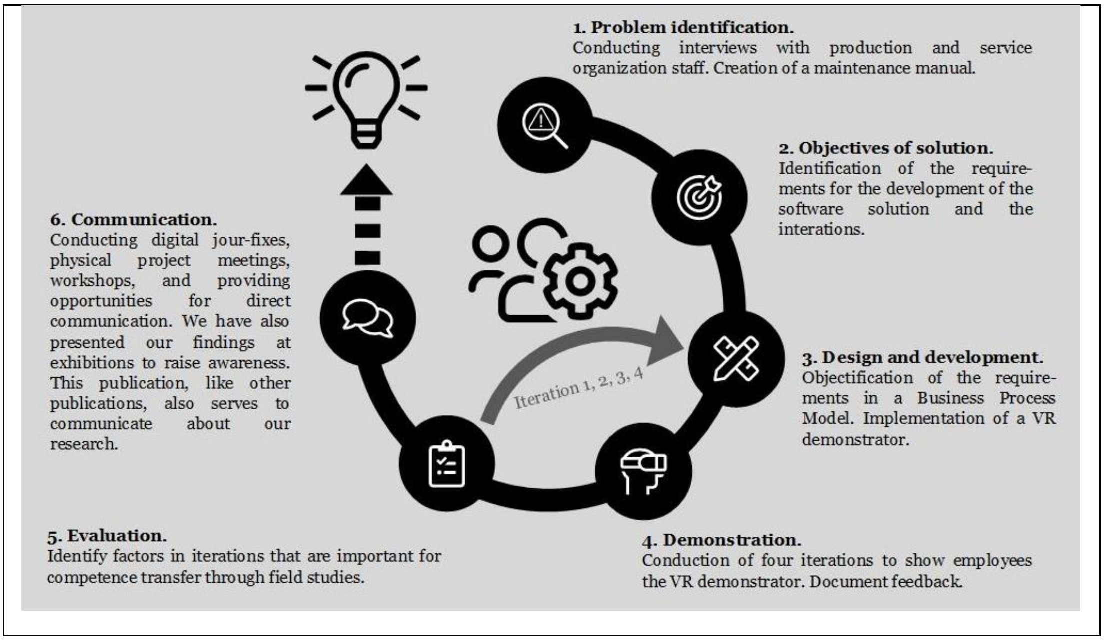


Figure 4.5 Overview and Application of the Design Science Phases

(Source: Weigel et al., 2022)

The findings of the 4 iterations were compared in terms of their key findings, which are summarized in Table 4.5. Table 4.5 shows that VR can add value to the digital transformation of work in the respective research areas: perspective taking, tacit knowledge transfer, interruptions, and collaboration (P12).

Iteration	**Research object**	**Key finding**
1	Perspective taking	VR can help designers add a service perspective to their general understanding of how their designs work. Environmental conditions or specific designs can be simulated and tested virtually. The lack of understanding of these specific conditions is reinforced by VR and perspective taking across organizational boundaries.
2	Tacit knowledge transfer	VR offers potentials to support the transfer of tacit knowledge in organizations. While in the past the transfer of tacit knowledge was often considered at the level of individual employees in an organization, these research results now enable the consideration of interrelated value creation processes across organizational boundaries.
3	Interruptions	To fully exploit the potential of VR use, one must also address the threatening side effects. Only if VR use is seen as beneficial, it will be used in reality. The research shows that work processes (in our case CAD processes) can be intentionally interrupted by VR use to gain an advantage, provided that the use of VR adds value.
4	Collaboration	Collaboration in VR is a promising method to share experiences between designers and service technicians. This could be defined in terms of technology, task, and user-related aspects.

Table 4.5 Summary of the Most Significant Findings from the Four Iterations

(Source: Weigel et al., 2022)

The positive implications for the research subject in terms of VR already relate in part to exchanges between organizational members along a hybrid value chain. The P4 study shows that the presence of the alignment of organizations in a hybrid value chain plays an important role in today's organizations. The study derives the relationships between alignment and technological support and discusses possible positive or negative effects. According to the study (P4), the adoption of perspectives reaches its limits when knowledge of the respective processes is not available. Employees identified VR technology as particularly important for this perspective taking. In VR, the knowledge bases of different work fields are connected and mutually responsive. In these simulations, users should interact and experience the consequences of their actions. The users should experience the situation from their perspective in order to link it to their previous experiences and actions and, thus, adapt the product to their abilities.

Building on the previous findings of this dissertation (P12), five hypotheses are combined with further data in a research model (P9). The immersive VR technology used in this experiment defines the starting point of the research model. As a result, cognitive absorption represents a positive moderator for perspective taking and social interaction. The opportunities for perspective taking and social interaction foster the transfer of tacit knowledge.

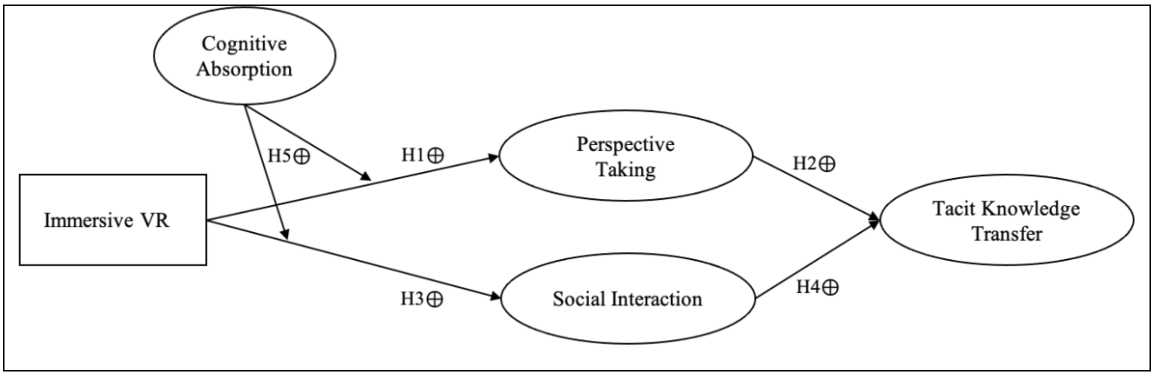


Figure 4.6 Research Model Immersive VR and Tacit Knowledge Transfer

(Source: Weigel, Sauter, & Niehaves, 2021)

This study (P9) and Figure 4.6 show that VR offers potentials in the context of work transformation to support the transfer of tacit knowledge in organizations. While in the past the transfer of tacit knowledge was often considered at the level of individual employees in an organization (P9), these research findings – with reference to VR – enable the consideration of interrelated value creation processes across organizational boundaries.

P10 has investigated into the conditions that influence the intention to collaborate in VR. For this purpose, the findings could be divided into technology, task, and user conditions. Thus, it was possible to distinguish between sufficient and necessary VR conditions that influence the intention to cooperate in VR. Necessary conditions represent the basic requirements for collaboration in VR. However, if these conditions are met, this does not mean that collaboration will necessarily occur; for this, sufficient conditions that promote collaboration in a multi-user environment are required (see Table 4.6).

<table>
<tr><th colspan="3">Condition</th><th>Example in the VR experiment</th></tr>
<tr><td rowspan="7">Necessary</td><td rowspan="5">Technology</td><td>Handling</td><td>Intuitive use of VR hardware and VR environment</td></tr>
<tr><td>Details of environment</td><td>Perception of crane assembly</td></tr>
<tr><td>Design of avatars</td><td>Perceiving each other as human</td></tr>
<tr><td>Immersion</td><td>Realistic representation of the assembly scenario</td></tr>
<tr><td>Communication</td><td>Exchange-related tasks</td></tr>
<tr><td rowspan="5">Task</td><td>Formulation of tasks</td><td>Allow collaboration</td></tr>
<tr><td>Transfer of information</td><td>Exchange about the assembly process</td></tr>
<tr><td rowspan="6">Sufficient</td><td>Realistic design of tasks</td><td>Require collaboration</td></tr>
<tr><td>Efficiency through collaboration</td><td>Division of tasks</td></tr>
<tr><td>Difficulty of the task</td><td>Need for collaboration</td></tr>
<tr><td rowspan="3">User</td><td>Personal acquaintance</td><td>The participants know each other before</td></tr>
<tr><td>Perspective taking</td><td>Taking on the role of the service technician</td></tr>
<tr><td>Transfer of knowledge</td><td>Exchange of experiences and knowledge</td></tr>
</table>

Table 4.6 Conditions Influencing the Intention to Collaborate in VR

(Source: Weigel, Zeuge, Baumgart, et al., 2021)

It remains to be noted that immersive VR is used by organizations as part of the digital transformation to innovate and optimize their work processes (P4, P9, and P10). To investigate the potential of VR technology in computer-aided design (CAD) processes, an experimental case study was conducted in P15. Based on dual process theory (Strack & Deutsch, 2004), a research model was developed by adding environmental congruence and perspective taking to investigate if different visualizations of a VR environment affect design decision behavior. The results have shown significant effects on behavioral changes related to environmental congruence, perspective taking, and both systems of dual process theory (i.e., reflective and impulsive system). Thus, the explanatory power of three theoretical approaches has been tested by proposing a unified theory of behavioral change in a VR environment, which has provided useful directions for further research (Figure 4.7).

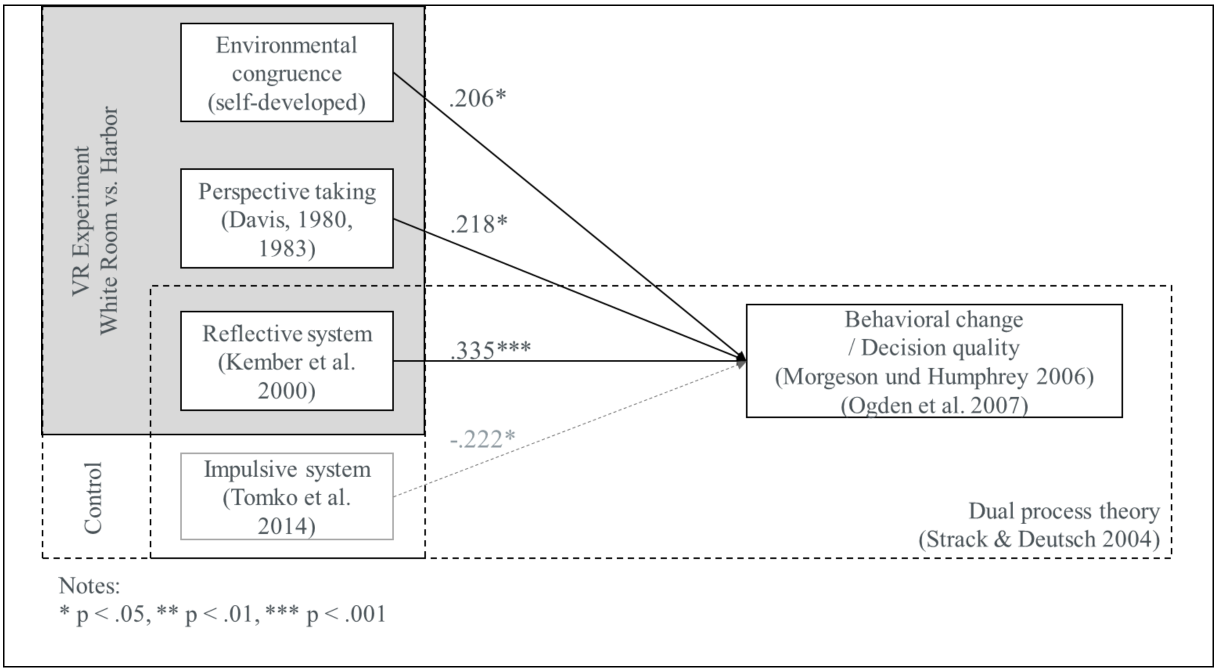


Figure 4.7 Results of Research Hypotheses

(Source: Weigel et al., under review)

5 Discussion and Conclusion

5.1 Conclusion

The main findings of this paper-based cumulative work are presented in relation to the three proposed RQs (see Section 1.4). Therefore, the following section is divided into three basic paragraphs, with each paragraph focusing on one of the proposed RQs (see Figure 1.1). Section 4.2 focuses on the transformation of the governance structures (P3, P7, and P11). Section 4.3 focuses on digital leadership strategies and methods (P1, P2, P6, P8, P13, and P14). Section 4.4 provides an overview of the results of RQ3 and highlights technology-related aspects of digital transformation (Contributions P4, P5, P9, P10, P12, and P15).

To answer RQ1 *(Which governance structures does an organization need to shape the digital transformation of work?)* it remains to be said that there is no defined right or wrong governance structure for organizations. The question of governance structures has to be considered in conjunction with several other factors, such as the individual IT competence of the CEO (P3) and the concepts of user involvement in the organization (P7). Depending on these accompanying circumstances, the appropriate IT governance structure can then be selected, e.g., to promote the use of VR in the company (P11).

In consideration with RQ2 (*Which strategies and which leadership styles of individuals favor the digital transformation of work?*), this dissertation provides the answer that this strongly depends on the individual. Be it in communication behavior (P1 and P2) or in leadership style (P6 and P8). But the general conditions (in this case COVID-19) do have an influence on the digital transformation of work (P13 and P14). To the question of which strategy and which leadership style is the right one, the answer is once again: it depends. However, the studies offer some promising approaches to this question.

To answer RQ 3 (*What are the benefits of future technology management regarding the digital transformation of work?*), it remains to say that the usefulness depends on the methodological approach, in this case the DSR is studied in detail (P5 and P12). In this dissertation, a user-centered approach was adopted, and the evaluations underlined that this approach is useful for the existing framework (VR use in SMEs). This usefulness can be seen in terms of increased alignment in hybrid value chains (P4) or successful transfer of tacit knowledge (P9). It also has been shown that collaboration in VR between two users can be achieved through future technology management (P10). Finally, there is the benefit related to the design of machines; here, technology in the form of VR has been found to be very useful.

In summary, the answers to the RQs on the digital transformation of work can be illustrated as follows (Figure 5.1).

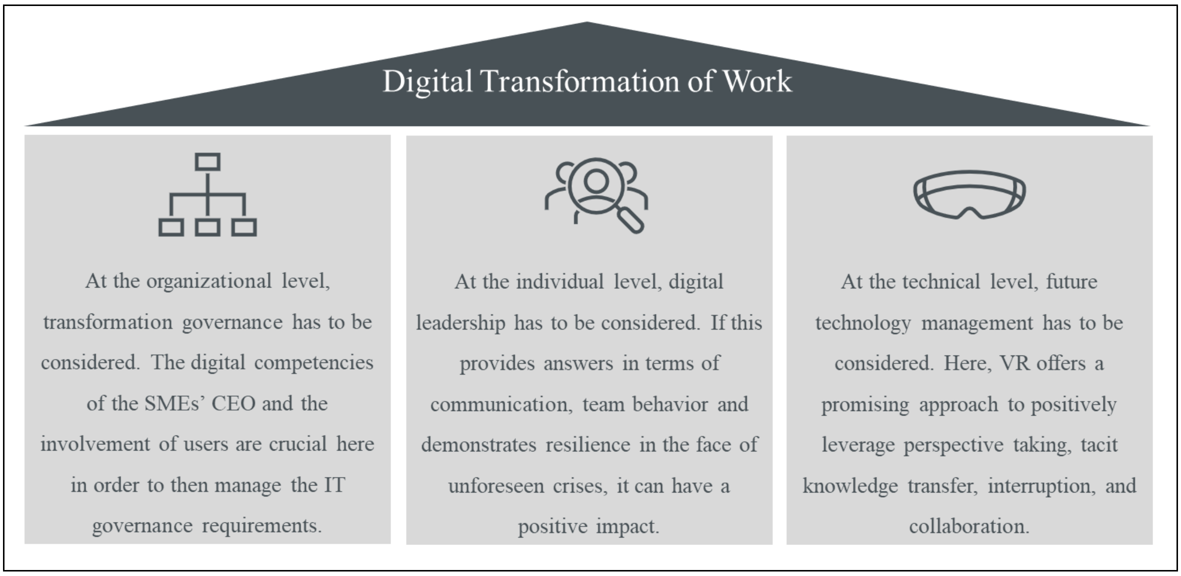


Figure 5.1 Overview of the Perspectives of the Digital Transformation of Work

5.2 Discussion

This dissertation addresses the ongoing digital transformation of work. The findings are organized according to organizational structures, strategies, and leadership styles of individuals as well as the benefits of future technology management. The approaches discussed in the studies and possible improvements in work processes will make it possible to draw attention to particularly significant challenges at an early stage. This dissertation can be used to enrich new findings, such as the conditions of collaboration in VR (Hatzipanayioti et al., 2019, P10) or the alignment of organizations (Wilkin et al., 2016) with each other through VR (P4), as well as already recognized scientific findings, such as PVT (Overby, 2008, 2012, P14) or dual process theory (Strack & Deutsch, 2004) adapted to the pandemic through VR (P15).

With regard to organizational structures, the influence of hybrid value chains on the business activities of organizations can be underlined (Leimeister & Glauner, 2008; Santos et al., 2015). The studies discussed offer several ways to see how hybrid value creation can be understood and used as an innovation strategy (P4, P5, P11, and P12). In this context, VR simulations have been identified as a valid option for addressing process complexity.

The common strategies of the organizations' objective has been identified as a particularly fundamental prerequisite. An essential part of this is the definition of the VR technology as a element of the future technology management strategy, which is considered by all organizations of the hybrid value chain to be suitable and meaningful to promote the following organizational strategic alignment along the value chain (Blackwell et al., 2019). Hereby, existing research approaches could be extended by the perspective of VR (Bullinger et al., 2017; Peterson, 2004). The importance of considering priorities of organizations in design hat to be properly considered, discussed, and prioritized (Wu & Wang, 2007). The positive relationship between user involvement and user satisfaction in system development already identified in the literature (Kujala, 2003; Mckeen & Guimaraes, 1997) has been confirmed in this dissertation and extended to the digital transformation of work. An essential factor for this is the organizational ownership of IT systems by the users (Lynne, 1983). The developed influencer concept leads to another essential factor in the processes (Weigel, Zeuge, & Sauter, 2021). This represents a bridging function between key users with a high level of IT domain knowledge (Maas et al., 2016; M.-Z. Pan & Mao, 2013) and end users with a high level of process knowledge (Wu & Wang, 2007). The organizational measures outlined in this dissertation can be used to meet the challenges of the digital transformation of work.

In terms of strategies and leadership styles of individuals, this dissertation shows that extensive application of management-related social skills can be beneficial (Weigel, Heger, et al., 2020). By creating a team atmosphere characterized by trust, virtual team leaders can increase the success rate of projects (Edwards & Sridhar, 2005; Sarker et al., 2003). This is particularly relevant against the background of the global pandemic. The studies discussed in this dissertation deal with the so-called crisis-driven digital transformation (Di Gangi et al., 2021). This expands the previous view of the literature on the impact of COVID-19 on crisis-driven digital transformation of organizations (e.g., Haslam et al., 2021). The relevance of strengthening team cohesion in virtual teams (Lepsinger & DeRosa, 2015; Yang et al., 2015) has been confirmed in the studies (P8 and P13). Strategies and "best practices" are also highlighted to address the limited opportunities for social interaction in a virtual team. Often, leaders have the intrinsic motivation to increase team cohesion through the identified strategies (e.g., virtual meetings, celebrating achievements, virtual escape rooms). It is likely that these "best practices", which are perceived positively by all stakeholders, also increase the motivation of team members (Kwak et al., 2019). This dissertation extends the existing literature on the digital transformation of work with a collection of 21st century best practices while taking a special focus on the pandemic.

VR technologies have continued to evolve throughout the studies in this dissertation. Not only have immersive VR scenarios (Mills & Noyes, 1999) been further explored subjectively from the perspective of users, but with the integration of eye-tracking into VR, also objective research findings have been incorporated. Therefore, the eye-tracking approach in this dissertation builds on existing studies that have shown success in other contexts (Mueller et al., 2011). It was confirmed that VR offers completely new insights into the design of many business processes and services. Considering the aspects of future technology management, the conditions for collaboration in VR could also be addressed. Here, previous research is addressed and extended (Hatzipanayioti et al., 2019; Mütterlein et al., 2018). The P10 study examines which conditions influence collaboration in VR. The three characteristics (telepresence, interactivity, and immersion) of VR (Walsh & Pawlowski, 2002; Wohlgenannt et al., 2019) could be considered in the studies and in this dissertation. Based on the results, telepresence (Sanchez-Vives & Slater, 2005) also has been divided into two components: first, the perceived details of the environment and second, the design of the avatars, i.e., the extent to which the avatars are perceived as human and thus present. The technology-related necessary condition listed here is that the operation should be as close to reality as possible to be perceived intuitively. Among the technology-related necessary conditions, immersion (Dede et al., 2017) could be identified and affirmed as one.

5.3 Contributions to Theory

For theory, this dissertation provides, among other things, implications about what are “good” IT leadership structures and which factors influence the suitability of IT leadership (P3). In this case, good IT leadership depends on the digital competencies of CEOs and the correctly selected IT governance structure (P3). Also, “influencers” (P7) with high digital competencies, for example, who mediate between the CEOs and their employees, are an instrument for passing on and implementing the decisions of CEOs or compensating for a lack of explicit digital competencies on the part of the CEO. It also has been found that CEOs in SMEs for a successful transformation mainly need general knowledge about the software and hardware used and less knowledge about technical details (P3). In addition, employees were identified as a key factor for successful IT leadership. This is in line with many existing research studies on IT leadership (Goh & Wasko, 2012; Salomo et al., 2003; Venkatraman, 1994).

Studies (P4, P9, P10 & P12) in this dissertation enrich existing research on multi-user VR solutions (Alghamdi et al., 2016). The VR scenarios often allowed multiple users to look around and move independently (P15). They also allowed users to interact with virtual objects and other users (Jalo et al., 2020). As well, they have confirmed the findings of previous research that VR is a promising medium for digital collaboration for several users (Hatzipanayioti et al., 2019; J. Li et al., 2020). First, based on previous research, the intention to collaborate in VR could be further explored (P10). The findings of this dissertation add to the existing literature by providing an overview of the conditions for collaboration in VR. These will allow future research to identify new starting points and further advance research in this previously understudied area. Apart from the VR literature, the findings provide implications for the field of knowledge transfer. The separation of information and knowledge transfer is consistent with the knowledge staircase theory (North et al., 2016). One of the definitions here is that information becomes knowledge only through the addition of experience. However, knowledge transfer is a sufficient condition, as user experience is crucial here. It can be concluded that classical approaches, such as the knowledge staircase (North et al., 2016), can also be used in innovative solutions, such as VR, and offer the possibility of further adaptations for theoretical purposes.

5.4 Contributions to Practice

Implications can be derived for practice, as well. A basis of trust with other key players is decisive for the success of digital transformation in the organization, whereas the IT competence of the CEO is not necessarily decisive (P3). Finally, functioning IT management structures based on the CEO's competence profile could be identified (P3). This enables the CEOs of SMEs to use the best practices identified and transfer them to their organization. User participation should lead to a better understanding of the developed IT solution and should be useful in the continuous improvement of processes. The introduction of the influencer role leads to a broader view of user participation in IT projects, as user participation should not only include software implementation but also process changes (P7). The influencer role serves focusing on important aspects in an IT project and, beyond, ensuring the digital transformation of work. For a successful implementation of the influencer concept, the intrinsic motivation of the influencer to participate in a successful implementation of the (IT) project is of particular importance. The results show that digitization projects are better accepted in SMEs if their benefits are directly visible in everyday work. This is where influencers come into play. They can convince end users of the projects and the associated project objectives. Influencers should have access to informal communication channels that enable information exchange with end users about the projects and the expected changes. The concept can also help business leaders and organizations reorganize and achieve greater acceptance of the changes.

The success of an organization depends largely on the extent to which team members feel a sense of belonging and unity (Beal et al., 2003; Huang et al., 2004; Keith et al., 2018); the studies in this dissertation contribute to practice. This dissertation provides a comprehensive and understandable overview of previous and further practical measures and "best practices" for virtual leaders to strengthen team cohesion in relation to existing research (e.g., Huang et al., 2004). Virtual leaders can build on this and integrate appropriate measures into their teams. This will not only help overcome feelings of loneliness and isolation during the pandemic but also after the pandemic as virtual teamwork increases further.

This dissertation provides an overview of the conditions that need to be considered when employees collaborate in VR, and that the conditions are either necessary or sufficient for the intended collaboration. Technical conditions, such as making the VR environment as realistic as possible, enable abstraction from reality. Conditions such as immersion should therefore be considered from the outset when designing VR environments. For designers, it is important to design the representation of users (avatars) in such a way that users are mutually perceived and verbal and nonverbal communication is enabled. Task design also has a significant impact on the intention to collaborate in VR. There are simple tasks, such as cutting screws, that do not invite collaboration, even when designed for collaboration. In contrast, more complicated tasks, such as correctly tightening the bolts on the crane, were approached by users directly in collaboration. For VR developers or VR designers, this means that the task difficulty in terms of complexity and time frame also plays an important role in VR collaboration. VR represents an opportunity to reduce the negative consequences of misalignment.

For practitioners such as VR developers, this dissertation provides an indication of the minimum conditions whether must be met to enable work transformation through technology management collaboration in VR. The sufficient conditions can then be additionally considered to promote the intention to collaborate. Depending on the objective of VR collaboration, the combination of users can be influenced. For example, if the objective of the VR collaboration is to achieve a formal learning outcome, then it makes sense to use a VR-experienced user as teacher and an inexperienced user as student. If problem solving is formulated as the objective, then users with similar levels of experience are advantageous because they can discuss and try out different approaches together.

5.5 Limitations and Future Research

As with any research, there are several limitations to this dissertation. This section focuses on the limitations of the dissertation in sum, while the individual limitations are mentioned in more depth in each study (e.g., Klesel, 2019; Lemmer, 2021).

The strength of this dissertation lies in identifying interrelationships among different organizations as reflected in business strategy, IS strategy, and strategic orientation of organizations. The relationship between the social and cultural alignment of IT organizations, perspective taking, and VR support could be theorized. The alignment of value creation across organizational boundaries has not been considered in this context, so far. However, the data suggest that VR-supported perspective taking could be a potential improvement here. There is an opportunity to test the theoretical approaches quantitatively.

The relationship between IT governance as defined by the five constructs and VR support could be demonstrated. VR theoretically offers the possibility to not only view processes in perspective but also to execute them virtually. The adaptation of value creation across organizational boundaries has not been considered in detail in this context, but promising starting points have been identified.

The studies in this dissertation do not provide an explicitly specific way for virtual team leaders to improve the success of their virtual teams. A comprehensive range of measures is presented that could lead to improvement in this context. A crucial point for further studies is to consider character traits, such as empathy or trustworthiness of leaders, against the background that not every leader automatically possesses such competence, and it is not easy to acquire this.

As communication technology allows locally separated workgroups, it is important for researchers to investigate new communication methods besides video telephony, online chat, or teleconferencing. Therefore, this dissertation focuses on a collaboration using VR now and in future research. Compared to today's established means of Internet communication, VR can provide a divergent interaction where the software can transmit more or different information depending on the use case.

Another influencing factor in all studies is the personality of participants. An open and communicative personality, for instance, can be particularly conducive to social interaction. When conducting the VR experiment, some influencing factors could be identified sporadically. These include the previous VR experiences of participants, the feeling of “motion sickness”, the age of the participants, and if the participants were wearing glasses. In the future, it may be helpful to investigate the analyzed correlations through quantitative analysis. It may be helpful to investigate the analyzed interdependencies through quantitative analysis. It can be expected to contribute to a more general theory about appropriate measures for the transfer of, e.g., tacit knowledge. This would open the possibility to include external or personal factors in the analysis to avoid blind spots in further research.

Lastly, this dissertation provides interesting results in the field of digital transformation of work in relation to organizational structures, strategies, and leadership styles of individuals and the benefits of future technology management. Therefore, a limitation is provided by the intensification of these topics. Other aspects also have an impact on the transformation of work, e.g., hybrid value chains. However, the aim of this dissertation has been to develop an approach that is comprehensible in theory and easy to apply in practice. It should be noted that the digital transformation of work is still an indescribable and ever-changing field of research, which will offer further potential for future examination.

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Part B

RESEARCH STUDIES

"Virtual reality was once the dream of science fiction. But the internet was also once a dream, and so were computers and smartphones. The future is coming."

— Mark Zuckerberg

I TRANSFORMATION GOVERNANCE

7 Crane Assembly and Service Processes meet VR (P11)

Paper Number	**P11**
Title	**Crane Assembly and Service Processes meet Virtual Reality**
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Table 7.1 Fact Sheet Publication

Crane Assembly and Service Processes meet Virtual Reality

Abstract. When crane assembly and service processes can be experienced in virtual reality (VR), completely new perspectives on these processes emerge. But before these mechanisms of VR take effect, well thought-out (IT) governance is required. Fundamentals such as hybrid business models and organizational frameworks must also be considered. To this end, interviews were conducted with 12 employees from two German medium-sized organizations. This enabled insights to be gained into which prerequisites are helpful for the successful implementation of assembly and maintenance processes in VR.

7.1 Introduction

Working in hybrid value chains has a strong influence on the business activities of German organizations [1]. The increasing complexity of our economy, accelerated by continuous change and technological progress, poses unprecedented challenges for market players [2, 3]. Within hybrid value chains, product-related services are often a central element. These include assembly, maintenance work, inspections, and the repair of machines and industrial plants. In our case, customer-specific requirements for highly customized crane solutions can often no longer be met by manufacturers alone. In addition, today's cranes have a high degree of specialization, which can only be offered in cooperation between the players within the entire value chain. If actors are left out of this work, the risk potential often increases. For example, for the new development of a crane, at least the participation of the manufacturer (here: VETTER Krantechnik) and the service provider (here: VETTER Kranservice) is required in order to develop viable products against the background of statics, feasibility, and assembly opportunities. If one partner is not involved (e.g., service provider), safety cannot be ensured when assembling the crane. Nevertheless, the production of tangible goods and the provision of intangible services therefore often take place within the boundaries of the organization. Work processes outside the organization's value chain are rarely known and integrated into the organization's value chain to a limited extent. The innovation potential (technical and social) can therefore not be fully exploited.

The assembly and maintenance of cranes are processes that are often associated with potential hazards [4] that include for instance great heights of crane installations or uncomfortable weather conditions associated with outdoor maintenance [5]. It is precisely these hazards that make it difficult to fully experience the processes on and around a crane if one is not the service technician [6]. However, the insights gained during assembly and service processes are necessary to already improve crane assembly conditions and maintenance during the design phase. Although maintenance processes are evaluated in the respective service organization, feedback and evaluation of the actual design based on the experience of the service employees often do not take place. If designers are enabled to evaluate the designs in terms of assembly and maintenance, this can result in improved conditions for maintenance and repair. This evaluation is often difficult to achieve because cranes are maintained e.g., at a very high altitude or under other dangerous conditions, so the service employees must be specially trained. Since the situation is not experiential, designers have limited ability to put themselves in the shoes of the service employees. Furthermore, the real wear and failure behavior of components and their maintenance is only known in this level of detail by the service employees. A possible answer to this problem could be that primarily employees not involved in maintenance processes get to experience this.

Virtual Reality (VR) offers the opportunity to experience service processes virtually and to actively work on them [7]. There is already research on how VR should be designed [6, 8], but how should VR simulations be embedded in organizational processes? Previous literature has not conclusively examined this, so this study addresses the following research question:

What organizational requirements do crane assembly and service processes need to perform in VR simulations?

7.2 Related Work

Hybrid business models and the associated changes in the organization of work pose major challenges for organizations [1]. The technological development discussed under the term Industry 4.0 [9] is essential for this. Current solution approaches are aimed at improving the integration of all value creation partners. Hybrid value creation can also be understood as an innovation strategy [10]. Existing approaches to this include the collaborative development of business models and processes [11]. However, it can be observed that physical products and services are usually developed separately. That is, services are only inserted "alongside the product" into the existing value creation process of organizations [1]. However, a completely integrated view of hybrid products is still rarely observed in research.

(IT) governance is the management system through which an organization's (IT) portfolio is directed and controlled [12] and is concerned with the centralization and decentralization of management decisions about business applications: in the case of this research of IT architectures and technology components. IT governance mechanisms, including decision-making structures, formal processes, and communication approaches, can positively influence business performance. This relationship is largely determined by the strategic direction of IT [13]. Effective IT governance that includes top management commitment increases the strategic controllability of IT, contributing to IT's effectiveness and impact on the business. [14]. It is often assumed that top management is a key factor in successful IT governance [15, 16]. CEOs, therefore, have a major impact on the effectiveness of IT in the organization and should actively take supportive actions to ensure that strategic visions are internalized. In addition, alignment between organizations (e.g., via IT) plays a role as an intermediary between IT governance and business performance.

Five constructs were derived from the literature to further specify IT governance. These constructs are strategic alignment, value creation, risk management, resource management, and performance measurement [17, 18]. This is accompanied by the concretization into an IT artifact, i.e., the definition of a system or a technical basis and its impact [19, 20]. In hybrid business models, the challenge is that each organization focuses only on concretizing individual parts. There is then few to no opportunity to discuss relative priorities holistically, and there is a risk that the activities of others will be ignored, glossed over, or not appreciated in their complexity [21]. VR simulation of the process can address these shortcomings [7].

With the development of head-mounted displays (HMD), rapid technological progress in recent years has enabled new ways to enter and experience VR [22]. Current trends and solutions are already demonstrating the possibilities that VR offers. In the context of collaborative work, learning, and perspective taking, VR offers great potential [6, 7, 23]. VR provides users with a 3D experience in a virtual space. Within VR, objects as well as processes can be represented with a very high level of detail. In addition, a closed VR space allows for a very focused interactive experience [23]. Thus, VR technologies are ideally suited for the described simulation of service processes.

7.3 Method

A group of organizations was considered, consisting of a production organization and a service organization that are locally separated, but are connected via a hybrid value chain. A total of six runs of a VR experiment were conducted: four runs with mixed pairs (production and service) and two runs with one same pair each (production or service) to validate our results (Table 7.2).

No.	Organization	Age	Gender	Position
1-1	Manufacturer	26	male	Design / Development
1-2	Service provider	19	male	Trainee
2-1	Manufacturer	34	male	Chief of IT
2-2	Service provider	23	male	Trainee
3-1	Manufacturer	32	male	Design / Development
3-2	Manufacturer	29	female	Sales
4-1	Service provider	25	male	Service technician
4-2	Manufacturer	29	male	IT
5-1	Service provider	51	male	CEO
5-2	Manufacturer	25	male	Design / Development
6-1	Service provider	26	male	Trainee
6-2	Service provider	27	female	Trainee

Table 7.2 Overview of the Participants

In each of these six experimental setups, the same scenario, the assembly process of a crane in VR had to be performed by the two participants. Physically, the participants were in two different rooms. Participants were selected regardless of age and gender, but it is necessary to say that all participants were from a limited group of employees from the two organizations under research. During the matching process, it was exclusively considered from which organizations the participants came. In VR, each participant was represented as a virtual human avatar so that participants could follow each other's movements and actions. In addition, communication between participants was enabled through the HMD via voice-over-IP. The entire assembly process in VR was performed collaboratively by two people at a time. Before the experiment, each participant was asked individually about their prior knowledge and experience with the process. Exemplary questions were: "What experience do you have with cranes in general?" and "Have you ever participated in a crane assembly?". This was followed by the experiment in which the participants had to perform an assembly in the multi-user mode of a VR industrial environment (Figure 7.1).

Figure 7.1 Screenshot of the Experiment

After the collaborative VR experiment, which lasted an average of 60 minutes, each participant was interviewed individually. For this, we used questions such as "To what extent did you experience the process of assembling the crane?", "What role can VR play in your daily work in the future?" and "What is the relationship between real assembly and assembly in VR?". For this purpose, we used a semi-structured guide with open-ended questions [24]. This allowed for the widest possible range of responses and allowed participants to speak freely about their experiences. Furthermore, Sarker's guide to qualitative research was applied [25]. This means that the first version of the questionnaire was evaluated after one experiment. Minor adjustments were then made to the questionnaire based on this evaluation. After a total of twelve interviews, we concluded that there were few opportunities for new insights in this area.

MAXQDA software was used to analyze the interview data. An open coding method was used to analyze the qualitative data. Ultimately, the coding methods included open coding, axial coding, and selective coding [26]. In the first step, two researchers independently open coded the data. This was followed by axial coding, in which individual findings were compared and grouped to identify relevant aspects of the research [27]. The axial codes found were then grouped by themes. In the event of disagreement between researchers, a researcher who was not involved in the coding process was brought in for discussion and a common axial code was determined.

7.4 Findings

Overall, the interviews showed that there is a high level of motivation for strategic alignment along the value chain on both organizational sides. Participants of the manufacturer organization were asked about their prior knowledge of the simulated service processes. The basic assumption here was that they had little prior practical experience with actual service processes. This research was able to confirm in all interviews with participants from the manufacturer organization that there is only a rudimentary understanding of service processes (assembly and maintenance) on their products. Many do have individual steps in mind or a rough idea of the service processes. Especially when it comes to challenges during the service processes, they lack a detailed idea of the processes to be able to consider them prospectively in their crane design. In order to establish a **strategic alignment** between the two organizations, the participants therefore see potential in the use of VR for their work.

> *I have no idea how to assemble a crane, just a rudimentary basic understanding, but I don't have all the steps in my head and certainly not what the components look like and what sequence to follow. Interview 4-2*

> *I can imagine that you get more of a feel for the assembly process and how it all works so that you simply experience it properly again. Most of our design engineers haven't been on an assembly line for ages or so. So, you just get to see it all again. Interview 1-1*

Participants described that the VR simulation created an awareness of service processes for them. Even though the VR simulation was simplified in some places compared to reality and the waiting times (e.g., when the mortar had to dry) were shortened, they were aware that reality is different. The VR simulation made use of alternative solutions, e.g., to represent heavy loads or a long waiting time. The participants perceived this and, despite the simplified representation, understood the actual challenges that can arise during a service process in reality. By simplifying the mapping of individual work processes (such as fastening the composite anchor plate), it was achieved that the user does not get bored during the VR scenario, which, among other things, should ensure the sustainable integration and use of the VR. In VR development, the simplified representation and use of alternative design solutions (e.g., gravity glove) have the advantage that a more lightweight solution makes development and adaptation more efficient in the context of **resource management**. Many scenarios can be mapped in VR without having to re-adapt the basic functions and design solutions (e.g., bridging waiting times and displaying heavy loads) without compromising the quality of the mapped VR scenarios.

Yes, I thought it was good, because I personally have never been to an assembly […] and I think something like that helps to understand it better. Apart from the time frame, how long something like that takes. But otherwise, the individual steps, already help you to have a better understanding of it. Interview 3-2

For me, clearly, I have no idea how to build a crane, even though I've already done it a few times. But I don't have all the steps in my head, and I certainly don't know what the components are called and where they belong. Interview 4-2

As part of **risk management**, it must also be ensured that no risk is created by the simplified representation of service processes in the VR scenarios. This could, for example, be that the employees of the manufacturer organization get a simplified picture of the service processes. In the interviews, however, it became clear that despite the simplified representation in VR, the participants are aware that the service processes in reality take much longer and that the conditions at the service side of the crane can vary and, therefore, are constantly associated with new challenges.

So, when I also think about the fact that they don't have such a cool glove, then I see the whole thing quite differently. So, it's still simplified. I noticed that there are a lot of steps. It's really subdivided into individual steps, but we only ever screwed in one screw, for example. These are things where I think to myself, what I've done now was already a lot, but they really have to do it again in duplicate and triplicate and also have to wait until this mortar has dried and so on. In any case, I now have more understanding of what they do and how they do it, and especially for the fact that it is a bit more complex than that. Interview 1-2

There are of course things that only occur in reality. When the colleague is drilling the hole on the composite anchor plate. Then he notices when he is drilling, when he is exerting force, he notices when he somehow encounters a flaw, when he encounters any cavities, and so on. This is very, very important, because if someone encounters a cavity, he cannot place the crane there. Interview 5-1

When asked if the simulation of service processes in VR could be profitable or helpful for their daily work, whether from a service or manufacturer perspective, the participants responded with great hope for the technology. Possible areas of application and ways to potentially improve existing service and design processes were addressed. Overall, regarding the **value delivery** of the VR solution, e.g., the simplicity associated with using VR for evaluation purposes during design work was described. VR use was compared with the traditional process, where only after completion (or in the case of innovations by building a prototype) it is possible to experience the design in realistic proportions in the hall environment.

> *I expect from VR that I can simply check things in VR during construction. That's not possible now, because it is finished at some point and then produced, and then you assemble it once in reality. In VR, you can just look at how these two parts can be put together. That is much easier to understand in the design. Of course, you notice things like that when you're building a prototype, and then you're guaranteed to change something about it, because then you notice things when you're assembling it. But with VR, it would be possible to try these things out quickly and flexibly in advance. Interview 1-1*

> *When colleagues from the manufacturer see our processes, this can be used positively in many ways. Firstly, of course, in development, you can look at a few things as a developer to see: Okay, the process is like this now. I need to do this and that, but if I design it differently, then I get better at it or realize it's the wrong sequence. On the other hand, if you're sitting in an office somewhere and you don't have a lot to do with assembly, I think you can get a lot of understanding of what we're doing. Interview 4-1*

> *As a designer, you construct something and sometimes you get a fright when you come down to the hall and see the things, that happens often. Interview 1-1*

Participants additionally mentioned added value in the process of onboarding new service employees. The VR demonstrator can be used to familiarize with the assembly and maintenance process in a safe room, either alone or together with experienced service employees in a multiuser mode. Mistakes can be made, and alternative ways can be tested without incurring costs for the organization. New service employees gain initial insights into the service processes and are made aware of frequently occurring challenges before they perform on the first proper maintenance or assembly. They can evaluate their work reflectively in the VR environment which provides them an expanded view of challenges occurring on the job. Accordingly, they are already familiar with some challenges and know what to pay attention to.

> *I think it would certainly be interesting for a manufacturer employee to experience the service processes, especially if there are innovations that can easily be experienced in VR. It would also be a good way for my new service colleagues to learn about the*

processes. It would also be interesting for the design engineer or the salesman. Interview 4-1

In general. So, I think that would certainly be interesting for a service technician, especially if there are any innovations and you would implement them there, or just for learning, that would certainly also be a nice thing. Interview 4-2

For organizations, the key is how performance can ultimately be measured using VR. Two key perspectives can be used for **performance measurement**: First, the use of the VR application in crane design must add value, and second, service processes must improve sustainably. Some interviews showed that the crane designers on the side of the manufacturer organization not only see potential in the use but can well imagine the use of VR technology as part of their design work and especially as an enlargement of the perspective on downstream service processes. It can help them consider service process challenges extensively during the design process, which subsequently results in more efficient crane assembly and maintenance processes. On the service side, performance measurements are also mentioned concerning assembly and maintenance processes. The service employees are made aware of possible challenges through the VR simulation and are provided with a space for learning. The use of VR in multiuser mode also enables a direct exchange between design engineers and service employees. They have the opportunity to view crane designs together and talk about possible challenges. Likewise, alternative design solutions can be discussed through input from the service side and trial assembly can be carried out

[...] you will probably have a different understanding of it if you only see it on a CAD drawing than if you are standing directly in front of one or have at least seen it in VR. And this then continues via training, via simple understanding among employees, I believe, because it is always interesting to get a taste of someone else's working world and then you have the parts where it is really interlocked, i.e. assuming there is something that is difficult for maintenance and you can then communicate and say 'Okay, for the next edition of the crane, maybe we'll move the fuse box to the other side so that you can get to it better. Interview 6-2

I can imagine getting into VR with the service employee and taking a look at the whole thing. [...] And then you can simply explain some of the details to them or they can try things out where they might have doubts in advance and could dispel those doubts or you could simply show them with the installer, that's how I imagined it, he's trying it *out in VR right now and can say, yes, I can imagine it like that or no, I can't imagine it like that. Interview 1-1*

The following table summarizes the five dimensions identified as requirements for the successful implementation of VR assembly and maintenance processes.

Dimensions	**Example in VR**
Strategic Alignment	A common objective to optimize the hybrid value chain through VR simulation must be in place.
Resource Management	The investment in VR, on the one hand, the development of the software, on the other hand, the time then to be spent in VR, must contribute to optimization.
Risk Management	Processes and associated risks must be mapped transparently through VR, including the associated risk of oversimplification in VR.
Value Delivery	The VR simulation must promise added value for the organization or the hybrid value chain.
Performance Measurement	The VR simulation must be followed by a measurable optimization of the real work processes.

Table 7.3 IT Governance Requirements for Crane Assembly and Service Processes in VR

7.5 Discussion

The influence of hybrid value chains on the business activities of German organizations could be underlined in this research [1]. The application example addressed in this paper offers a way to see how hybrid value creation can be understood and used as an innovation strategy [10]. In this context, VR simulations to cope with the complexity of our processes have been identified as a proven option [7]. The use of VR thus provides a strategy for a complete view of hybrid products.

To answer our RQ (What organizational requirements do crane assembly and service processes need to perform in VR simulations?) we enriched the IT governance requirements identified in the literature (strategic alignment, resource management, risk management, value delivery, and performance measurement) with examples related to VR crane assembly and service processes [17, 18]. The examples given (Table 2) could be derived from the interview results and thus provide direct insight from experiments conducted in the organizational practice. The aim was to provide a strategic approach for organizations that are connected via a value chain to consider as prerequisites for a successful integration and sustainable use of VR technology. A particularly fundamental prerequisite is the common strategic objective of the organizations. An important element is the concretization of VR technology as a commonly used IT artifact, which is seen on both sides as suitable and useful for promoting strategic alignment along the value chain [19, 20]. In both organizations, it is therefore fundamentally important that there is a consensus on the objectives of the use of VR technology and why these objectives create a common added value (value delivery) for the organizations along the value chain. Efficient management of resources relates to both the development of the VR simulation and the time that employees ultimately spend in VR. The task for IT governance is to define and specify both in terms of the agreed objectives.

The interviews also identified risks (risk management) associated with the VR simulation. However, these can be minimized by presenting them transparently at the beginning in order to take them sufficiently into account during development and integration. In practice, this means that the priorities of both organizations must be adequately considered, discussed, and prioritized for the design of the VR simulation [7, 21]. VR simulation for the representation of crane assembly and service processes means to a certain degree always visualizing an abstraction of reality. This simultaneously creates the risk of simplification by the user. So, when employees of the manufacturing organization experience the service processes in VR, they have to be aware that the VR simulation is an abstraction and simplification of reality (unrealistic assembly times, simplified representation for lifting heavy weights, etc.). Therefore, it is important for the users to be aware of the actual aim of the VR use, so that there arise no false assumptions about the work of the service employees.

7.6 Limitations and Outlook

This research provides interesting qualitative results in the field of IT governance research related to VR. However, this research has its limitations. Other aspects will also have an impact on IT governance concerning hybrid value chains. However, the objective of this research was to develop an approach that can be easily applied in practice.

The strengths of this research are the identification of IT governance examples related to VR that are reflected in the strategic alignment of organizations in a hybrid value chain. These findings are of interest to practitioners and researchers alike. As with any qualitative evaluation, the interviews give us a sense of the facts and allow us to develop theory. The relationship between IT governance, in terms of the five constructs, and VR support could be demonstrated. In theory, virtual realities provide the opportunity to not only view processes in perspective but also to execute them virtually. The adaptation of value creation across organizational boundaries was not considered in detail in this context, but promising starting points were identified.

7.7 Acknowledgement

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8 CEOs of SMEs (P3)

Paper Number	**P3**
Title	**CEOs of SMEs: How IT-Governance compensates the Lack of Digital Competencies**
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Table 8.1 Fact Sheet Publication

CEOs of SMEs: How IT-Governance compensates the Lack of Digital Competencies

Abstract. The literature assumes that the small and medium-sized enterprises enterprise (SMEs) depends on the (digital) skills of the chief executive officer (CEO). In this paper, we examine the influence of CEOs competencies regarding digital transformation of SMEs and show, based on explorative research, which competencies of CEOs are necessary for a successful digital transformation. We conducted five IT ex-pert interviews within the framework of the study to examine these influences. Subsequently, 20 CEOs of different SMEs were interviewed to discover their (digital) skills. The interview data showed that not only competencies are responsible for a successful digital transformation, but that the organization's Information Technology (IT)-Governance makes a significant difference. The interviews show that IT-Governance decisions are closely linked to the competencies of the CEOs. Based on the implicit and explicit competencies, interesting insights into the structuring behavior of the CEOs were gained. Especially for CEOs with a good digital competence profile, some pitfalls became visible, which can only be avoided by IT-Governance measures. Access to IT knowledge became another decisive factor. Based on our findings, we propose IT-Governance strategies depending on CEOs competencies. This enables to implement IT-Governance structures which best suits CEOs individual level of competencies, giving insights of potential behavioral structures.

Keywords: Digital Competencies, IT-Governance, Exploratory Research, SMEs.

8.1 Introduction

Digital transformation dominates current discussions on the future direction of companies (Bilgeri et al., 2017; Riasanow, Galic and Böhm, 2017). Due to external pressure from competitors, customers, or suppliers, well-established companies are obliged to digitize their processes and products. From this obligation, multiple challenges arise for the governance of companies, for instance: Who decides on how established processes and products are to be digitized? Who decides on the prioritization of digital transformation projects? How can the necessary digital competencies be obtained?

Especially for SMEs with more limited resources compared to large companies, these challenges are hard to face (Chen et al., 2016; Li et al., 2018). SMEs need to find a compatible way of digital transformation, in contrast to start-ups created by digital technologies. The digital transformation (Mergel et al., 2019) of these SMEs depends on the (digital) competencies of the CEO (Wilkin et al., 2016).

Traditionally, the governance structures of SMEs are more strongly oriented towards the CEO than those of large companies. The CEO gets involved in various activities regarding the organizations business units, processes, and products. Consequently, investments in the digital infrastructure of SMEs require decisions by the CEO. Here, the question arises on how decisions on the digital transformation of SMEs are made if the CEO has a low level of digital competencies.

It can be assumed that deficits in the digital competencies of CEOs can be compensated for by suitable IT-Governance structures. IT-Governance deals with the direction of IT-related decisions, actions and involves determining which individuals make IT-related decisions (Huang, Zmud and Price, 2010). It is therefore a task of the CEO to develop governance structures which, on the one hand, strengthen the CEO’s authority to make IT-related decisions if they are competent to do so or, on the other hand, shift the authority towards individuals with higher digital competence who can make better decisions.

Yet, there is little research on the relation between the digital competencies of the CEO and suitable IT-Governance. So far, research has identified several governance structures that have an impact on an organization's digital transformation. For example, the relationship between IT-Governance and organ-ization performance from different perspectives, such as strategic alignment, IT leadership, IT capability and process performance, resource relatedness, and culture (Vejseli and Rossmann, 2017). Board-level IT-Governance, for instance, positively influences organizational performance; however, this relation is negatively moderated by authoritarian governance style (Turel et al., 2017). Although the CEO plays an essential role for the digital transformation of SMEs, the focus of studies on IT-Governance and leadership lies on the chief information officer (CIO) (Vejseli and Rossmann, 2017).

Further studies dealing with competencies in enterprises focus on the organizational level under the term "skills of information systems" (Aydiner et al., 2019). Although such studies provide valuable insights into the importance of digital competencies for the organizational performance, they do not provide any indication about the importance of the digital competencies of the CEO. Accordingly, the goal of this study is to identify relevant digital competencies of CEOs for the digital transformation of SMEs and to derive appropriate IT-

Governance measures dependent on the CEO's existing or missing digital competencies. Hence, we propose the following research questions (RQs) guiding our research:

RQ1: Which digital competencies do CEOs of SMEs need for the successful digital transformation of their organization?

RQ2: Which governance structures support existing digital competencies or compensate for missing digital competencies of CEOs of SMEs?

The study presented in this article is part of a research project to explore and identify competencies among executives in SMEs in the digital age. The study is intended to exhibit possibilities for competence development in connection with the digital transformation of SMEs. SMEs are of great importance for the German economy. SMEs have often been established in the market for several decades, as our data show. As a result, SMEs have experienced a technical "revolution" or two since they were founded, which, for instance, led to the decline of mining in large parts of Germany or the emergence of IT in general. Digital transformation is another, but much faster, development, for which companies are looking for solutions and best practices.

Given its explorative nature, our study uses an exploratory research approach. In doing so, we first use the literature on IT competence and IT-Governance, particularly regarding organization leaders, to get a first insight into the subject. Based on this and five expert interviews, we develop a semi-structured interview guideline and interviewed 20 CEOs of SMEs. Our findings show that missing digital competencies of CEOs can be compensated by suitable IT-Governance measures. Subsequently, we discuss our findings by deriving practical and theoretical implications. We conclude by stating limitations of our study and recommendations for future research.

8.2 Related Work

8.2.1 Digital Competencies of Business CEOs and Leadership

IT competencies of business CEOs are defined as explicit and implicit (tacit) IT knowledge, whereby "explicit knowledge is the formal knowledge that can be clearly transmitted using systematic language" (Bassellier et al., 2001, p. 164) and tacit knowledge is the "ability to perform well" (Bassellier et al., 2001, p. 164). Explicit knowledge comprises five components: technology, applications, system development, management of IT, and access to IT knowledge, whereas tacit knowledge covers the manager's experience and cognition (Bassellier et al., 2001). Based on the concept of CEOs' IT competence, it has been shown to have a strong influence on the CEOs' intentions to promote IT in their organization (Bassellier et al., 2003) as well as on the success of IT projects (Engelbrecht et al., 2017). Especially knowledge on applications has been shown to be a major success factor.

From a broader perspective, several studies demonstrate the importance of good leadership for the digital transformation of companies. Digital transformation, for instance, requires CEOs to be actively involved in planning, experiencing, leading, engaging, and establishing an appropriate organization culture (Kohli and Melville, 2019; Mergel et al., 2019; Pillay et al., 2012; Wiesböck, 2019; Yoo et al., 2010a, 2010b). At the same time, the digital transformation of companies changes good leadership. Digital transformation, as defined by Mergel et al. (2019), is expected to increase transparency and complexity or to remove hierarchies and to enable and enhance features of transformational leadership. Transformational leaders "attempt and succeed in raising colleagues, subordinates, followers, clients, or constituencies to greater awareness about the issues of consequence. This heightening of awareness requires a leader with vision, self-confidence, and inner strength to argue successfully what he sees is right or good […]" (Bass 1985, p. 17). Transformational leadership positively influences leader-member exchange (Wang, 2005). Although these studies deal with good leadership and the competencies of organization leaders regarding IT and digital transformation, the connection between the digital competencies of individual organization leaders and suitable IT-Governance measures is still missing.

8.2.2 IT-Governance

IT-Governance defines "the enterprise management system through an organization's portfolio of IT systems is directed and controlled" (Peterson, 2004, p. 8) and deals with the centralization and decentralization of management decisions on business applications, IT architecture, and technology components, whereby in centralized structures and senior-level executives have decision-making authority for IT investments (Peterson 2004). Centralization "leads to greater specialization, economies of scale, consistency, and standardized controls, whereas decentralization enables business control, a sense of business ownership, and provides greater responsiveness and flexibility to business needs" (Peterson 2004, p. 10). Small as well as large organizations see strategic alignment of business and IT, clarity of ac-countability and of responsibility, and improved stakeholder engagement as key benefits of IT-Governance (Wilkin et al., 2016). This finding is reflected by empirical findings that show that IT-Governance mechanisms, including decision making structures, formal processes and communication approaches, positively influence organizational performance. This relationship is mediated by IS strategic alignment (Wu et al., 2015). However, not only alignment but especially strategic IT agility leads to high competitiveness, which means "consistently using IT to strategically outdistance rivals, who are constantly playing second fiddle" (Tiwana and Kim 2015, p. 656). Here, IT-Governance enhances IT strategic agility only when it is discriminatingly aligned with departments' peripheral knowledge, which is the department's knowledge in the other's domain but outside its own (Tiwana and Kim, 2015). IT government success, which includes top management commitment, increases the strategic controllability of IT which, in turn, contributes to IT effectiveness and business impact (Buchwald et al., 2014).

There are different ways to implement effective IT-Governance. For example, it is recommended to implement governance led by a board of directors to achieve organisational performance improvements but to avoid an authoritarian style as it is detrimental to performance (Turel et al., 2017). A study with an explicit focus on SMEs argues that formal IT steering committees, composed of executives who have a consensus on their standards and values, positively influence the effectiveness of IT-Governance (Huang et al., 2010). Senior leadership is suggested to be an essential factor for successful IT-Governance (Weill and Ross, 2004; Liang et al., 2011). Top CEOs have great influence on the effectiveness of IT in the organization and are recommended to actively exhibit supportive actions to ensure that strategic visions are internalized, to adapt their level and content of support to fit what is needed, and to demonstrate the importance of ensuring their visibility throughout the entire IS implementation process (Dong, Neufeld and Higgins, 2009). Moreover, social capital or social alignment between business and IT has been identified as mediator between IT-Governance and business performance (Wagner et al., 2014; Schlosser et al., 2015). For example, this is confirmed by a study on the effects of leader-member exchange, which recommends positive relationships between leaders and their followers, on the performance of virtual teams (Goh et al., 2012).

Since IT-Governance deals with the question about who makes IT-related decisions, competencies play a major role. IT-Governance "is less about who is vertically positioned to be in control, and more about the complementary - business and IT - competencies an organization possesses, and how it can integrate these to develop the strategic flexibility required for realizing and sustaining business value from IT in a complex and dynamic environment" (Peterson 2004, p. 20). Studies on IT-Governance and leadership emphasize the important role of the CIO or chief digital officer, since the CIO is assumed to have the highest competence on IT and is responsible for the digital transformation of an organization. CIOs are expected to be visionary, to have leadership, strategic, and analytical skills, to be competent in the organizational business domain and business models, and to have general knowledge about technologies and their impact (Tahvanainen and Luoma, 2018). A high social capital between the CIO and top CEOs is expected to have positive effects on organization performance (Karahanna and Preston, 2013). Here, the CIOs' understanding of their CEO plays a more pivotal role in predicting the quality of CEO–CIO collaboration than CEOs' understanding of their CIO (Benlian and Haffke, 2016). The CEO is an important factor in the digital transformation of SMEs, the identification of suitable IT-Governance structures dependent on the digital competencies of the CEO remains an open task.

8.3 Methodological Approach

8.3.1 Research Design

This research takes an explorative approach to understand what digital competencies CEOs need to deal with digital transformation processes. In a supportive way, this study examines the structures prevailing in the organization to identify possible correlations. Based on the explorative nature of this study, we have used tools from the coding methodology of Grounded Theory (Glaser and Strauss, 1967; Gioia and Chittipeddi, 1991; Urquhart et al., 2010; Gioia et al., 2013), which are explained below.

In order to determine the series of relevant interview questions to answer our research questions, we have chosen a multi-level research approach. (1) In the first exploratory phase, we conducted five expert interviews with proven experts from the fields of technical development and IT consulting. These were not CEOs of SMEs. Each of these experts has a minimum experience of 10 years in IT, digitization, digitalization or digital transformation (Mergel et al., 2019) topics. We had an open discussion about the research questions and the experiences in this area so far. This exchange resulted in an open interview guide that enabled us to address the research questions as precisely as possible. (2) After we had created the interview guideline, we conducted a two-stage interview series. In a subsequent pre-test phase, we conducted 5 interviews with CEOs of SMEs based on the guideline. In this way, we were able to test the interview guide. After these interviews, we were able to further optimize the guidelines accordingly. (3) The last step of our research comprised interviews with 15 CEOs of SMEs based on the guideline. In order to categorize the companies, we collected the structural data of the companies such as employees, fluctuation, age of the organization, age of the interviewee, and gender. In addition, all respondents had to evaluate their organization regarding digitization, digitalization and digital transformation in comparison to their competitors in their respective industries.

8.3.2 Data Collection and Analysis

We conducted a total of 20 interviews (16 men, 4 women) along the interview guideline. The participants were the CEOs of various owner-managed German SMEs. For this purpose, the regionally and nationally known companies were contacted. Of 64 contacted companies, 20 allowed us to interview them. This study concerns SMEs, as these organizations are particularly affected by the digital transformation. A start-up, for example, starts with all digital possibilities, and a large organization has the means and the personnel to successfully implement its own digitisation efforts. In contrast, the SMEs surveyed have been in the market for 96 years on average. Due to their special structures, such as the limited number of employees, employee retention in SMEs, and the connection to organization tradition, these companies face a special challenge in the digital transformation. Among them were organizations from the fields of industry, trade, and services. An overview of the respondents is given in Table 8.2.

No.	Age	Gender	Educational background	Sector	Organization age
1	49	M	Mechanical engineering (M. Sc.)	Industry	45
2	48	F	Business administration (M. Sc.)	Industry	25
3	47	M	Master craftsman	Trade / Craft	100
4	58	M	Nurse	Service	13
5	46	M	Business administration (M. Sc.)	Trade / Craft	71
6	51	F	Mathematics (M. Sc.)	Service	275
7	59	M	Retail salesman	Service	13
8	55	M	Engineering (M. Sc.)	Service	30

No.	Age	Gender	Educational background	Sector	Organization age
9	50	F	Certified Pedagogy (M. Sc.)	Service	123
10	41	M	Insurance salesman	Service	18
11	43	M	Business administration (M. Sc.)	Service	7
12	51	M	Business administration (M. Sc.)	Industry	215
13	64	F	Business administration (M. Sc.)	Trade / Craft	97
14	45	M	Industrial engineering (M. Sc.)	Industry	70
15	50	M	Computer Science (M. Sc.)	Service	34
16	37	M	Industrial engineering (M. Sc.)	Industry	29
17	62	M	Metallurgy (M. Sc.)	Industry	102
18	45	M	Business economist (M. Sc.)	Trade / Craft	69
19	68	M	Industrial engineering (M. Sc.)	Industry	560
20	40	M	Business administration (M. Sc.)	Industry	24

Table 8.2 Overview of Interviewees

We carried out a two-stage approach. First, we conducted five semi-structured interviews. We took up open questions such as "How do you assess the importance of digital transformation for your organization" or "Is it part of your role as a manager to drive digital transformation forward by yourself?”

We have analyzed the data based on the Grounded Theory approach. First, we started with the Open Coding process (Glaser and Strauss 1967; Strauss and Corbin 1990) by using the MAXQDA software. Two of the researchers implemented the open coding procedure independently from each other. They have read the transcribed interviews and proposed code phrases that represent the content. Subsequently, similar codes were collected from the interviews and defined a common code, the axial coding. In our coding paradigm, the explicit IT competencies of the CEOs and their experience in the IT area could be assigned to the causal conditions, as well as access to internal and external expertise. The strategies and attitudes of the CEOs were assigned to the action strategies, the IT governance characteristics to the consequences. The coding paradigm for the type "weaker structured corporate relationships" is presented below as an example. Subsequently, the axial codes were bundled according to subject areas, which can be found in the results section of the table. Differences of opinion were discussed with a third researcher and settled by agreement.

We ended this process after all researchers agreed that there was a low probability that significant new insights could be generated by additional interviews, since our data at this stage already included important aspects about the digital competencies and governance structures. Finally, it was a matter of identifying similar and different competence profiles and IT-Governance structures in order to summarize them in types. We found that the distribution of competencies within the organization is one of the most important factors in distinguishing between the different governance structures. It was helpful to first deal with outstanding cases. For the findings, we attempted to describe the various sets of IT-Governance structures. In the process of typing the various phenomena, we have identified the types of structuring. Structures and their nature create different relations, connections and relationships, through which the digital transformation in the organization is formed. Especially in small and medium-sized companies, these structures are shaped to a large extent by the CEO and influenced by his or her skills, as he or she assigns corresponding roles and functions and forges alliances. These structures are based on the concept of a horizontal and vertical organisational structure, which is concerned with the distribution of responsibilities and the design of action relationships. Additionally, if they are strongly structured, they are less flexible and adaptable, as they are already top-down, abstract and difficult to accept at the local level. Weak structures are more ad hoc and in the situation. Both times, the aim is to translate the corporate strategy into roles and interests in order to align them together. For the actors, the question is: Who are we and what should we do? If this question can no longer be answered clearly and with consensus, the organization becomes dysfunctional (Jacobides, 2007). The challenge is to keep the structure constant and at the same time flexible.

8.4 Findings

8.4.1 Overview

The interview data shows us that we can group the interviews. First, the continuum of the CEO's explicit IT competence (IT-C). Secondly, the continuum of the CEO's practical IT experience (IT-E). It should also be noted that access to further IT knowledge distinguishes the cases under consideration (IT-K). Based on this data, the selected IT governance structures (IT-GS) were examined and defined in more detail. The following table provides an overview of these; more detailed statements follow below.

CEO		Organization		Explanation / Definition	No.
IT-C	IT-E	IT-K	IT-GS		
Low	No	Internal	Weaker structured corporate relationships	These CEOs do not see their role as a digital actor, but as a driving force in digital transformation. With these impulses, the respective experts have a high degree of personal responsibility. It is therefore essential to avoid hierarchic structures, but rather to create network structures.	*6, 7, 12, 14, 15*
Low	No	External	Learning structures	Especially the smallest companies can be confronted with the problem that neither the CEO nor an employee has a high level of IT knowledge. Here it is necessary to fall back on external knowledge. However, one should use this knowledge to build up one's own knowledge in these areas.	*1, 10, 17*
Medium	No	Internal	Structures of trust between business manager and IT	If the CEO recognizes a value of digital transformation for his organization, but is not an expert himself, it is advisable to build up a strong trust structure to internal experts. The potential changes of digital transformation can be very profound.	*9, 13*
Medium	Yes	Internal / External	Structures of nearness, adaptations and mediators	The CEOs know from their experience how to develop their employees in a targeted way and how to guide them through the digital transformation. Digitization is understood holistically, and digital transformation can lead to changes in the organization. The CEO is more likely to act as a mediator.	*4, 8, 20, 18*
Medium	Yes	No	Strong structures of distance and resistances	The CEOs act as "lone fighters" in the field of digital transformation of SMEs. The companies are characterized by strongly hierarchic structures. The employees are at most involved in operational activities.	*2, 16*
High	Yes	Internal	Everyone has to adapt	A field of tension can arise if the CEO and the CIO each have very high IT competencies. Here it is recommended that CEOs can adapt and that the focus is on networked, cooperative structures.	*3, 5, 11, 19*

Table 8.3 Overview of Discovered IT Competencies and the Associated IT-Governance Types with Characterization

8.4.2 Digital Competencies of CEOs of SMEs

Evaluation of their competitive position. 19 respondents stated that their own organization was at least average in terms of digital transformation in comparison to the competition in their sector. 12 of the respondents said that their rating was even better than the industry average.

Only one respondent said that his organization was currently lagging behind the average of its competitors, but that he was confident that this would change soon due to current efforts.

Low IT competence was particularly noticeable when the respondents used the organization's IT but did not understand the structure and essential background of these systems. The following interview extracts illustrate the lack of detailed knowledge:

> *"I can only give impulses. Stimulating and stimulating the thought, because I am not an IT specialist myself. I also don't want to lay power lines at home." - 7*

> *"[...] I can only use Google, I'm not involved in day-to-day business, no matter if it's a phone line, Microsoft Office or licenses, I'm just not in business..." -16*

High level of IT competence we attributed to participants with detailed knowledge of the programming languages and methods used in software development.

> *"I'm scrum master and product owner myself [...]." - 5*

> *"with Navision which is based on HTML5, the customer service can then complete their order with the iPad at the customer's site." - 15*

However, most executives did not believe that explicit IT competence was important for them. Of the 19 participants who felt well positioned in the digital transformation, only two had explicit IT skills. We concluded that the explicit IT skills of CEOs are not decisive for the success of digital transformation. More important, however, is knowledge of the fundamental interaction between hardware and software.

Most respondents were concerned with interrelationships, dependencies and interfaces between enterprise systems or between software and the Internet. The CEOs were less interested in how the interfaces could be provided technically than in error-free and secure communication.

> *"If the Internet fails, it means standstill." - 12*

> *"Of course, I don't always understand everything technical, but I must have so much experience in linking these things." - 20*

Experience with IT projects and IT management reflects the manager's practical, local experience at the implementation level. This point is important because many CEOs tend to stay out of implementation issues. Their role in the projects varies greatly. The roles range from controllers and consultants to project CEOs and even employees.

> *"I'm the only one giving ideas, sometimes my brother together with me. We are the ones who often give the impulse. Then I am basically active in project management up to a certain point, but not down to the last detail". - 2*

> *" I am less involved, this is usually done by one of our employees and my son has made himself very strong, especially in working with a start-up organization and the various companies that are still working there. [...] Because alone we are certainly not sufficiently trained and do not have enough knowledge." - 19*

The implicit knowledge also includes the vision that the manager imagines of digital transformation. The CEOs' ambitions differed greatly from one another. Some of them talked about digital transfor-mation processes, while others were talking about the next update of their ERP system.

> *"A vision, a little yes, I'm already worried about the next development, e.g. the ERP system needs a release change, which is now overdue" - 16*

Access to external IT knowledge becomes critical to CEOs' competence preferences. Frequently, this advice is provided by service providers or research institutions, which can affect projects or strategies as well as parts of the organization or the entire organization.

> *"We were advised by a research institute and there were workshops in which we turned ideas into concrete concepts." - 1*

> *"The external consultants advised us so that we talked to them every few weeks and they gave us orientation and help." - 16*

Access to internal IT knowledge is guaranteed by the qualification of the organization's own personnel. This is done through training or autodidactic. Nevertheless, both CEOs and employees are dependent on internal and external impulses. In this context, the willingness for lifelong learning as well as open-mindedness and self-criticism were placed in the foreground by the interviewees.

> *"It is important to take your employees with you as far as possible and offer appropriate training opportunities. My experience is that if you do it well, people are willing to participate." - 8*

> *"Through internal training and external training and to the point that we also work with other companies and exchange with external professionals." - 10*

In addition to these explicit competencies, implicit IT competencies were also surveyed. These are personal experiences and points of contact with the topic of digital transformation that cannot be articulated directly but have an impact on the strategic view of the CEOs.

8.4.3 Supporting IT-Governance Structures

Current IT research expects that IT-competent CEOs are willing to manage IT, enter into a partnership with IT experts and participate in IT projects. In our study, we follow the CEOs and their IT competencies to find out how they define themselves and other actors, how they connect and interact with each other and what scope for action they allow themselves and others in their companies. The first step is to determine which competencies and which distribution of competencies in the organization goes hand in hand with which structures. They take on different roles and construct them for others, connect them with each other and mobilize them. The roles the leader assigns and the connections they try to establish depend on the knowledge and understanding of digital transformation that the CEO has.

Strong Structures of Distance and Resistances: Experience with IT projects, IT management and no access to internal IT knowledge. Structures become visible when there are disturbances. If the objectives of the actors do not coincide with those of the actors in the organization, or if the manager no longer represents the actors, resistance arises. Resistance blocks the executive's goals, making it very difficult for CEOs to realize projects. Two respondents with a lot of project experience and less experience in cooperation and partnership are confronted with such resistance:

> *“This stupid planning machine my locksmiths get to run in a week, but this new IT process has given us sleepless nights. So, it was really exhausting. It is resistance, excessive demands, a very important topic. The employees often feel extremely overwhelmed.” - 2*

> *“I'm worried about the jump. Our ERP needs a release change that is overdue. [...]It took an extremely long time until we were ready, and if we now do a complete release update again, it costs money and time again and the employees are confused. [...] The older the people are, the more difficult it becomes.” - 16*

What structure have these two respondents established? Both managing partners have structured their companies into departments as a structure of distance, some of which are staffed by siblings. All IT decisions are made by the CEOs themselves and they have a lot of room to maneuver.

> *"I decide. Both in the selection of the software and in the planning of the processes within the IT changeover, because I have an overview. This is the part that I also cover in our organization, to say I know how the processes run, I know the different IT systems in the organization and can decide best which process has an effect at which point." - 2*

A medium understanding of IT is enough for them to make IT-related decisions. It is important for them to have an overview of the processes in the organization. By controlling IT projects, these CEOs have an overview of IT implementation processes. They have an overview about the level of implementation and the internal processes and believe that they no longer must worry about local perspectives. In the perception of the CEOs, nobody else in the organization understands IT apart from them. Like many of our respondents who experience an IT competence vacuum, executives do not trust IT staff:

> *"In retrospect, it wouldn't have been wrong for an internal employee who understood the entire system to support me. [...] I don't regret anything, but it would have been good if someone with IT expertise had been there." - 16*

> *"And one of the biggest problems is that IT serves the process. This means that the IT staff is often overwhelmed with a complete overview of the organization and does not understand at all which processes need to be tackled and how. [...] And that's a big problem." - 2*

Employee development is reduced to the bare minimum. IT contact persons are the executives them-selves. There are hardly any regular meetings in groups or arrangements. This reduces participation. There are neither structures that help to transfer the strategic understanding of the manager to the em-ployees, nor structures that integrate the local perspective of the employees into strategic considerations. Overall, these CEOs do not have access to external and internal sources of knowledge, which can impair the organization's ability to innovate and act in the long term. The CEOs in this group are relatively young, as is their organization.

Structures of Nearness, Adaptations and Mediators: Experience with IT projects, IT management and access to internal IT knowledge. There are also participants who go a different way with a lot of project experience, but more experience in cooperation and partnership.

> *“Many think "I'm introducing a new technique" and change the organization and then it fails, but it wasn't the technique. There are a lot of examples and projects of companies, also big known companies, that did something like that and failed, because nobody was willing to tackle the organization.” - 8*

In order to avoid resistance, it is important to create structures that involve employees and assign new roles to CEOs and employees.

> *“It is important to take existing employees with you as far as possible and to offer appropriate training opportunities. My experience is it works, if you do it well.” - 8*
>
> *“I'm trying to get people to stand behind it and support it.” - 20*

From this perspective, CEOs with project experience should exemplify new processes and working methods, collaborate and create closeness. In short, the manager must be one of them in small teams:

> *“We have no heights or distances here, otherwise we would not be successful. […] We have to be really open and close and do living by example, so we have to really show the others how to do it and set an example, otherwise you won't be successful.” - 8*

The strong hierarchy structure of the organization is similar, but there is a structural change that can undermine this structure. A possible solution, if the manager does not want to interact with the employees themselves, is to give some employees the role of a "mediator". In this case they are called "key users". They are characterized by a high ability to communicate. The key users are the contact persons for the employees so that they have an overview of the processes and interfaces in the organization. They meet each month for a key user meeting where projects and problems are discussed and prioritized together.

In companies that do not have an internal IT expert, the management works more closely with the mediators. The manager needs external expertise. In this case it is IT specialists and project CEOs as free-lancers. However, internal competencies are also being built up. The mediators are called influencers. They are supposed to teach employees how to enjoy IT and to convince them. The influencers are the extended arm of the managing director, who also sees himself as a motivator. Since the IT expertise is not available internally, the managing director sees his main talent in developing his employees:

> *“You have to imagine it this way, we don't have any professionals now, we have a freelancer who supports us a little bit, but my ability is that I can develop people quite well. […] I chose this colleague because he was interested and wanted to continue his education.” - 20*

Employees who are responsible for IT but do not have the expertise act as translators or as interfaces to external parties. They have a basic understanding of IT and good communication skills. In addition, every training course is made possible.

There are also cases where the management alone acts as mediator. These executives attribute them-selves little IT professional competence, but a high social competence.

> *“My competence lies more in introducing a program that we can pass on to our colleagues with enthusiasm and not as a burden or something. Above all, to take away the fear of it. I have the highest social competence that we have, so I have also developed the blind version, that calms down tremendously. Art is leadership in the truest sense of the word.” - 4*

Internally, there is no one with IT expertise. In decision-making processes, the management relies on the recommendations of the external IT specialist. Individual mediators are often used when the organization is decentralized, but a connection to the office still must be established. They are therefore ex-ternal mediators. These companies have either different locations or a branched organization. This would explain why these CEOs have mediators who represent them and increase their sphere of influence. The challenge of taking everyone along in the event of spatial or organisational separation is more pronounced here.

Everyone has to adapt. Connecting, Cooperative Structures: High level of IT competence and experience with IT projects and IT management. Another way to undermine strong hierarchies is to create a whole area as a mediator and translator for digital transformation. CEOs are made just as competent as employees and the structure for cooperation is transformed. Heads of department and employees all work together in an interdisciplinary manner, understand each other, trust each other and think holistically. Digital transformation staff also implement a guide concept in which employees act as multipliers. CEOs of these areas are often Chief Transformation Officers or Chief Digital Officers, equipped with a lot of IT expertise, but also with IT project experience. They coordinate cooperation, remove barriers, give impetus and implement participative forms of communication.

> *"We have introduced a social corporate network with the aim of connecting employees and creating the conditions for cooperation." - 5*

They introduce formats such as digital fitness programs, leadership programs, explanatory films, a digital transformation day, or a digital breakfast. They also integrate external experts so that everyone can learn something about digital transformation, regardless of their position. The CEOs here all have contact with public institutions or are one themselves. This could be the result of a tendency to anchor ideas in organizations rather than individuals.

Structures of Trust: A close relationship between business manager and IT. If the IT expert has a close relationship to the business manager and is also part of the management, a strong trust relationship develops. Then the alignment between business and IT is high:

> *"What is also important for me, because it is my son, i have more than a hundred percent trust. [...] I realize that it's not the case in many companies and that they are not so well positioned with IT decision-makers. I think we are very well positioned in this respect." - 13*

Here, decisions can be made centrally without leaving employees behind, because IT decision makers are in active contact with employees and CEOs have the opportunity to reflect on each other. Many top-down controlled companies with little internal competence want such a relationship of trust, which they cannot build up with IT professionals. It is striking that such relationships of trust lead to stronger co-operation with external partners. In this group the IT experts are all part of the family.

Weaker Structured Corporate Relationships: A high density of internal IT experts. Executives who work in an organization with a high density of IT experts or an IT staff unit have a clear under-standing of leadership:

> *"I think that's the leadership understanding we have today. Leading where the boss has all the ideas and knows all the designs and the customers and knows everyone, the times are over, so these one-man shows. Instead, today we lead transformational, we rely very strongly on the individual strengths of our colleagues and that is how I understand myself." - 15*

Decisions are increasingly made by the IT experts themselves, while CEOs accompany this process.

> *"IT has a duty to provide impetus" - 14*

> *"For this, people have the confidence and sit accordingly on the project and then they have to be able to decide." - 15*

The IT experts have a lot of room to maneuver and are on the move throughout the entire organization. In contrast to other companies, it is the task of the IT experts to coordinate their work with the specialist departments. Business CEOs ask questions, help shape goals, set requirements, translate ideas, ensure transparency and mediate between business units. IT as a topic of understanding becomes central, since here interdisciplinary cooperation is required. The hierarchies here are rather flat, but great importance is attached to creating living project and networking structures. If the hierarchies are too strong, digital transformation will be established as a synergetic working topic or interdisciplinary working group. The CEOs here have a stronger business focus than in other groups.

Learning Structures: Access to external IT knowledge. At the end of the day, those CEOs are left who do not bring any special skills with them - both personally and internally. Yet they do have a special competence. They are very open-minded and learn constantly. That is why they get external help not only with implementation issues, but also with strategy issues.

> *"We also received this confirmation because we were given a hand in the introduction of digital transformation by a research institute. They accompanied us through the process and said that we have made a good progress in the meantime because we have also implemented a great deal together with them." - 1*

This gives the business CEOs self-confidence and structure, which are things that they can transfer to their employees. They also give their employees responsibility, as they have learned from external consultants, even if they often remain the decision-makers. Here, too, comparatively young CEOs can be found in young companies.

8.5 Discussion

If we now look at the relations between the different types of structuring, some exciting relationships emerge. First of all, three superordinate structuring levels seem to emerge. On the weakly structured level there are "learning structures" and "weaker structured cooperative relationships". On the level of nearness are "structures of nearness, adaptations and mediators" and "structures of trust between business managers and IT". Strongly structured, on the other hand, are "everyone must adapt" and "strong structures of distance & resistances". The weak structures tend to be formed by CEOs who have neither explicit IT knowledge nor IT experience. At the near level, explicit IT knowledge is increasingly found, while IT experience predominates in strongly structured companies. In strongly structured companies, it is more common for both competencies to fall on the CEO. It is interesting to note, however, that at this level both the companies with the highest degree of digital transformation and the companies with the most deficits can be found. What could be the reason for this? Firstly, these two types differ in their excellence - these companies have the highest level of competence in both areas (everyone must adapt) and are so far advanced in their digital transformation. But there is another important point: the companies with the greatest challenges combine both competencies in their CEOs, but have neither internal nor external experts. In all types, the lack of internal experts tends to lead to CEOs deciding everything themselves, probably also because they feel they have to (also in the "learning structures" type). The companies that are furthest along have many internal experts - these companies are strongly geared towards cooperation and participation - all of them participate (as with the "weaker structured cooperative relationships" type). This prevents employees from blocking projects, as everyone works together and makes decisions. Due to the high density of experts, only a few really need to be convinced. If this is the case, however, closeness structures are better suited for this purpose, because even the highly structured "high performers" are not willing to do the work of persuasion - everyone must adapt. This is where structure makes the difference. The "structures of nearness" type of organization has a similar skill set to "strong structures of distance and resistances", but in addition to internal and external expertise it has a very different mindset. These companies work with mediators such as influencers, key users and the like. It is important to the CEOs in this group that employees enjoy digitalization, are enthusiastic and share a common vision. The CEOs act as role models and work very closely with their employees, taking them by the hand. So, despite having a common set of skills, these two groups are very different from each other. In this group, the enthusiasm and eagerness to experiment seems to have something to do with external expertise, because the "learning structures" group also likes to try out new things. Overall, it is noticeable that CEOs with a lot of IT experience and medium explicit knowledge often have a need to take employees by the hand. With these groups, one has the feeling that they are on the way to the next level. Either they manage to move many employees ("structures of nearness, adaptations and mediators"), or they look for a close confidant (applies to "strong structures of distance and resistances"). For the latter, this would probably be a first step, because companies that do not have internal experts have less confidence in experts. Internal expertise is widespread and appears to be an important building block in the transformation process. Overall, however, it can be said that only the group "strong structures of distance and resistances" does not see itself as far along the road to digital transformation.

There is often a hierarchy of skills - first the explicit knowledge to be able to communicate, then experience. The former will help to carry out management tasks and provide impulses, the second will complete the transformation. It is important not to do and decide everything yourself, otherwise you will lose contact with the organization and the employees. Not having any IT skills as a CEO can work if CEOs remain flexible and adaptable and gain strength from this ("learning structures", "weaker structured cooperative relationships").

8.5.1 Implications for Theory

This study contributes to literature with three implications for theory: First, the study provides further insights into what “good” IT-Governance structures are and which factors influence the suitability of IT-Governance. In this case, good IT-Governance is dependent on the digital competencies of the CEO. For instance, “mediators” with high digital competence between the CEO and their employees are a tool to pass on and implement the decisions made by the CEO or, in turn, to compensate for missing digital competencies of the CEO. The centralization-decentralization continuum of IT-Governance (Peterson, 2004) can be adjusted according to the competencies and self-image of the CEO. Secondly, the concept of IT competence of business CEOs was placed in the context of CEOs of SMEs (Bassellier et al., 2001). The concept has been supplemented by the identification of digital competencies which are needed by CEOs of SMEs to successfully transform their companies. We found that, for instance, the most CEOs have little knowledge of technical details but rather require general knowledge about the software and hardware used in their organization. Third, we identified factors of “good leadership” in the digital age. Our study confirms other studies, who identified social capital as essential for successful IT- Governance. The interviewees especially mentioned transformational leadership as their model in the digital age (Schlosser et al.,2015; Wagner et al.,2014; Goh et al.,2012).

8.5.2 Implications for Practice

Based on our findings, we can derive implications for practice. Firstly, it should be noted that the technological knowledge or IT competence of a CEO is not necessarily decisive for the success of a organization's digitisation. It is much more important to create a basis of trust for dealing with other key players. No internal or external expert knowledge is useful if the CEO does not trust this knowledge. Overall, trust played a major role in the surveys and there was often little trust from external experts when they were outside the university environment. This makes it more important to build internal competencies among employees in order to align digital transformation with the interests of the CEO and the business. In any case, however, it is important to use other sources of knowledge in order to trans-form oneself and the organization and to organize the transformation through the development of employees. The IT competence profiles developed in the findings can help CEOs to classify themselves and their competencies and to assess the consequences. Finally, we were able to identify functioning IT-Governance structures based on the CEO's competence profiles. This enables CEOs of SMEs to use identified best practices and transfer them to their organization.

8.6 Limitations and Future Work

This qualitative study is based on a total of 20 interviews and was conducted in Germany. Like every other empirical study, this study shows typical limitations of qualitative research (e.g. weak internal validation). Apart from those, it is important to acknowledge further limitations: The composition of the sample of 4 women to 16 men corresponds to the gender distribution in relation to management positions in the German economy. It has several limitations, motivating further research. Our approach uses a qualitative method to connect the identified competencies with the existing IT-Governance structures. It is difficult to discern which phenomena have caused other phenomena. For example, some governance structures may also have an impact on the distribution of competencies. In such cases, it may be helpful to examine interdependence by means of a qualitative analysis. Qualitative studies are also able to address a wider population and provide more generalizable insights. Additionally, it may be assumed that external factors such as organization size, sector, competition, or financial resources as well as personal factors such as character or interests play a significant role for IT-Governance in SMEs. These factors have been ignored, since the focus lied on the connection between IT-Governance and the CEO’s digital competence. Taking further factors into account could broaden the perspective on IT-Governance in SMEs. In addition, cultural aspects have been neglected.

Hence, this study offers potential for further research. It can be used to contribute to a more general theory on suitable IT-Governance measures for SMEs. This would open the opportunity to add external or personal factors to the analysis. Such a theory could then be tested by a quantitative approach. Furthermore, the study could be conducted in other cultures to get broader insights into the topic.

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9 Influencers of Digital Transformation (P7)

Paper Number	**P7**
Title	**Influencers of Digital Transformation: A New Concept of User Participation in IS Projects.**
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Table 9.1 Fact Sheet Publication

Influencers of Digital Transformation: A New Concept of User Participation in IS Projects.

Abstract. Influencers are very common in online marketing. Our study claims that the influencer concept can also be applied to digital transformation projects. Influencers of digital transformation projects may contribute to visualize the benefits of these projects and convince the end users of these projects. Therefore, we introduce the "influencer" as a new concept for user participation, and investigate how it enhances the conversational key-user concept. We conducted an explorative study in small and medium-sized enterprises (SMEs), which implemented either the key-user or the influencer concept as participation concepts for digital transformation projects. We explored the relevance of influencers, by highlighting the differences of both concepts (i.e., influencer and key-user concept) in terms of focus, role, motivation, communication, function, direction and objective. Finally, we investigated the success factors of digital transformation in this influencer concept. Based on our results, we formalize the influencer concept, enabling the further implementation within organizations.

Keywords: Influencer, Exploratory research, Project participation, Project management, IS project, Digital transformation project, SME.

9.1 Introduction

On the internet, influencers play an important role. Whether it is on Instagram, YouTube or Facebook – they inspire or influence other people in their purchasing decisions for products (Brown & Hayes, 2008). Regardless of whether the consumer's decision concerns the next holiday trip, the new cosmetic product or the latest computer game, influencers have become one of the decisive factors in online marketing. The metaphor of a fisherman is often used to explain the effect of influencers (Brown & Hayes, 2008). The fisherman casts a big net to catch more fish. In terms of influencers, this means identifying those who have a large network and thus reach social communities so that as many people as possible can be influenced.

User participation is commonly defined as activities performed by users during system development (Barki & Hartwick, 1994a). Thereby user participation can have a positive impact on the success of an information system (IS). For example, it was shown that there is a positive link between user participation and user satisfaction (Kujala, 2003; Mckeen & Guimaraes, 1997), system quality (Lin & Shao, 2000; Melchor & Chaparro, 2008), as well as user acceptance (Bachore & Zhou, 2009). Two main types of user groups can be distinguished: end-users and key-users (Wu & Wang, 2007). End-users are the ultimate users of an IS (Wu & Wang, 2007). Key-users are users of the IS who are assigned to support other end-users in the immediate work environment and who, for this purpose, participate during system development and cooperate with organizational as well as external specialists (Maas et al., 2016). Key-users are typically software experts (Maas et al., 2016) and act as educators, trainers, advisors and change agents (Wu and Wang, 2007). The participation of key-users in the development process can significantly affect the success of an IS (Pan & Mao, 2013).

We claim that the concept of influencers can also be applied to IS projects. Subtypes of IS projects are information technology (IT)-enabled organizational transformation and digital transformation projects (Wessel et al., 2021). According to Wessel et. al (2021) IT-enabled organizational transformation projects leverage digital technology in supporting the value proposition and enhance an existing organizational identity. However, digital transformation projects in contrast leverage digital technology in (re)defining an organization's value proposition and involve a new organizational identity.

In our study we are proposing a new concept for user participation, the "influencer", and investigate how it enhances the conversational key-user concept in digital transformation projects. To this end, we look at small and medium-sized enterprises (SMEs) and their efforts to successfully address digital transformation. Since SMEs have more limited resources compared to large companies, the challenges of digital transformation are more difficult to meet (Li et al., 2018; Weigel et al., 2020). Therefore, SMEs are dependent on finding a compatible path of digital transformation. We argue that influencers of digital transformation projects can help to make the benefits of these projects directly visible in the daily work and can convince end-users of the project and its goals. This might lead to a better acceptance of IS projects in SMEs and can thus maintain the competitiveness of SMEs.

Therefore, we raise the following research question (RQ):

RQ: What are concepts of user participation in digital transformation and how do they differ?

Our study follows an explorative research approach. First, we use the existing literature on user participation and key-users to gain a deeper understanding of the topic. Subsequently we briefly introduce the concept of champions, which seems to be similar to the identified influencer concept. Than we interviewed a total of 11 people with a semi-structured guide. Our results show that the influencer concept has the potential to revolutionize SMEs' approach to digital transformation. We discuss our results by deriving practical and theoretical implications. Furthermore, we show the limitations of our study and identify avenues for future research.

9.2 Related Work

9.2.1 User Participation

User participation can be defined as "participation in the development process by a member or members of the target user group" (Olson & Ives, 1981, p. 2). User participation enables users of an IS to interact with system designers and aid in many aspects of the system development process: planning, analysis, design, testing, and implementation (Lin & Shao, 2000). While some scholars use the term "participation" interchangeably with "user involvement", others differentiate between these two terms (Harris & Weistroffer, 2009): For example (Lin & Shao, 2000, p. 285) define user participation as "a behavioral construct (the degree of participative behaviors of users during the development process)" and user involvement as "a psychological state reflecting the importance and personal relevance that a user attaches to a given system". Harris and Weistroffer (2009) suggest that user involvement encompasses user participation, including both hands-on and psychological contact during system development. We refer to (Barki & Hartwick, 1994a, p. 60) and use "user participation" when referring to "the assignments, activities, and behaviors that users or their representatives perform during the system development process" and the term "user involvement" when referring to "a subjective psychological state reflecting the importance and personal relevance that a user attaches to a given system".

Barki and Hartwick (1994b) identified two research streams on user participation: The first research stream investigates the impact of user participation on system development outcomes e.g., system quality, use, and satisfaction (e.g., Hartwick and Barki 1994; Ives and Olson 1984). The second research stream investigates interpersonal processes, i.e., intervening and mediating the relationship between user participation and system outcome (e.g., Bostrom 1989; Robey et al. 1989). More recently, Schermann and Merz (2018) highlighted the role of user participation in a variety of project tasks including engineering, user training, and system adoption, as the predominant research stream (e.g., Hsu et al. 2008; Coughlan and Macredie 2002). Furthermore, research identified the relationship of user participation and adoption of IS (e.g., Hartwick and Barki 1994) as well as the role of user participation in the context of information security risk management as important research streams (e.g., Spears and Barki 2010).

Literature confirmed that user participation is expected to have a positive impact on the implementation and ultimate success of an IS (Cushing, 1990; Hunton & Beeler, 1997). It was shown that there is a positive link between user participation and user satisfaction in IS development (Kujala, 2003; Mckeen & Guimaraes, 1997). Markus & Mao (2004, p. 535) propose that the quality of engagement by business professionals is important because "participation richness is related to [both] solution development and solution implementation success". Moreover, it was pointed out that user participation can increase system quality (Boland, 1978; Lin & Shao, 2000; Melchor & Chaparro, 2008). It is confirmed that user participation can increase user acceptance of the system (Bachore & Zhou, 2009; Kujala, 2003) and that IS developed with user participation better match requirements and specification than systems designed solely by IS professionals (Barki & Hartwick, 1989). Moreover, literature demonstrated that user participation creates a feeling of ownership to the IS, whereby user resistance will decrease and user commitment will increase (Lynne, 1983).

9.2.2 Key User

There are two main types of user groups: key-users and end-users (Wu & Wang, 2007). Key-user groups are "the main groups of direct users of the IS – those users who access the system directly, or who use its direct outputs"(Gable et al., 2008, p. 387). They are selected from the operating department (Mahdavian & Mostajeran, 2013). As part of an IS project team (Wu & Wang, 2007), key-users represent the involved business units, have domain knowledge, and have extensive software knowledge (Pan & Mao, 2013; Maas et al., 2016). In contrast, end-users are the ultimate users of the IS. Their knowledge is limited to the part of the IS which they need for their work (Wu & Wang, 2007).

Key-users are involved in almost all stages of IS implementation projects (Mahdavian & Mostajeran, 2013): In the development phase, key-users are the developers of the requirements of the IS (Mahdavian & Mostajeran, 2013). In the implementation phase, they are involved in the tests needed for implementing the system (Rizoto-Vidala-Pesoa & Kuzņecova, 2017). In the roll-out and hand over phase, key-users function as specialists in parts of the IS and act as trainers, help-desk resources, advisors, and change agents for end-users (Rizoto-Vidala-Pesoa & Kuzņecova, 2017; Wu & Wang, 2007). However, most of the key-users still fulfill their on-going business functions (Maas et al., 2016).

The relevance of key-users was highlighted by Pan and Mao (2013). The authors mentioned four reasons, why key-users are critically important for system success: First, as representatives of the involved business units, their acceptance of the IS is a precondition for the system's success. Second, one of the key-user responsibilities is to provide business knowledge that is required for system configuration to ensure the fit between the IS and the respective business. Third, key-users, as representatives of their business units, support business units' managers in important system decisions. Fourth, key-users are a prerequisite for effective knowledge sharing among multiple stakeholders, e.g., vendors, consultants, and end-users from different business functions.

9.2.3 Champions

The role of champions was identified by (Schon, 1963) in a seminal article on radical military innovation. Schon (1963) claims that a champion who identifies the innovation as his or her own, promotes the innovation actively and vigorously through informal communication channels. He or she risks his or her position and prestige to ensure the innovation's success is the key to overcome indifference and resistance that major technological change provokes.

Champions in terms of organizations are defined as individuals who informally emerge in an organization (Howell & Higgins, 1990) and "who made a decisive contribution to the innovation by actively and enthusiastically promoting its progress through critical stages in order to obtain resources and/ or active support from top management." (Roure, 1999, p. 4). Their primary focus is to "make a decisive contribution to the innovation process by actively and enthusiastically promoting the innovation, building support, overcoming resistance and ensuring that the innovation is implemented" (Howell & Higgins, 1990, p. 40).

Champions are often proposed as a means to promote the adoption of IS (van Laere & Aggestam, 2016). To accurately reflect the nature of IS, to accurately capture the non-technical aspects that are seminal to successful IS innovation and to precise "critical stages" and "top management", the definition of Roure (1999) was refined by Renken and Heeks (2019, p. 835) for the IS discipline: They defined champions as "any individual who makes a decisive contribution to the socio-technical innovation by actively and enthusiastically promoting its progress through critical innovation and diffusion stages in order to obtain resources and active support from all stakeholders." Their primary focus therefore is to circumvent or push the innovation beyond approval and implementation barriers (Beath, 1991). By promoting their personal vision actively and vigorously, champions express confidence in the innovation, involving and motivating others to support the innovation and persisting under adversity (Beath, 1991; Howell & Sheabb, 2001). Renken and Heeks (2019) derive three characteristics to refine who IS champions are and what they do: First, IS champions focus on long-term results rather than short-term obstacles and therefore have a strategic vision about successful project outcomes and even beyond. Second, IS champions focus on relationships to promote ideas, rally support, and build consensus. Third, IS champions focus on resources by actively identifying and mobilizing resources needed to advance the project.

9.3 Methodological Approach

9.3.1 Research Design

This research is based on 8 interviews (5 individual interviews and 3 focus group interviews) with a total of 11 participants, conducted between January and March 2020. The interviews lasted between 40 and 60 minutes. Focus group interviews were sought whenever a participant had only been employed in an organisation for a few years (<=5). It could be assumed that these participants had not yet fully experienced the participation opportunities due to their low organisational affiliation and thus the evaluation might be limited. When making the appointment, we asked if there was a supervisor or colleague who could also take time for the interview. In the case of K-1, the response to our interview request was the organisation's IT expert. In response to our question about the supervisor, he additionally invited the managing director. In the case of K-3, the Chief Financial Officer (CFO) agreed to conduct the interview with us, who additionally invited the IT expert. Participant K-4 felt able to answer all the questions himself and independently, which was true. In interview I-2, participant 1 had only been in the organisation for 2 years, whereupon he invited a colleague with more years of organisational affiliation. The interviews follow an explorative approach to find out how concepts of user participation are used in the organization to successfully implement the digital transformation. Originally, we wanted to better understand the concepts of user participation in SMEs. However, we came across a new type of user participation, the "influencer". In our interviews, it became clear that 4 respondents followed this very exciting and innovative approach.

We used a two-step approach to scientifically investigate user participation. In a first step, we asked open questions, such as "What is your management structure in the organization?" or "How did you organize the responsibilities in the organization, especially the IT-related decisions?” In this process, we discovered the role of the organizational influencer. Based on this, we were able to further developed our semi-structured interview guide in the second step. The interview guide was supplemented by specific questions, e.g., " To what extent are you involved in the projects??" and, "Explain how the position of the influencer came about?”. This gave us insights from different perspectives, of user participation, namely from the organizations that use a key-user concept and those that use an influencer concept. The explorative character of this study is based on instruments of the Grounded Theory coding methodology (Gioia et al., 2013; Glaser & Strauss, 1967; Urquhart et al., 2010).

9.3.2 Data Collection and Analysis

All interviewed organizations have in common that they are active in the German industrial sector and are to be classified as SMEs. This combination enabled us to obtain different perspectives on the implemented participation concept. Table 1 gives an overview of the conducted interviews.

Interview		**Used Concept**	**Age**	**Position**	**Work experience in years**
K-1	**-1**	Keyuser	45	CEO	20
K-1	**-2**	Keyuser	40	IT	5
K-2	**-**	Keyuser	49	CEO	23
K-3	**-1**	Keyuser	51	CFO	2
K-3	**-2**	Keyuser	64	IT	30
K-4	**-**	Keyuser	50	CEO	5
K-5	**-**	Keyuser	37	CEO	10
I-1	**-**	Influencer	42	CEO	12
I-2	**-1**	Influencer	37	Sales	2
I-2	**-2**	Influencer	22	Sales	6
I-3	**-**	Influencer	46	Sales	6

Table 9.2 Overview of the Respondents

We started with the open coding method using the software MAXQDA (Corbin & Strauss, 1990; Glaser & Strauss, 1967). Two researchers read the transcribed interviews and applied independently the open coding method. The sentences and paragraphs were assigned code phrases that best represent the content. Next, similar codes were collected from the interviews and converted into the axial code. In this coding paradigm, the experiences and characteristics of the influencer concept could be captured and mapped. For instance, for the subsequent citation: “*I always think from the customer's point of view, because in the private customer sector it is almost normal for the customer to configure something like this digitally.*” (Interview I-1), two independent codes (“customer orientation”, and “customer as digital native”) were found. Finally, “customer orientation” was used as the axial code. Subsequently, the axial codes were grouped by subject areas. Different opinions were discussed with a third researcher and settled by agreement. We ended the data collection phase after all researchers agreed that there was a low probability that significant new insights could be generated by additional interviews.

When analysing the user participation concepts in the interviews, some text passages could be clearly assigned to the key-user concept. In other text passages we found significant deviations from this known concept. Whenever we found deviations from the key-user concept known from the literature, we noted them. One interview partner (I-1) called his approach the influencer concept. After reviewing the commonalities of the interviews (I-1 to I-3), it became clear that we had found a new form of user participation. However, interviews I-1 to I-3 all describe a similar conceptual approach, so we combined them into a new unified concept, the influencer concept.

9.4 Findings

First we present the results of the interviews on the key-user concept (K1-K5) and then the findings on the influencer concept (I1-I3). The researchers found that the self-image of the influencers and their attitude towards digital transformation issues played an immense role in the organization. We examine both the top management perspective, which looks at organisational conditions, and the employee perspective, which looks more at operational conditions. Subsequently, the differences between the two concepts are presented and discussed.

9.4.1 Interviews about the Key-User Concept

Organizations that apply the key-user concept are characterized by the fact that key-users are responsible for a specific purpose. For example, one of the interviewed CEOs limits the area of responsibility of the key-users to a specific software. Furthermore, different key-users are responsible for the different departments of the Enterprise-Resource-Planning (ERP) system. Thus, the responsibilities of the key-users are limited to the process steps in a software.

> *"Our key-users are always responsible for a specific system. We have key-users for our ERP system and others for the CRM system. For our ERP system, we then have different key-users for the different perspectives. For example, one person is key-user for*

purchasing, another person is key-user for the sales process in the software."- Interview K3-1

This quote makes clear that key-users are always limited to their task and the software they use. The scope is deliberately limited, all alternative solutions or process steps that are not covered by the software are not intended. The key-users are selected by the CEO and e.g. by the IT manager based on their previous knowledge. In the event the key-users have new tasks to perform, they are sent for training to acquire skills that they will pass on to other employees in the organization.

"A key-user is a person who is already well acquainted with the software used. Depending on the area, you take the person who has worked most with the software so far. If nobody really knows the software, a young colleague, for example, is assigned to look after the software as a key-user. This person is also trained."- Interview K3-2

"In the end we usually make one of them an expert and he passes this on to the others. This is definitely the case when using a 3D scanner and the corresponding software. The training was so expensive that we could only send one person for training. That was the key-user, who then trained the other colleagues internally."- Interview K-2

It is interesting that a key-user often does not select the task, but is appointed to it or selected due to his or her qualifications. In the project context, a managing director sees the key-user's task to provide impulses for the new IS and to gain an overview of the software's areas of application. The key-user is invited to identify further possible applications of the software. However, the key-user is always limited to the software. It is in his or her responsibility to ensure a smooth operation of an existing IS.

"I see the demands on the key-users as being to provide impulses for software use, to give an overview of the main topics, and since the existing business operation is in the foreground, the business operation must simply run optimally with the software."- Interview K-2

For the purpose of process optimization along a software development, the key-user acts as an intermediary between management, IT and end-users. During the development process, he or she should pass on the requirements of the end-users to the Information Technology (IT)-department so that the IT-department can implement these requirements. Afterwards, the implemented requirements are communicated to the key-users, who in turn pass the information back to the end-users. The information exchange from key-user to end-user often takes the form of small training sessions. In this way, the key-user becomes a multiplier for the new functions available in the software.

> *“The key-users define the requirements for further system development. The IT-department then implements them and returns this information to the key-user. The key-user in turn then informs the department”- Interview K-1-1*

Key-users have the possibility to report problems and suggestions for improvement. These are forwarded to the IT-department as change requests. In contrast to the IT-department, the key-user has a very good overview of the individual processes in the organization, as he or she represents the interests of the department he is working for. This facilitates mediation between management, IT-department and end-users.

> *“Key-users know how to present the problem or suggestions for improvement verbally, but they also have a good overview of the individual processes within the department, the individual interfaces to other departments and can keep track of thing.”- Interview K-1-2*

The CEOs in our sample avoid making instructions or decisions without discussing them with the key-user, since the key-user has knowledge and experience in the project as well as the daily business and has an overview of the suggestions of other employees. Key-users pursue the objective of finding a solution that takes into account the suggestions of the end-users and represents an optimal solution for the organization. In addition, the expertise of the key-user is taken into account and – since the key-user knows the software – the technical possibilities of the IT solution are also considered.

> *“I do all this only in cooperation with the key-user. I don’t make decisions or give instructions at this, let me say, I like it when employees make alternative suggestions so that we can discuss them and find the best solution for the organization.”- Interview K-4*

9.4.2 Interviews about the Influencer Concept

The interviewed CEO is organizationally responsible for the influencer concept in his organization and has introduced the concept in the organization. He laid the foundation for the digital transformation and the influencer concept by taking his customers' perspective. Since the organization mainly produces for private customers, this customer group is already used to using digital tools for product configuration. The CEO enables his organization to digitally map a customer order from inquiry to delivery.

> *"I always think from the customer's point of view, because in the private customer sector it is almost normal for the customer to configure something like this digitally." - Interview I-1*

From this strategic perspective, the CEO has created a feasible roadmap for the digital transformation. He analyzed the current situation of the organization and determined that there is not enough internal IT expertise available for this transformation. The CEO therefore recruited an IT specialist as a freelancer to accompany the organization on the transformation-journey. However, it was important to the CEO that the organization built up its own digitalization competencies. Hence, he selected employees in whom he saw the potential to help shaping this digital change. These employees were to learn from the freelance IT expert and translate his expertise into practical applications for the organization.

> *"You have to imagine it this way: We don't have any IT professionals, we have a freelancer who supports us a little bit, but my ability is that I can develop people well. Then I chose this colleague because he was interested and wanted to continue his education."- Interview I-1*

For the CEO, an employee's motivation to drive the digital transformation is the most important factor, i.e., the intrinsic motivation of employees to improve their work with digital tools. For each of the digital transformation projects there is a one-hour meeting every week and the influencers have become the driving force in this meetings. The CEO even observed that the actual progress of these projects has accelerated compared to previous projects. In addition, the influencers are more capable than the CEO of convincing the end-users of the need for change. The CEO concludes that the process knowledge of the influencers significantly reduces the resistance of other colleagues to possible changes. He reasons that the influencers have really understood why these changes are necessary for operational processes. The influencers are involved in the entire process from idea to implementation. This involvement the dissemination of information from the projects much more efficient, as the influencers inform the other colleagues almost casually about the project steps.

> *"The organization consists of three product areas, and I looked at who had an intrinsic interest in digital transformation and I pulled these people from each area together. These influencers are part of the project groups, which means they are present at the*

weekly one-hour meetings. My experience is that the influencers understood that things change and that you have to change. Also, everything is getting faster and faster. It's a good idea to involve these influencers in the project from the beginning and then give them positive feedback to each department. That goes down much better than someone who implements it as a manager. If someone doesn't want to implement something, he always finds reasons why something doesn't work. This method works quite well."- Interview I-1

After the introduction of the influencer concept, the CEO's role in the projects also changed. From being a driving force of digital transformation in the beginning, he increasingly became a mentor for the influencers. Initially, he actively supported the project. As the development progressed, the CEO was able to withdraw more and more, since the influencers as digital transformation drivers were much more involved in the projects than the CEO could have been. The involvement of influencers goes as far as that the digital transformation only works because the influencers are involved.

"What the influencers lacked was structure. I had to create a structure, purely organizational. For example, the influencers had to learn how to approach projects once a week, organize it and follow it up. That took about two years, but now it's working very well and I just sit down at the Jour Fixe and they report. Sometimes they ask me, but that works quite autonomously. (...) You can see that the influencers have become independent in the meantime, because they enjoy it. (...) I have a feeling that the digital transformation will only work if the influencers participate."- Interview I-1

The interviewed influencers are commercial employees who spend only part of their working time in the digital transformation projects. They are still involved in the operational tasks of the organization in their departments and the task as influencers takes a second place. One of the interviewed influencers can also draw on experience in IS projects from his previous job. The other influencer, however, was recruited solely on the basis of personal motivation. Both influencers state that they can only successfully manage the digital transformation in cooperation with external IT experts.

"I've just already managed a few IT projects in my life. Of course, the CEO found this fact interesting and included me. In the future it will be about the development of a new configurator, I'm not writing the software but I'm the manager who creates the concept

and supervises the implementation. For the actual implementation we have external people."- Interview I-2-1

"The CEO addressed me: "Here's the situation, IT-wise, how fit are you?" I said at the time that I was relatively inexperienced. But I'm interested in it. And then he gave me the chance. The good thing is that we work with an external IT company. When they finish various tasks for us, I look at the results and then the next time I can do it myself." - Interview I-2-2

The two influencers work very closely together in their secondary activities. The interesting thing about their main tasks is that there is hardly any overlapping of expertise. Therefore, the influencers jointly examine possible projects and then jointly decide who will take over which project. Of course, digital projects concerning the main tasks are also supervised by the influencers, but projects that cannot be clearly assigned to a specific department are then "tackled together". Thus, with the involvement of external IT experts, this clearly shows that nobody feels left alone with the projects at any point in time.

"We also divide the projects up a bit, depending on what we know. We come from two different departments, so he makes the configurator for one product group and I make the configurator for the other product group. The big projects, the projects where nobody is operationally specialized, we tackle together."- Interview I-2-1

In addition to this self-organized division of tasks, the handling of the digital transformation projects is also an interesting aspect. Here it can be observed that the influencers apply the usual methods and procedures of project management. For example, a specification sheet is created that serves as a basis for external offers. On this basis, an offer is selected that appears to best meet the requirements. As the project progresses, it is remarkable that change management seems conventional at first glance. Only the persistence of the influencers should be mentioned. Since the influencers do not insist on a specific software, but always have the optimal handling of the process in mind, they always question the project result itself very critically. For the influencers, a successful project is first and foremost a project that improves the previous process.

"We had defined an artificial intelligence that could automatically classify documents. For example, an algorithm that can distinguish between internal and external invoices. When the IT expert we hired told us that it didn't work fully automatically (...), we wondered if another competitor could do it better. During the project we weighed up

the pros and cons again. (...) In our projects we pay more attention to the process to be improved than just the software."- Interview I-2-1

At the end of a project the process must convince the influencers. This internal conviction is very important to convince the end-users of the success of the projects. Here, the influencers highlighted that they still feel responsible for their project results and the associated process even after a project has ended. For example, the influencers do not force these new processes on any of their colleagues but concentrate on showing the improvements. This convinces the end-users after a certain training phase.

"My colleagues can always contact me if they have any questions. Usually it's like this, then I don't really get any feedback on the new projects. After one or two weeks, I talk to my colleagues to get feedback (...) I then show the end-users what benefits they have from the solution or what time can be saved."- Interview I-2-2

The level of communication between influencers and their colleagues is very informal. Information is passed on to colleagues almost casually, for example in short meetings or during coffee breaks. In this way, the influencers can inform about the progress of the projects at very short intervals. For more formal content, which is not intended to convince but to explain, the influencers use presentations sent by e-mail. According to the influencers, all this is done via "small channels". More rarely, however, meetings in the presence of all colleagues and, for example also with the management, are possible to discuss project topics.

"We have a channel. On one project, I wrote a PowerPoint presentation and sent it around: "Look, it is super fast, super easy...""- Interview I-2-1

"We communicate on a buddy basis. (...) I would say you could just get everyone together and talk to them."- Interview I-2-2

Besides communicating and influencing internal colleagues, the influencers also serve to translate the digital requirements. Through their entire experience in digital transformation projects, they know how to draw up their own problems and the problems of their colleagues for IT experts and the CEO. Thus, a problem description first becomes a process analysis and then, depending on the urgency, a requirement for the software. In the opposite direction, the influencers are able to communicate the answers and solutions of the IT experts to their colleagues in an understandable way. In this way, possible misunderstandings and dissatisfaction are largely avoided.

"I am called in because of my experience to get to the heart of the projects, because I have often dealt with IT people and businesspeople who don't necessarily speak the same "language"."- Interview I-2-2

It is interesting to observe that the influencers do not see themselves directly as such. They identify themselves essentially through their main activity in the organization. Although the activity as influencers is not primarily in the foreground, this function is nevertheless omnipresent when the influencers casually talk about their projects and project progress. It goes without saying that the influencers consider current digital topics such as artificial intelligence and its implementation in one of their projects. The influencers also take responsibility for these projects and serve as contact persons for the CEO, end-users and external parties. Here, they often provide unsolicited and casual information about the current status.

The end-users are well informed about the projects of the influencer and organization. This is particularly interesting because the respondent states that he is not primarily affected by one of these projects, but nevertheless knows what the status of the project is and what possible consequences it will have for him or her.

"The influencers have told me this before, but I have not actively asked them about it because it does not directly concern me. It is then casually explained that it is a separate project to make our organization as paperless as possible and that colleagues are familiar with its implementation."- Interview I-3

It is also interesting that the end-users want to become influencers for a solution as soon as this solution is available. Even more restrained, but then in all clarity, the remaining end-user are aware that as soon as a project is in the introduction phase, it should be supported. Due to a strong "feeling of unity", every end-user feels very identified with the organization and projects of the influencer. This suggests that the influencer concept probably works because end-users do not feel negatively manipulated, as it may be the case with external interventions such as management policies or objectives (Green & Pawlak, 1983). The end-users themselves feel much more infected by the project and its positive effects on their work.

"And when that happens, yes, then of course I have to become more of an influencer. Then I also have to inspire people that this is a great project and that they have a positive value for their daily business."- Interview I-3

The end-user has a very positive attitude towards the influencer concept. Furthermore, the end-user understands the sense and value of the projects. Finally, it is easier for him or her to accept possible changes at an early stage. He or she feels involved in the projects, even if he or she is not an original member of the projects. The end-user is passively and casually provided with information about the projects. This means that he or she is also aware of the effects of the projects on his or her future working environment and can adapt to those early on.

9.4.3 Overview of Key-User Concept vs. Influencer Concept

The influencer concept can be seen as an enhancement to the key-user concept that has been widespread and established in other organizations. The influencers have become the decisive factor for digital transformation projects. In table 2 we compare the main points of the influencer concept with those of the key-user concept. In the following section we go into these points in more detail.

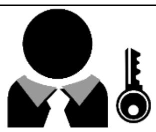
Concepts	Key-user	Influencer
		
Focus	Software implementation	Process transformation
Role	In the project and the daily business	Mainly in the daily business
Motivation	Extrinsic	Intrinsic
Communication	Request / Response	Publish
Function	Represents professional interests	Promotion of the transformation
Direction	Top-down	Bottom-up
Objective	Sustainability of the software	Sustainability of the process

Table 9.3 Comparison of Key-User Concept vs. Influencer Concept

Focus: The focus of the respective concepts seems to be different, although both concepts pursue user participation. While key-users focus on a specific software implementation (Maas et al., 2016), influencers take a more holistic view of process change. Influencers, as we found out in this research, are experts in the business processes and always focus on the best possible change for the respective process. In case of doubt, influencers use different software solutions for the optimal process. Key-users acquire specific knowledge about a single software solution and therefore have a more narrow focus because they are more involved with the software than with the process.

Role: Key-users in the project team are often only involved in certain phases of a project (Mahdavian & Mostajeran, 2013). For example, they are involved in the project for the collection, evaluation and training of requirements (Wu & Wang, 2007). This involvement of key-users in the projects is a necessary, but not sufficient, condition for the success of many projects. On the contrary, influencers are both, a necessary and a sufficient factor for digital transformation projects. Influencers are therefore an elementary component of the project. However, influencers are still active in their actual roles in the organization. Influencers continue to carry out their previous tasks and manage to fulfil both tasks well through synergies between the digital transformation project and their main task. Key-users are also divided into two roles as described (Maas et al., 2016). However, they often have one main role in an organizational process and the other role in a development project.

Motivation: The combination of main tasks and project tasks often motivates influencers intrinsically, as they can see the possible improvements in the processes they work on every day. In addition, when influencers are chosen, care is taken to ensure that they have an interest in the framework of the digital transformation. Since key-users are selected, e.g., by the project manager, they consider this task independently from the overall project (Mahdavian & Mostajeran, 2013). They are also used to the process, but their focus is on adapting the process to the project or software. Usually this key-user task is another task for which key-users are paid or otherwise rewarded.

Communication: Key-users often communicate in a request and response process. This means that key-users receive a request, e.g., from the project manager (Pan & Mao, 2013). This request is answered with a software test or processing (Wu & Wang, 2007). This communication usually takes place internally, i.e., with the project team or with the end-users. The project team plays an important role for the key-users and their task in the project. Influencers, however, see themselves as independent and serve as the central point of communication within the project. They communicate in a kind of publication process. This means that influencers communicate regularly and unsolicited with end-users as well as other people involved in the project. This does not require a request but rather happens randomly.

Function: Influencers pursue the function of promoting the change that the project aims to bring about. They are responsible for the projects and acceptance of these projects. It is therefore in the influencers' interest to convince end-users early on of the changes brought about by their project. However, they do not understand this task as a work instruction, but rather implicitly promote the changes by letting the possible improvements speak for themselves. This refers not only to their own process, but also to the organization´s processes. The function of key-users, on the other hand, is to represent the interests of the respective departments from which they were appointed (Maas et al., 2016; Pan & Mao, 2013). This can mean that only those process steps that affect the respective department are taken into account by the key-user (Mahdavian & Mostajeran, 2013). For example, downstream and upstream processes must be considered by other key-users. This can lead to tensions between departments, if a positive change in one department leads to negative changes on other departments.

Direction: The way how a concept is introduced has a significant influence on how the concept is lived afterwards. This difference becomes particularly clear when considering the two concepts. When key-users are formally named by the CEO, they also see their task as a formal task. Here there is a clear top-down system. Although the influencers themselves are called to this task by their responsibility for a process, it is more a passion than a task. Here, a bottom-up development is obvious.

Objective: In summary, key-users are responsible for the software. Moreover, they train end-users and are experts in the respective software. Key-users are interested in further developing and adapting the software. They are involved in the expansion and sustainability of the software (Pan & Mao, 2013). In contrast, influencers are responsible for the business process. The software solution used is not as important to them as the expected improvement through it. When influencers notice that the changes do not achieve the desired effects, they question the decisions that have already been made. This leads to an enormously high sustainability of the processes, but it also creates risks regarding project continuity.

9.5 Discussion

To address our RQ, we surveyed SMEs that have implemented user participation concepts. We conducted explorative interviews with CEOs, IT managers and end-users to understand the different perspectives on the used concepts. Our research question aims to investigate the differentiation of the key-user concept and the influencer concept. We were able to identify seven key aspects in which these concepts differ: First, the focus with which the employees pursue their respective tasks differs. Second, the roles of key-users and influencers in the organization differ. Third and fourth, we found differences in motivation and the communication process. Fifth, key-users and influencers fulfill different tasks in a project. Sixth, the goals pursued by the two concepts differ and finally, the direction from which the user participation was initiated.

The discovered influencer concept for digital transformation projects allows a transfer of the findings to the social media influencer. The influencer of digital transformation processes has the focus on the process transformation with the objective of a sustainable process. Also, for the social media influencer it is important to keep an eye on the development (and thus a process) of their own content. To remain sustainably credible and trustworthy, social media influencers should be aware of their external impact and actions at all times. To this end, it is important to stand up for one's own views, to regularly reflect on one's external impact and, above all, to rethink one's communication (Enke & Borchers 2019).

It turned out that the concept of influence was introduced by the organizations themselves. In the absence of IT specialists, external IT support was purchased, and this support was always accompanied by an influencer. Since these influencers had a personal interest in the success of the IS projects, the concept was made more stable. The influencer concept does not only allow for user participation, but user participation is a fundamental part of the concept. Since the influencer can be project manager and user at the same time, he or she has a very strong opinion and expressiveness. This will certainly not work for every type of employee. Therefore, choosing the right influencer is an important task. In the case of the interviewed influencers, they are characterized by a high level of enthusiasm for digital transformation. Additionally, they have a high level of commitment and good communication skills.

9.5.1 Implications for Theory

The concept of champions (Schon, 1963) is in some respects similar to influencers. However, champions are primarily strategically oriented and aim for successful implementation of their projects. In this paper, we investigate user participation and propose a concept that extends the conventional key-user concept. Since champions do not take over the role of a user in the system development, champions can be unambiguously distinguished from the influencer concept. This research proposes another new concept of user participation.

User participation should not only lead to a better understanding of the developed IT solution, but also be beneficial in the continuous improvement of processes (Barki & Hartwick, 1994a). Therefore, the introduction of a new role leads to a broader view of user participation in IS projects, as user participation should not only comprise software implementation but rather process change. The influencer role serves to bundle important aspects in an IS project and beyond. By introducing the influencer concept for IS projects, our research provides a new perspective on user participation and enhances the understanding of user participation in IS projects.

Since this is the first study exploring the concept and relevance of influencers in IS projects, our research provides initial knowledge about influencers in IS. We described in detail how influencers were introduced and implemented in an SME. From this, we were able to deduce and create knowledge about the relevance of influencers for both management level and end-users. Moreover, our research provides a detailed differentiation of key-user and influencer in IS projects by means of identified dimensions, i.e., focus, role, motivation, communication, function, objective and direction. On the one hand, this differentiation expands existing literature on key-users by providing a structured overview of the concept and its key characteristics. On the other hand, the differentiation of the two concepts contributes to a deeper understanding of the influencers. This enabled us to conceptualize the influencer in IS projects. Overall, research can benefit from this study as a point of departure for further research on influencer as a new user participation concept in IS projects.

9.5.2 Implications for Practice

From the researched influencer concept we can derive implications for the practical application in organizations. It should be noted that the influencer concept can be an exciting enhancement of user participation in IS projects. The proposed influencer concept was presented and explained in this study and contrasted to conventional key-user concepts. In order to implement this influencer concept successfully within the organization, it should be noted that pure IS knowledge of an influencer is not necessarily decisive for the success of IS projects. Rather, it is important that influencers are motivated intrinsically to drive these projects forward. Therefore, this research will help organizations to take up the influencer concept and to implement it fully or partially in their organization. When selecting personnel, motivation for the project topic is a crucial factor.

The results of this study lead to the conclusion that digital transformation projects are better accepted in SMEs if these benefits are directly visible in the daily work – this is where influencers can help. Overall, these expected benefits played a major role in the interviews used to communicate about the projects. In this way the influencers can convince the other end-users of the projects and the projects' goals. This makes it all the more important that the influencers have access to informal channels of communication. These channels of communication enable the end-users to informally exchange information about the projects and the expected changes.

In any case, it is important that the CEO supports the influencers in changing their own way of working and that of the organization. The influencer concept, as outlined in the results, can help CEOs and organizations to reorganize themselves and there are projects to achieve greater acceptance of the change. Even though the influencer concept relates to the context of SME, there is no argument against its application in larger organizations. Especially in larger organizations, where communication is less dynamic than in SMEs, the influencer concept can help to communicate projects and their goals and generate a wider reach.

9.6 Limitations and Future Work

We conducted a qualitative study to conceptualize influencers and highlight the main differences between influencer concepts and key-user concepts. Moreover, this study demonstrates the relevance of introducing influencers for IS projects, by highlighting the shortcomings of key-users. However, as with every study, this research comes with limitations, which invites future research to build on our research. Since this research is based on a qualitative study, it comes with typical limitations of qualitative studies (e.g., weak internal validation). Apart from those, it is important to acknowledge further limitations, which may create opportunities for future research: 64 German SMEs were contacted. These SMEs were selected because they have gone public with their IS projects, e.g. in the form of an article on the company homepage or in newsletters from industry associations. Of these, 20 organizations were willing to be interviewed. An initial review revealed that only eight of the organizations had involved users in their development process. The interview partners of the eight organizations were all male. In addition, more respondents commented on the key-user concept than on the influencer concept. The assumptions for the influencer concept are therefore based on four different views on the topic. In our opinion, however, this is sufficient to understand and conceptualize the influence and implementation of the concept in the organization. Therefore, the proposed influencer concept should be considered as a blueprint for digital transformation projects. We encourage future research to further investigate this concept in more detail. For example we are convinced, that the influencer concept is also suitable for and applicable to IT-enabled organizational transformation projects (Wessel et al., 2021). Moreover, future research could investigate the influencer concept for organizations of other size e.g., start-ups or corporate groups.We encourage future research to explore the applicability of our findings to different industries. For example, it could be examined whether the concept needs to be adapted to organization size or whether the organization industry impacts the implementation of the influencer concept. These findings could be used to further develop the proposed concept and its implementation. For example, this could lead to a better understanding of whether the implementation of the influencer and key-user as two disjoint concepts is useful or whether the combination of the two concept is more practicable. In addition, we encourage future research to evaluate the success of introducing influencers for IS projects (i.e., change acceptance, employee-satisfaction, process improvement), since our research is focused on the conceptualization. Furthermore, the influencer itself could become the object of research. For example, it could be investigated which personality traits positively effect participation in IS projects.

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II DIGITAL LEADERSHIP

10 Individual Boundary Management (P1)

Paper Number	**P1**
Title	**Individual Boundary Management: An Empirical Investigation on Technology-Related Tactics**
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Table 10.1 Fact Sheet Publication

Individual Boundary Management: An Empirical Investigation on Technology-Related Tactics

Abstract. Elevated through the increasing digitalization, employees are expected to be available always and everywhere. According to boundary theory, individuals can manage their boundaries between work and private life on a continuum of integration and separation. As individuals have different preferences for integration or separation, they are implementing IT tactics to meet their preferences. However, there is a lack of research addressing this topic. Therefore, we used an exploratory approach using tools from Grounded Theory in order to detect IT-related tactics which employees use to manage their boundaries between work and private life in a way that is in line with their preferences. We identified six tactics that varied in their ability to foster integration or separation and could be administered either manually or automatically. These tactics ranged from physical detachment in which employees separate work and private life manually through creating distance between the device and themselves up to dynamic filters with which the device automatically filters messages from different people and lets only relevant messages come through.

Keywords: Boundary Theory, Boundary Management, Individual IT Tactics

10.1 Introduction

Due to the technological evolution of mobile technologies including smartphones, tablets and wearables, job-related tasks can be performed nearly anywhere and anytime (Karanasios & Allen 2014; Reyt & Wiesenfeld 2015). According to a forecast from the International Data Corporation (IDC) in 2015, mobile worker population will grow steadily in the next years, increasing from ca. 96 million in 2015 to over 100 million mobile workers in 2020 – only in the U.S. By the end of the forecast period, mobile workers will account for almost three quarters of the total U.S. workforce (IDC 2015). Key drivers behind the growth of mobile workers includes reduced prices of smartphones and tablets combined with the growing acceptance of corporate bring your own device (BYOD) programs in organizations (IDC 2015). Additionally, technological innovations such as wearables, near-field communications (NFC), voice control and augmented reality are enabling workers to increase their productivity by optimizing communication along organizational workflows (IDC 2015).

Based on the technological advancement, there is a fundamental change with regard to workplace design, i.e. working times are getting more flexible and workplaces are getting location-independent. Therefore, organizations are facing new demands, norms and a cultural change. Concepts like BYOD ("Bring Your Own Device") and IT-Consumerization (Köffer, Ortbach, Junglas, Niehaves, & Harris 2015) are well-known examples and force organizations to rethink their policies and cultures with regard to the organizational use of technology.

Previous research on the use of mobile technologies has found both positive and negative effects on an individual's work and private life domain (Allen, Cho, & Meier 2014). Besides positive effects (e.g. increased productivity in business tasks (Cecchinato, Cox, & Bird 2015; Cousins & Robey 2015; Duxbury, Higgins, Smart, & Stevenson 2014; Fleck, Cox, & Robison)), tensions between work and family domains (Kreiner et al. 2009) can have a negative impact on an individual, resulting in stress or work and private domain overload (Kreiner, Hollensbe, & Sheep 2009). Individuals may lose control over their boundaries between work and private life domains (Jackson et al. 2006) resulting in a change from "work anytime and anywhere" to "work all the time and everywhere" (Cousins & Robey 2015; Davis 2002).

In the last decades, researchers have used boundary and border theory to analyse how individuals manage boundaries between work and family domains. Different boundary management tactics, styles and strategies have been developed (Allen et al. 2014). For example, Kreiner et al. (2009) describe different tactics priests use to leverage their technology in order to organize their boundaries within behavioural tactics. Findings of Duxbury et al. (2014) of the adoption and use of Blackberry smartphones indicate that successful boundary management depends on the development of a strategy in order to manage the device prior to adoption. However, research on technology related boundary tactics is sparse. Against this background, the objective of this study is to facilitate greater understanding of individual tactics to manage the boundaries between work and private life domains using information technology.

To answer this objective, the paper is structured as follows. First, we will define and describe the core themes of our study, namely boundary and border theory, and will explain how they have been used in general and in IS literature specifically (Section 2). After explaining our methodological approach (Section 3), we will present our findings in Section 4. In section 5, we will conceptualize and integrate our findings and discuss them in terms of potential generalization beyond our area of interest (Section 6). The paper concludes with an outlook, formulating the limitations as well as implications for future research and practice (Section 7).

10.2 Related Work

10.2.1 Boundary Theory

Boundary theory (Ashforth, Kreiner, & Fugate 2000; Clark 2000; Nippert-Eng 1996; Reyt & Wiesenfeld 2015; Rothbard, Phillips, & Dumas 2005) refers to the way in which people try to create, maintain, change, simplify or order their environment. Specifically, boundary theory focuses on boundaries between roles. Katz and Kahn (1978) outline roles as expectation, placed on an individual in a social system. Therefore, in the context of our study we use the term boundary to describe a limitation of space and edge of a role, varying on a continuum from thin to thick (Allen et al. 2014; Kreiner et al. 2009). Thin boundaries are associated with being weak and open to influence, whereas thick boundaries are supposed to be strong and not influenceable (Ashforth et al. 2000; Hartmann 1991).

Boundary theory has been used in different contexts e.g. psychology, organization theory and political science (Kreiner et al. 2009). Based on a cognitive theory of social classification with the focus on how people prioritize work and home (Allen et al. 2014) boundary theory evolved from sociological work of Nippert-Eng (1996). When applied to the work and family literature, boundary theory describes key challenges individuals face, managing work roles (e.g. as an employee) and family roles (e.g. as a parent) and the transition between those two roles, as they are defined as distinct from one another (Ashforth et al. 2000; Hall & Richter 1988; Kossek & Lautsch 2008; Nippert-Eng 1996). The transition between those roles, as described above, can be of a psychological or physical way and can differ, regarding an individual's preference in terms of their flexibility and permeability (Ashforth et al. 2000). Due to the variance of transitions a continuum of border demarcation arises, showing on the one-hand integrators, (individuals, drawing a thin line between work and family roles) and on the other-hand separators (individuals, drawing a thick line between work and family roles) (Nippert-Eng 1996). Ashforth et al. (2000) further distinguish between macro (infrequent, involving permanent change) and micro transitions (frequent, involving routine activities).

10.2.2 Boundary Management – Preferences, Tactics and Styles

Research of boundary theory states that there is a difference between boundary preferences, tactics and styles. Kreiner (2006) describes boundary preferences as an individual's preferences of either implementing or segmenting aspects of work and private life domains. An important aspect is that an individual's preference describes the wish of an ideal boundary management.

Therefore, individuals use tactics to create their preferred style of segmentation or integration (Kreiner et al. 2009). Whereas the boundary preferences refer to the integration or segmentation preference, the boundary styles refer to the actual enactment of integration or segmentation (Kossek, Rudermann, Braddy, & Hannum 2012).

Kossek and Lautsch (2008) identified three different boundary management styles: integrators (blending work and family domains), separators (dividing work and family domains) and volleyers (switching between those two strategies). In order to define boundary management in more detail, different frameworks developed over time (Allen et al. 2014). Allen et al. (2014) identified two lines of research that arose based on Kossek and Lautsch (2008). One line identifies specific boundary management tactics (Kreiner et al. 2009; Sturges 2012) whereas the other line analyses boundary management styles (Ammons 2013; Kossek et al. 2012).

Kossek et al. (2012) defined six different clusters that can be used to classify individuals that describe how an individual manage its personal preferences of boundary styles. These six clusters (“work-warriors”, “overwhelmed reactors”, “family guardians”, “fusion lovers”, “dividers” and “nonwork-electrics”) differ regarding their control of demarcation, focus on work or family domains and break-behaviour of boundaries (e.g. “fusion lover” and “nonwork-electrics” have a high control in contrast to “work warriors” and “overwhelmed reactors”, whereas “fusion lovers” and “overwhelmed reactors” both focus on both work and family and “work warriors” and “nonworkelectrics” describe the ends of boundary continuums) – focusing on either work for “work warriors” or maintaining a small identification with their family for “nonwork-electrics”. Break-behaviour of “work warriors” is defined by a high permeation from work to private, whereas “overwhelmed reactors” are described by a break-behaviour in both directions – work and family. “Fusion lovers” and “nonwork-electrics” tend to integrate both break-behaviour patterns allowing work permeation during family time and the other way around (Kossek et al. 2012).

Since individuals are able to actively change their boundary style, Kreiner et al. (2009) describe tactics individuals use in order to design their preferred living of work-home integration and segmentation in daily life. These tactics can be of behavioural (e.g. involving other people), temporal (e.g. controlling work time), physical (e.g. managing separate artifacts for work and family domains) or communicative style (e.g. confronting boundary violaters either during or after a violation (Kreiner et al. 2009).

We carefully note that some work has been done in extant literature describing boundary management tactics using information technology. For instance Kreiner et al. (2009) describe a microcategory called "leveraging technology" which is a sub-category of behavioural tactics. This microtactic is linking directly to the use of information technology to manage boundary strategies. In his comprehensive study with Priests, they identify the use of voice-mail, caller ID, e-mail and the Palm Pilot Calendar as technologies that help them to facilitate their boundary management. Similarly, Duxbury et al. (2014) discovered individuals as not being able to segment between the two domains due to a lack of self-discipline and self-control when using smartphones (e.g. Blackberry). Köffer et al. (2015) found six technology-related aspects (dual use of company IT for private task, dual use of private IT for work tasks, remote access to work data, distinct devices for private and work purposes, separate private and business accounts and quality of company provided IT), explaining the intensified professional use of IT. They concentrate on IT which was originally developed for the consumer market to manage boundaries between work and private life domains. Cecchinato et al. (2015) observe the use of e-mail accounts across devices to manage boundaries in more detail, finding micro-boundary strategies in e-mail management.

Although there has been significant research in the field of boundary management so far, only limited research addresses technological aspects on boundary management. Against the background of technological advancement including the emergence of IT Consumerization previous research show that technology influence boundary management (Köffer et al. 2015). Consequently, more research is needed to shed light on technology related boundary management.

Therefore, we want to bridge this gap by further differentiating information technology microtactics. In order to identify these tactics, we conduct an explorative study with the objective to uncover IS tactics used by individuals to manage their boundary styles. Taking a qualitative approach, we build on the foundation of Kreiner et al. (2009), Kossek et al. (2006), Köffer et al. (2015) and Cecchinato et al. (2015) and extend current research by including technology related aspects. In order to address our aim, our research is guided by the following research question:

RQ: How do individuals use IT in order to manage their boundaries between work and private life?

10.3 Research Method

Method selection. Although various studies from psychology and organizational science already explored and analysed individual tactics and strategies to maintain boundaries, information systems research did not exploit the full potential of boundary theory so far. Therefore, this research pursues an explorative approach, to gain insights on how individuals use information systems to implement boundary management tactics. Based on the explorative nature of this study, we made use of tools from Grounded Theory methodology (Glaser & Strauss 1967; Urquhart, Lehmann, & Myers 2010) which is explained next.

Data collection. We conducted a total of 15 interviews (10 males, 5 females). The participants were selected out of different organisations including industrial sector, financial sector, IT-business and public sector. An overview of the interviewees is presented in Table 10.2

Position	**No of Interviewees**	**Average work experience in years**	**Number of the interviews**
Employee	9	6	1, 2, 3, 4, 5, 7, 8, 11, 13
Manager	6	14	6, 9, 10, 12, 14, 15

Table 10.2 Overview of Interviewees

We conducted a two-step approach to conceptualize individual tactics. First, we conducted four semi-structured interviews. We included open questions like "*Do you separate private and business technology?"* or *"What are technological approaches to meet your boundary preferences?"* In this first round, we interviewed doctoral students from the business faculty (employees), because they are provided with mobile technologies and they have a great degree of freedom on how, when and where they work since they are generally managed by objectives.

Based on this first step, we further adapted our questions. We continued by interviewing another eleven individuals from industry. To get insights from different hierarchies, we included both employees and manager. Furthermore, we particularly included practitioners with working experience (9.2 years of working experience in average) to capture individual strategies that have been already implemented.

Data analysis. Following the Grounded Theory approach, we analysed the data beginning with open coding (Corbin & Strauss 1990; Glaser & Strauss 1967). Three of the researchers implemented the procedure of *open coding* independently. They read the transcribed interviews and proposed codes that represent the content. Afterwards, similar codes were collected out of the interviews and grouped as a common denominator what is known as *axial coding*. For instance, for the subsequent citation "*I own an IPhone and it is equipped with the tool to only permit phone calls from people which I chose, at the times which I selected.*" (Interview 1), three independent codes ("filtering", "manage communication", and "automatic filtering") were found. Finally, "filtering" was used as an axial code. Disagreements were discussed with the remaining researchers and settled by a mutual agreement.

We finished our process when all researchers agreed that there is only little chance that new essential concepts would emerge. Since our data highlights key aspects of the integration or separation between work and life, we finish our analysis by relating our results with existing literature (theoretical coding, Section 5).

10.4 Findings

Physical detachment. Kreiner et al. (2009) analysed physical tactics describing dismantling local boundaries between work and private life domains. However, Kreiner et al. (2009) did not link physical tactics to IT. When looking at the interviews, we noticed that employees, having two devices, for example a private device and a corporate device, tend to separate between those two devices. Most commonly, they separate based on the ownership. Therefore, the corporate owned one is exclusively used for work and the private device in exclusively used for private purposes. The following excerpt illustrates this behaviour:

> *"Ultimately, that's why I own two smartphones, one for work and one for my private matters. The same for computers. Generally, I respect the separation to use the company device only for work related issues and my private phone or laptop for everything else. […] Well, that means, I keep the usage of my private device for company matters to the minimum. I would glance at emails via a SharePoint, but I would never download an Outlook Client to have fully access to my company emails." (Interview 12)*

For example, when looking at the private life domain, ways to foster separation using mobile devices could consist of leaving the corporate device at work, switching it off or to turn it to a silent mode. The following quote shows an individual separating using two ways. First, the silent mode is used in order to prevent interruption. Second, he puts the corporate smartphone aside in order to prevent a confrontation with checking it for notifications:

"After my working time, when I am at home or in the gym, I put my phone away – in silent modethen I don´t realize that a message or a call came in and I won´t answer it." (Interview 15)

Automatic notification. As technology enables the automatization of processes, it also opens the door for the individual boundary tactic, especially, in terms of communication applications there are prevailing ready-to-use configurations to define automatic notifications for instance in terms of absence times. A common use of automatic notifications can be found in E-Mail applications. The following excerpt describe how one employee use automatic E-Mail notifications.

"I assigned my email account to automatically answer received emails with the message "Thank you very much for your email, however right now I am unable to answer it, I will be back on XY-day." Obviously, after this email is sent and I return, I will check back to answer it appropriately. Then, of course, it will be my problem." (Interview 13)

Although this excerpt illustrates how automatic notifications can be used, it also emphasize the importance of individual behaviour. Conclusively, if an individual uses that tactic to separate, at this point, technology does not enforce a strict separation.

Pull information. There are different ways of getting access to phone calls, e-mails and further information and notifications. Pulling information describes an individual's behaviour to inquire their current notifications. One way is described as choosing where and when to get access to information and notifications. One employee describes his preference to pull e-mails from web account browser in order to be able to decide when and where to check e-mails:

"I determine the time. […] That´s why I usually use the browser to access my emails. Using the online account, I decide when to check work emails." (Interview 13)

Another employee states his preference on pulling information as viewing notifications on his smartphone, when turned on the silent mode, anytime and anywhere he prefers to:

"Most of the time, my private phone is in silent mode. Now and then, I would check if someone texted me and I would answer, although I am at work. It also depends on the moment, if I am very busy or if I have a little downtime to check my messages." (Interview 9)

Pulling information is described by another employee as a routine defining when and where to check e-mails regarding, working together across different time zones: As different time zones implicate the possibility to get e.g. e-mails anytime, anywhere from everywhere, the employee talks about a routine behavior in order to cope with this permanent flow of information. He talks about a routine describing to pull information when you want to but to answer only if you need to:

> *"As I said, the time in China is 4 am when it is 10 pm here. On the other hand, it is 10 pm here in Germany when it is afternoon in the U.S.. Since my company has offices everywhere, I could receive an email in the middle of the night. The message will be read, but by now, the routine is there." (Interview 10)*

Push Information. Another way on getting information is not to decide when and where to access these information but rather just let these information go through anywhere and to anytime. In temporal intervals, e.g. e-mails being automatically queried, an individual gets to know new notifications using vibration or sounds to signalize these. An employee illustrates below how his emails are pushed anywhere at anytime:

> *"I receive every message. I don´t block out any notification. The internet on my phone is not shut down and I don´t disable private accounts, which I administer with my MacBook. That means, I am available all the time. However, whether I react to the notifications depends on the problem at hand." (Interview 7)*

Another employee states how she decided to get e-mails pushed at an interval of 30 minutes in order to be up to date with her notifications:

> *"Every half an hour I receive a notification. I assume half an hour is enough time, it doesn´t have to be adjusted to a minute-by-minute routine." (Interview 3)*

Different employees confirm that setting an automatic interval in order to get notifications about received e-mails is helpful to be all the time informed about work and private life domains happenings. It is also described as easier due to not to have to log in every time in order to be able to check for example their e-mails. An interviewee states below:

> *"I think that the email account is updated every 30 minutes. [...] I would have adjusted the settings similarly, to avoid logging in every time. However, this setup allows the emails to refresh automatically and I would have a look at the new emails." (Interview 4)*

Dynamic filtering. Employees who want to be available only for important issues when they are at work or at home have the opportunity to filter their incoming messages dynamically. When applying dynamic filtering, only messages or phone calls from specific individuals are received in a set time frame. For example, one employee explained that he told his smartphone to only let through phone calls from his family when he is at work.

> *"I own an IPhone and it is equipped with the tool to only permit phone calls from people which I chose, at the times which I selected. For example, from 10 am until 8 pm, only my family can reach me and they only call when it is important. All other callers are blocked. Like that, I created my own free time." (Interview 1)*

When using this tactic, employees mainly separate work and private life. They only want to integrate work and private life when an intrusion from the other domain is important enough for themselves.

Boundary App. Technology can enable employees to manage their work life balance in helping them to focus on their currently active role. When employees are engaged in their work, technology prevents interruptions from family and private life. Similarly, when employees want to have private time, technology inhibits work related interruptions. Therefore, employees can integrate and separate to a certain degree to their own preferences. One employee illustrated this with a setting in his smartphone that enabled him to switch either to work or to private life:

> *"The new Blackberrys have a feature where you are able to separate work and your private information. That means, on one device you can switch between a work mode and a private mode. The private mode is used for private emails, WhatsApp, Facebook, etc. whereas work related emails can be checked using the work mode of the phone." (Interview 14)*

However, this technology might have both positive and negative effects. The advantage of a boundary app is that one can use the same device for multiple purposes without being interrupted from another life domain. Therefore, they can integrate their work and life at whatever time they like to but still keep this time free from interruptions because they separate. As a downside, at least in the context of our interviewee, there is the risk of invading users' privacy:

> *"The advantage is that I only have one device. However, the downside is that I give my employer information about my private life." (Interview 14)*

10.5 Conceptualization of Individual Tactics

The maturity of technology use is an important aspect with regard to our research question, because it has a major influence on how individuals implement boundary tactics. Maturity in general has been addressed in various IS studies for instance as an overall technological maturity (e.g. Karimi, Gupta, & Sommer 1996) or on an individual level based on self-efficacy (e.g. Venkatesh, Morris, Davis, & Davis 2003). Since we focus on individual tactics, self-efficacy and individual maturity in terms of technology use is most relevant. Automatization of business processes can be understood as a high level of maturity, whereby manual processes can be considered as low maturity (Dumas, La Rosa, Mendling, & Reijers 2013). Based on this distinction we propose four different domains of individual boundary tactics which are summarized in the following table.

Boundary Preference	**Technological Maturity**	**Implementation Tactic**
Integration	High (automatic process)	Integration is integrated by automatic mechanisms (e.g. dynamic filtering)
	Low (manual process)	Integration is conducted loosely through manual mechanism (e.g. manual procurement of information)
Separation	High (automatic process)	Separation is implemented by automatic mechanisms (e.g. automatic response notifications)
	Low (manual process)	Separation is conduced manually (e.g. physical detachment)

Table 10.3 Four Domains of Individual Boundary Tactics

Our findings suggest that there are various approaches to comply with the individual tactic. Since automatization of IT is often on a continuum (ranging from manual to full-automation), a strict separation is of these tactics is rarely possible. For instance, the configuration of a communication filter (e.g. disable phone-calls after 8 pm) has both manual and automatic parts. In that case, we would argue that the core mechanism, namely the filtering, is mainly automatic. Conclusively, we propose a matrix including a continuum from integration to separation (Ashforth et al. 2000) and a continuum describing the technological implementation from manual to automatic. Building on this framework, the domain-affiliation of the different tactics are summarized in Table 10.3

Individual tactic	Primary objective	Examples for technological implementation
Physical detachment	separation	Leaving technology at work when at home; turning work-related technology off when at home or turning technology silent or on vibration.
Automatic response		Using an answering machine; sending e-mail-notifications for e-mails that arrive after hours or on vacation.
Pull Information	mediation between integration and separation	Actively looking up new messages and phone calls without being informed just in time.
Boundary App		Possibility to change actively within the same technology between home and private life domains.
Push Information	integration	Being informed just in time about incoming messages and phone calls.
Dynamic Filtering		Setting up filters that let notifications of specific individuals come through.

Table 10.4 Overview of Individual Tactics

In summary, we identified six major IT tactics that allow individuals to maintain their boundary preferences. As they are located on a continuum (Ashforth et al. 2000), we recapitulate them in the following figure.

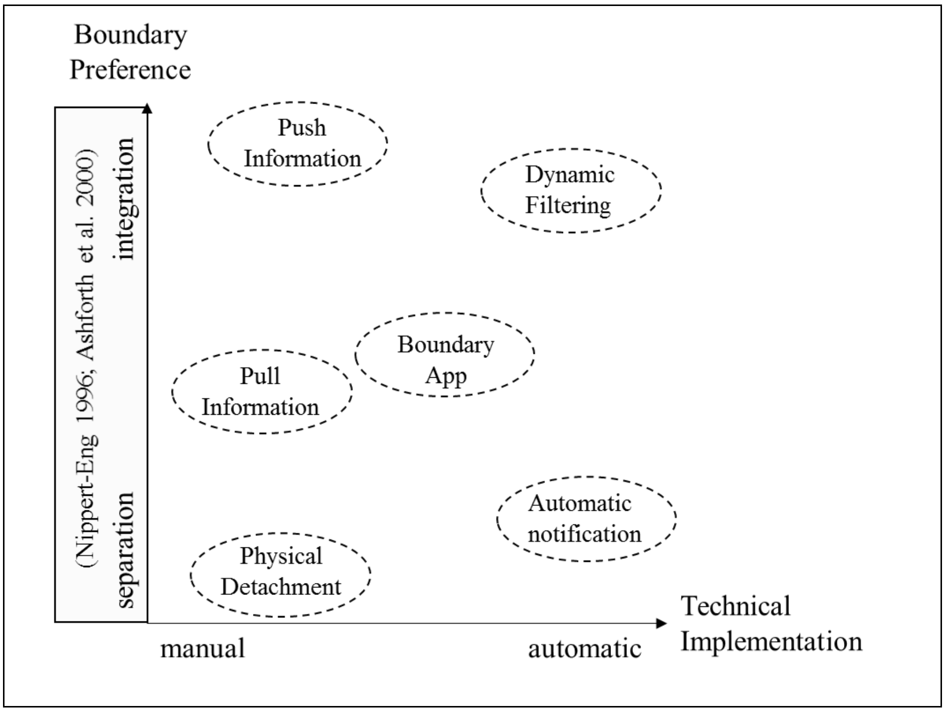

Figure 10.1 IT-related Boundary Tactics

10.6 Discussion

Summary. Information technology fundamentally influences all aspects of our life. It is therefore not surprising that IT enables a multitude of possibilities to implement and maintain individual tactics to meet one's preferences. In order to answer our research questions, we identified six different individual tactics (physical detachment, automatic notification, pull information, boundary app, push information, and dynamic filtering) and systematically categorized them with regard to boundary preferences and technical implementation (see Figure 10.1).

Implications for theory. As our findings propose a more granular distinction of technology-related tactics, they enrich the findings of previous studies. By exploring individual boundary tactics, our research primarily contributes to boundary theory (Ashforth et al. 2000; Nippert-Eng 1996). In particular, our findings enrich the boundary tactics from Kreiner et. al. (2009) by differentiating technology-related tactics. As such we added another continuum dimension besides integration and separation, namely technological implementation, to include technology-related aspects based on their automatization level.

We also contribute to the study of Duxbury et al. (2014) who describe the complex relationship between mobile technologies and individual boundaries. Their results show that developing a strategy to manage the use of mobile devices across work and private life domains is essential for reducing conflicts between work and private life domains. Our findings can be further used to analyse the relationship between mobile technologies and boundary preferences against the background of the identified technological tactics (see Figure 10.1).

Köffer et al. (2015) suggest that there are six aspects related to the consumerization of IT that influence work-life balance. They propose that the allowance or the permission of these aspects leads to work-life balance and conflict. With our findings, we further develop this idea by proposing a set of alternatives that can be used to improve individuals balance (for instance by offering a "boundary app").

Finally, we also contribute to Cecchinato et al. (2015) who put emphasize on micro-boundary strategies related to e-mail accounts. By extending our research beyond e-mail communication, we further identified technology related aspects that are relevant for individual boundary management. Specifically, the use of a mobile "app" that is used for a broad variety of scenarios (email, phone, text message etc.) allows valuable insight into individual strategies, that can be used to further develop the device management as proposed by Cecchinato et al. (2015).

Implications for practice. Based on our findings, we can derive implications for practice regarding the autonomy and the knowledge of the employee as well as the possibilities of the organization to influence an employee's boundary management. First, since individuals have different preferences in general and in terms of boundary management it is recommended that organizations try to offer enough freedom to implement them. Related to technology this can be done by offering chances to adapt and personalize technology.

Second, an individual's knowledge on technology is a main aspect on implementing boundary preferences. Without sufficient capabilities to adapt technology, individuals are not able to meet their preferences. According to person-organization fit (Chatman 1989; French, Caplan, & Van Harrison 1982; Kristof 1996) organizations are encouraged to further train their employees on how to use (mobile) technology with a focus on individual adaptation.

Finally, organizations can easily influence an individual's boundaries by setting defaults. For instance, when using a pull mechanism as default for e-mail communication, it is most likely that a great number of employees do not change to push (Thaler & Sunstein 2009). Therefore, the organization can facilitate separation between private and work life.

10.7 Limitations and Outlook

Limitations. Besides common limitations of qualitative research, this study has limitations that are worth mentioning. First, we asked the interviewees about general tactics related to IT. However, in specific scenarios, for instance employees using wearables or augmented reality technologies which can be even less separated in terms of boundaries than mobile technologies, there might be more tactics which we did not cover so far.

Furthermore, using the level of technology automation is only one possible dimension with regard to technology. Others could be mobility, complexity or ubiquity. Therefore, our findings are limited to only one specific dimension. However, our findings are well suited to transfer to other dimensions as well.

Outlook. As our study explored general tactics with regard to boundary management, our findings propose a sound foundation for future research. Especially with regard to design science, experimental research could further explain various effects by matching individual preferences and the design of IT artifacts. Furthermore, affective technologies can be included in order to be able to identify individual's preferences.

10.8 Acknowlegements

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11 Individualized Design (P2)

Paper Number	**P2**
Title	**Individualized Design: The Role of Individual Boundary Preferences on Technology Acceptance and Work-Life Conflict**
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Table 11.1 Fact Sheet Publication

Individualized Design: The Role of Individual Boundary Preferences on Technology Acceptance and Work-Life Conflict

Abstract. Reaching the ideal level of work life balance can be beneficial for various factors, including well-being and health. Research has already shown that technology plays an important role in facilitating or diminishing work life balance. In this research in progress paper, we want to find out which design elements a) individuals prefer and b) can minimize work life conflict based on their boundary preference. To test our proposed model, we plan to conduct a 2 (Boundary Preference Design: Integration vs. Separation) x 2 (Automaticity: Manual vs. Automatic) between-subjects experiment. With our results, we aim to extend the theory of IT-related boundary tactics by showing which design options are getting preferred depending on the individual boundary preference.

Keywords: Boundary Management, IT-related boundary tactics, between-subjects experiments, boundary preference design.

11.1 Introduction

Due to the increase in mobile devices used by individuals in their work and private life, the importance of setting boundaries becomes more and more relevant (Chen and Karahanna, 2018; Ezzedeen and Zikic, 2017; Klesel et al., 2018, 2016; Köffer et al., 2015; Lim et al., 2017). With the growing number of ubiquitious information systems (IS) (Sørensen and Landau, 2015; Vodanovich et al. 2010), we can see how individuals can adopt hardware and software to reach an optimal balance between work and private life (Baskerville 2011).

Looking at this blurred use of IS, especially with the use of mobile devices, the phenomenon of "IT consumerization" has emerged. IT Consumerization describes the trend that employees use their own Information Technology (IT) (hardware and software (Klesel et al., 2018)), to fulfill working tasks (Klesel et al., 2018; Ortbach et al. 2013). Looking at IT Consumerization from a conceptual point of view, we can see that phenomenon's like Bring-Your-Own-Device (BYOD), which expresses Bring-Your-Own-Behavior (BYOB) are getting more popular (Ortbach et al. 2013).

The increasing availability of technology, fostered by IT consumerization, lets individuals face new challenges to maintain and improve their work life balance (Duxbury and Smart, 2011; Mellner et al. 2014; Sarker et al. 2012). Recent literature have used Boundary and Border

Theory to analyze how individuals manage their work life balance with setting boundaries between work and private life. Especially, previous research have looked at positive and negative effects on an individual's private and work life with information technology (Allen et al. 2014). For example, positive effects (e.g. increased productivity in business tasks (Cecchinato et al. 2015; Cousins and Robey 2015; Duxbury et al. 2014; Fleck et al. 2015)) can support an individual, whereas tensions between work and family domains (Kreiner et al. 2009) can result in stress or work and private domain overload. These results in a negative effect on the individual (Kreiner et al. 2009).

In the last decades different boundary management tactics, styles and strategies have been developed (Allen et al. 2014; Kreiner et al. 2009; Duxbury et al. 2014, Jahn et al. 2016), showing how we use IT to manage work and family domains. Jahn et al. (2016) introduced IT-related boundary tactics individuals use to integrate or separate between work and private life (Jahn et al. 2016). However, research on design options, which are getting preferred depending on one's individual boundary preference are sparse. Based on the IT-related boundary tactics from Jahn et al. (2016) (Psychological detachment, automatic response, pull information, boundary App, push information and dynamic filtering), we aim to develop design elements to first, confirm the assertions of Jahn et al. (2016) and second, to analyze the influence individual preferences have on the acceptance and the work life conflict of design elements. In order to address our objective, this paper is guided by the following research question:

RQ: How do individual preferences influence perceived usefulness and work life conflict of design elements?

This paper is structured as follows: First, we give a short overview of the theoretical background and the development of our model. In the second section, we introduce the method used in this study. Section three will end with discussing our expected findings, proposing implications for theory and practice and showing chances for future research.

11.2 Theoretical Background and Model Development

Boundary Management describes the way of how individuals manage, this includes trying to create, maintain, change, simplify or order their work and private life (Ashforth et al. 2000; Clark 2000; Nippert-Eng 1996; Reyt and Wiesenfeld 2015; Rothbard et al. 2005). Nippert-Eng (1996) shows that a continuum of border demarcation arises due to the variance of transitions, showing on the one hand individuals who integrate (drawing a thin line between work and family roles) and on the other hand individuals who separate (drawing a thick line between work and family roles) between work and family domains.

Existing literature has already differentiated boundary management tactics for technology use. For example, Kreiner et al. (2009) describe a sub-category of behavioral tactics with a micro-category called "leveraging technology". This micro-tactic is relating to the use of information technology to manage different boundary strategies (Jahn et al. 2016). Similarly to Kreiner et al. (2009), Duxbury et al. (2014) discovered individuals as not being able to separate between the two domains of work and family life due to a lack of self-discipline and self-control, e.g. while using mobile devices (e.g. smartphones). Köffer et al. (2015) found six technology-related aspects (dual use of company IT for private task, dual use of private IT for work tasks, remote access to work data, distinct devices for private and work purposes, separate private and business accounts and quality of company provided IT), describing the intense use of IT at work. Jahn et al. (2016) found six different IT-related boundary tactics individuals use in order to go along with their individual boundary preference of separation and integration of the private and work domain.

Qualitative research indicated that employees use different IT-related tactics in order to be able to live their individual preference to integrate or to separate between work and private life and adapt technology accordingly (Jahn et al, 2016). The technical implementations (here referred to as automaticity) were divided into two dimensions, namely manual or automatic implementation. When talking about the manual implementation the individual has to actively engage with the technology in order to be informed, whereas the automatic implementations needs to be set up for once by the individual and is afterwards automatically applied.

Following our objectives, we aim to extend recent research by Jahn et al. (2016) and we introduce our research model for this study (Figure 11.1) with our hypothesis.

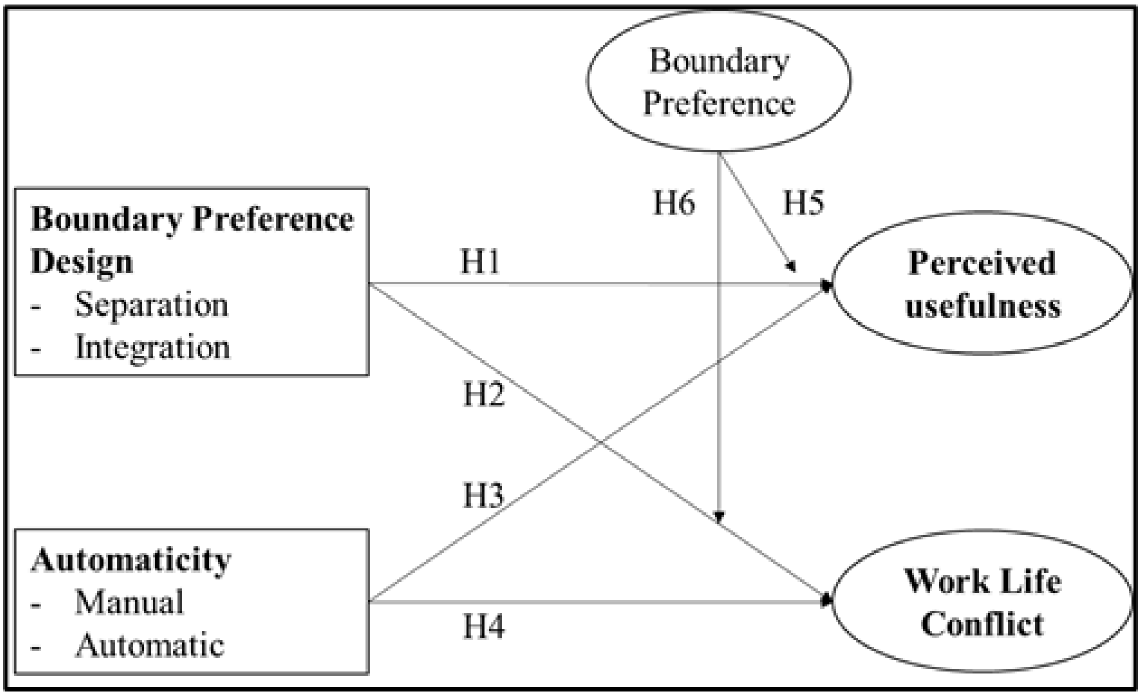

Figure 11.1 Research Model for the Influence of Boundary Preference Design

Aligning to task technology fit (Dishaw and Strong 1999; Goodhue and Thompson 1995) and boundary theory (Allen et al. 2014; Kreiner 2006; Kreiner et al. 2009) literature, preferences of an individual have an effect on usefulness. Technology, which supports an individual's preference, is seen to be more useful (Goodhue and Thompson 1995). As we have different preferences in our study using one specific task, we hypothesize that individuals will find it useful when their preferences will be supported. We decided to use perceived usefulness as it describes an antecedent of acceptance as dependent variable. Thus, we expect that individuals perceive IT, which helps them to follow their preference of integration or separation, as more useful. Additionally, research has yet to investigate whether technology design facilitates individuals' work life balance depending on their individual boundary preference. Therefore, it is important to find out to what extant design options effect work life conflict and address an individual's preference to integrate or separate work and life domains. Because first literature showed a relationship between preferences and enactment, we hypothesize an interaction effect for work-to-life conflict and boundary preference design (Allen et al. 2014).

H1: Boundary preference design for separation leads to increased perceived usefulness compared to integration.

H2: Boundary preference design for separation leads to decreased work life conflict compared to integration.

H3: *Automaticity that reacts automatically leads to higher perceived usefulness than manual implementation.*

H4: *Automaticity that reacts automatically leads to lower work life conflict than manual implementation.*

H5: *The relationship between boundary preference design and perceived usefulness is moderated by individuals' boundary preference. Individuals with a separation preference experience higher perceived usefulness for separated boundary preference design (compared to integrated design) whereas individuals with an integration preference experience higher perceived usefulness for integrated boundary design (compared to separated design).*

H6: *The relationship between boundary preference design and work life conflict is moderated by individuals' boundary preference. Individuals with a separation preference experience lower work life conflict for separated boundary preference design (compared to integrated design) whereas individuals with an integration preference experience lower work life conflict for integrated boundary design (compared to separated design).*

Table 11.2 gives an overview of how the constructs of this study are defined.

Construct	**Definition**	**Source**
Boundary Preferences	"“Segmenters” prefer to keep the two domains as separate as possible, creating and maintaining a boundary or “mental fence” (Zerubavel,1991); “integrators,” (…), prefer to combine elements of both domains, essentially removing boundaries between the two and blending facets of each. Of course, most individuals are not “pure types”—rather, their position on the continuum bounded by complete integration and complete segmentation depends on the particular circumstances and individuals involved."	Kreiner et al. 2009, p. 710
Boundary Preference Design	The degree to which technology design facilitates to enact integration or separation.	Jahn et al. 2016

Construct	Definition	Source
Automaticity	The degree to which a technological implementation can react to events automatic (e.g. through predefined filters) or the user has to react manually (e.g. through deciding the reaction after reading a message for push notification).	Jahn et al. 2016
Perceived usefulness	As an antecedent of acceptance, perceived usefulness shows how users perceive technology to enhance their work life balance.	Agarwal and Karahanna 2000; Davis et al. 1989
Work Life Conflict	“A form of inter-role conflict in which the role pressures from the work and family domains are mutually incompatible in some respect.”	Adam et al. 1996; Ahuja et al., 2007

Table 11.2 Construct Definitions

11.3 Method

11.3.1 Data Collection

Method selection. In order to answer our research questions, we will gather data from an online survey including design options and demographics, including work experience, working position, working hours per week and educational degree. Using an online survey for this purpose is most convincing to address our research question because participants can answer these questions for example on their computer or with their mobile devices (e.g. smartphone, tablet and laptop) which is close to a work life boundary management environment.

Participants. We will recruit 128 participants by promoting the survey via e-mail and facebook. We will recruit participants of different working contexts (e.g. project partners from the public sector and different industrial companies).

11.3.2 Measures

Boundary Preferences. To ask for the individual preferences of the individual we adapt the segmentation preference scale from Kreiner (2006). We use four items describing whether the individual prefers to integrate or to separate work and family domains. Participants will be asked to indicate their preference using a scale ranging from 1 (strongly agree) to 5 (strongly disagree). Aligning to Kreiner (2006) the following item is used as an example: “I prefer to keep work life at work.” (Kreiner 2006).

Perceived Usefulness. To measure perceived usefulness we align to Argarwal and Karahanna (2000). We adapt the scale using a 5-Point Likert scale instead of a 7-Point Likert scale, from 1 (strongly agree) to 5 (strongly disagree) and adapted the items to our context using mobile devices to manage work and family boundaries. One example item for perceived usefulness is: "Using the mobile device enhances my effectiveness at work and private life".

Work Life Conflict. Aligning to Ahuja et al. (2007) we adapt items from Adam et al. (1996), as they used already a short item scale for work life conflict in Information Systems Research. We adapted the scale using a 5-Point Likert scale instead of a 7-Point Likert scale, from 1 (strongly agree) to 5 (strongly disagree): For example, we ask: "If you are not married and/or do not have children, you can choose to respond to these questions in terms of your life outside of work in general (for example, replace "family" with "friends" and think of your other commitments, such as gymnasiums, book clubs, or any other: The amount of time my job takes up makes it difficult to fulfill family responsibilities."

Control Variables: As possible control variables, we ask for Perceived Ease of Use, "It is easy for me to become skillful at using the mobile device.", for Personal Innovativeness, "I like to experiment with new information technologies.", and for Behavioral Intention to Use, "I plan to use the mobile device in the future."

Manipulation checks. We used following self-developed items, measured using a 5-Point Likert scale, ranging from 1 (strongly agree) to 5 (strongly disagree) for a manipulation check. For example, we ask: "I made the setting to get my emails pushed, when I receive them. I had to check my received e-mails autonomous. When I get an e-mail and I am out of office, the sender will get an automatic notification about the date when I am back at the office. I sorted my contacts in different groups, so that I can differentiate between the people I want to get anywhere at any time e-mails from and people I do not want to get notifications from."

Procedure. After opening the link to the survey, a cover page will be provided, including a short introduction that will explain the context of the survey. The short introduction will also assure privacy for our participant´s answers. Next, we will ask participants about their individual preference of separating or integrating work and private life. We will also ask for their average weekly working hours, their average time working at home or in the office, and how many years they had been working at their current employer. Then, participants will be instructed to read the following text before being presented the different design options:

"It is Sunday and you are sitting with your family at the breakfast table. You just submitted an important project report at work on Friday. You worked on this projects and its report for the last three months. You are not sure how your supervisor will react, and in the past, his reactions ranged from only changing a few words to changing the whole concept. You know that it will be fine for your supervisor if you read his feedback on Monday."

Thereafter, four design options (push and pull information, dynamic filtering and automatic notification) will be presented in random order and each participant has to indicate his or her reaction for each design option displayed. We selected the design options because they represent the outer points of the dimensions automaticity and boundary preference design. They are shown in Table 11.3.

Automaticity / Boundary Preference Design	Manual	Automatic
Separation	Scenario 1 – pull information „After breakfast you decide to check your e-mails. You open up your Outlook Application and look actively for responses from your supervisor. "	Scenario 2 – automatic notification "Your supervisor did response to your e-mail and got an automatic notification, saying that you are not available until Monday, when you are back at the office."
Integration	Scenario 3 – push information "Your phone is ringing as you got a new e-mail from your supervisor about the project and you already can read the email while looking on the display of your mobile phone."	Scenario 4 – dynamic filtering "Your phone is ringing as you have got an incoming e-mail from your supervisor. You actively choose your supervisor to be one of the people who are able to e-mail you on the weekend so that you see the e-mail right away."

Table 11.3 Design Options for Pulling and Pushing Information, for Automatic Notifications and for Dynamic Filtering

When participants afterwards open the e-mail, following e-mail will appear:

"Hi,

I just got around proving your work on our project. Enclosed you will find my revisions on your work for our project report. I had some mayor revisions, so please do not forget, that this report needs to be finished by Monday 12am. Please send it to me until Monday 10am, so I can review it for the last time before we have to hand it in.

Best regards

Alex”

Afterwards participants will be asked to answer the questions for the indication of perceived usefulness and work life conflict. Finally, participants have to fill in information about e.g. their gender, age, and had the opportunity to give additional comments in a free text field.

11.3.3 Data Analysis

We will analyze the data using ANOVA and covariance-based structural equation modeling.

11.4 Discussion

With the experiment, we plan to show which design options are preferred depending on the individual preference of setting boundaries between work and private life.

We propose that there will be a possibility to show empirically that the proposed IT-related tactics of Jahn et al. (2016) fit with the way of individual preferences and the way of automaticity. Thus, we propose, that the option of pulling information will be part of the individual preference named separation and the automaticity of manual settings. We also propose, that automatic notifications can be a way of separate automatically between private and work life by installing for example automatic response e-mails upfront, before changing into the domain of another part of life. Looking at pushing information, we propose that this is a possible way of fully integrate work and private life, as e-mails, phone calls and text messages will always come through, not depending on the location, time or domain an individual is located in. We also propose that dynamic filtering is a form of automatic moderation between integration and separation. In this status an individual does not want to get all messages and phone calls from each individual in their life. Instead, an individual can actively choose, which person are allowed to, for example call and come through any time they want.

Implications for theory. We aim to extend future research, specifically by Jahn et al. (2016), in order to show which design options are getting preferred depending on one’s individual preference to separate or integrate between private and work domains. We want to show experimentally that the proposed IT-related tactics of Jahn et al. (2016) match the automaticity and which design options are needed for this.

Implications for practice. Showing which design options are getting preferred depending on one´s individual preference of segmentation and integration, organizations can use our results to support their employees in order to find the right balance between work and private life.

Based on our results, we expect that future research can extend our study by developing a construct for IT-related boundary tactics, giving the possibility to use it for measuring effects on and of IT-related boundary tactics and work life conflicts.

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12 Leading Virtual Teams (P6)

Paper Number	**P6**
Title	**Leading Virtual Teams – A Literature Review**
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Table 12.1 Fact Sheet Publication

Leading Virtual Teams – A Literature Review

Abstract. With the outbreak of COVID-19, many organizations are facing the challenge of switching to virtual work. A large number of teams suddenly need to work no longer physically but digitally together. However, switching to virtual teamwork is not only a special requirement for the team, but also for the leadership of virtual teams. Despite great efforts to explore virtual leadership, research still lacks an overview of the leadership of virtual teams. We address this gap by presenting the results of a narrative literature review conducted by five independent scientists to map the broadest possible spectrum of results with special attention to a heterogeneity of the results. Thereby, our work provides a point of departure for a structured exploration of virtual team leadership.

12.1 Introduction

Almost nothing is as it was before COVID-19. All over the world people are getting sick, schools and companies are closing, and the health system is overloaded in many places. The worldwide pandemic forces us to rethink many areas of life. At the same time, the crisis offers great opportunities. In the work context, for example, digital communication channels are increasingly used and the remote or mobile working is becoming a matter of course (Gaudecker et al., 2020).

Even before COVID-19, many digitization projects were initiated, started and implemented, too (Oztemel & Gursev, 2020). With the advent of the virus, however, digitization had to be carried out much faster. In various organizations, it became necessary at short notice that both the actual work and the cooperation with colleagues had to be carried out digitally. In the past, multinational companies and organizations have faced this challenge with a slower pace. Due to COVID-19, all organizations have to face this challenge and replace the established meeting room with virtual solutions. That is why virtual team meetings are now as much a part of working life for many people as real meetings were before the crisis.

Digital collaboration is not only a requirement for team collaboration, but also for team leadership (Gibson & Cohen, 2003). The implementation of virtual teams had to be done quickly and consistently after the discovery of the virus. Where these processes had often been characterized by long consultations and inhibitions before the crisis, solutions now had to be implemented quite fast. The preparation time for employees and managers was correspondingly short. Best practices and examples of how this could be solved as effectively as possible were of little or no use, as the framework conditions of these examples were completely different from those of the current situation.

Virtual teams have already been considered in research, but a comprehensive overview of the current situation is missing. Further research is needed because the future will continue to be shaped by virtual teams during and sometime after the rapid change. The aim of the paper is to give an overview of the current state of research on virtual leadership and its implementation. It provides a starting point for further research and suggests future studies to investigate virtual leadership in more detail.

To meet the objective, the following sections are structured as follows: First, we give an overview of the virtual teams. Then, we describe our methodological approach and discuss our findings. We conclude with providing potential contributions for theory and practice and highlight the limitations of our work.

12.2 Related Work

What are virtual teams and how are they defined? Existing literature provides different definitions, for example: “Virtual teams are geographically and organizationally dispersed teams […]. Due to such dispersion, physical contact in virtual teams is reduced or lacking altogether which means that collaboration is enabled by IT-solutions such as computer-based communication“ (Lilian, 2014, p. 1251). Under the conditions of COVID-19, many people were enabled to work in such a virtual team, even if they were not actually geographically dispersed. Consequently, this definition does not give a comprehensive answer in the current pandemic. This shows that it is necessary and possible to use hybrid approaches. There is not only one definition of a virtual team but rather a continuum between the design of presence and virtual work (Bell & Kozlowski, 2002). Another study offers a literature review with definitions of virtual teams. It identifies and extends 12 key factors that need to be considered and describes a methodology that focuses on supporting work in virtual teams. (Ebrahim et al., 2009).

The change from presence to virtual work is foremost a process change that must be established itself, like the introduction of software in companies, which is often understood as a process change. Effectiveness increases with the experience of working in virtual teams. Employees need time to get used to the new situation. In addition, communication in virtual teams must be more precise, concise and unambiguous (Bakshi & Krishna S., 2008). This explicit communication is essential to avoid misunderstandings, which can arise practically faster than in personal communication. It is therefore necessary to clearly define areas of responsibility and to set standards and fixed deadlines. The establishment of structures and fixed virtual meetings are important to enable regular ‘personal’ exchanges, e.g. through video conferences. This increases trust in the team, strengthens cooperation despite distance and reduces the feeling of ‘being alone’. Teams generally benefit from communication and from the exchange of personal information between team members. Consequently, this must be possible or made possible in the virtual space (Pierce & Hansen, 2008). Virtual leadership plays a special role in discovering common ground. This strengthens the bond within the team and creates trust among team members and in the leader herself or himself. To achieve this, it is even more important that the team members have the feeling that they are working towards the same mission and master the same challenges. The leadership of virtual teams is a decisive factor. In the literature it is assumed that the establishment of availability times is important, because working hours can vary, and constant availability can lead to an increased stress level (Naik & Kim, 2010).

12.3 Methodological Approach

To answer our research question, we took a close look at existing research (Rowe, 2014; Schryen, 2015). We proceeded our literature review in a narrative manner and carried out the search with five independent scientists in order to map the broadest possible spectrum of results. We searched in common search engines such as Google Scholar, Web of Science, Scopus and PUBMED. We did not make any restrictions according to the year of publication or subject area, because we wanted to cover the widest possible range of sources. In addition, each scientist chose her or his own keywords to ensure the greatest possible variance. Even if some terms were similar (e.g. “virtual teams”, “virtual leadership”, “remote work”), a great heterogeneity was achieved.

After searching, the five researchers gathered the results in a joint workshop, discussed the manuscripts, prioritized them and – if necessary – excluded them. After a comprehensive literature database with all articles was created, every scientist read the texts and was able to gain a broad impression into the state of research on virtual teams. The first insights and intermediate results were then discussed and reflected in workshops with practitioners. Against this background, the current work is composed of theoretical and practical insights.

12.4 Findings

12.4.1 Changing from Presence to Virtual Work

Digital technologies are a prerequisite for digital teamwork. However, the introduction of digital technologies is not adequate to make a virtual team effective (Ebrahim et al., 2009). Internal group dynamics and external support mechanisms should also be considered (Lurey & Raisinghani, 2001). One key task of leaders in the initial phase, is to ensure role clarity, i.e. all team members are aware of the different roles and responsibilities, as a lack of visibility can make the team members feel less able to achieve results (Ebrahim et al., 2009).

In addition, research suggests that virtual team leaders should complement virtual teamwork with structural support (Bell & Kozlowski, 2002; Hoch & Kozlowski, 2014; Kiesler & Hinds, op. 2002). Virtual teamwork is characterized by turbulence and unpredictability, which can be compensated by stability and the reduction of ambiguities provided by structural support (Zaccaro et al., 2001; Zigrus, 2003). Structural support indirectly influences the motivation and behavior of team members via structural attributes (Bell & Kozlowski, 2002). Hoch and Kozlowski (2014) highlight that structural support in virtual teams has a strong positive effect on team performance. Structural support can be provided by a fair, motivating and reliable reward system (Hertel et al., 2005; Hoch & Kozlowski, 2014; Nunamaker et al., 2009), and by a transparent communication and information management (Hoch & Kozlowski, 2014).

Furthermore, literature suggest that virtual team leaders should create a flexible environment by incorporating principles of agile development. This helps to reduce risks related to communication, coordination, and control inherent in virtual teams, and helps teams to improve their communication (Paul et al., 2016; Yadav et al., 2009). To ensure a flexible environment, Paul et al. (2016) emphasize that it is crucial (1) to provide an opportunity to meet together face-to-face at least once initially or, if that is not feasible, to provide an intentional socialization phase, (2) to encourage the teams to discuss and establish project coordination protocols, and (3) to provide adequate technical support, with recommendations of appropriate technology use and support for the technology itself.

However, in addition to the support provided through the leader in switching from physical to digital work, the most important thing is that the leadership acts as a role model (Kayworth & Leidner, 2002; Roy, 2012). Since the team members look to the leader for guidance, it is their responsibility to set a good example (Roy, 2012).

12.4.2 Computer-Meditated Communication

Communication in virtual teams includes the use of computer-mediated communication and thus differs from face-to-face communication (Haines et al., 2018; S. K. Johnson et al., 2009). First and foremost, virtual team communication is usually based on computer-mediated asynchronous information and knowledge dissemination, i.e. different conversations on different topics can be conducted simultaneously by several team members (Lilian, 2014).

Furthermore, research has shown that individuals on virtual teams communicate and participate more evenly (Dennis & Garfield, 2003; Fuller et al., 2016, 2016), but the communication is also more impersonal (Lepsinger & DeRosa, 2015; Schlenkrich & Upfold, 2009). Encounters in the coffee kitchen and office grapevines are missing. One of the most important challenges for managers is therefore to motivate their team to engage in continuous communication, which increases cohesion and motivation, and to build trust, which together leads to successful team performance. (Lilian, 2014; Purvanova & Bono, 2009).

Since virtual teams lack informal spontaneous opportunities to connect, Lepsinger and DeRosa (2015) highlight strengthening the team members' relationships as another important task of the leadership. They suggest different ways to strengthen team cohesion: (1) If celebrations (e.g. birthday parties or debuts) cannot take place physically or some team members cannot be physically present the celebrations should be hosted online. (2) Virtual coffee breaks should be introduced, to give room for informal spontaneous conversations. (3) The virtual team leaders should make "care calls" to get to know the team members on a personal level.

12.4.3 Leadership Style

The leadership style of the team leader is the key to minimize motivation and coordination losses and sustain the effectiveness of virtual teams (Hoch & Kozlowski, 2014).

Existing literature suggests that the transformative leadership style is particularly suitable for virtual teams using computer-mediated communication (Purvanova & Bono, 2009; Ruggieri, 2009). Researchers proposed that transformational leadership is based on four principal factors: Inspirational motivation, idealized influence, individualized consideration, and intellectual stimulation (Kark et al., 2003). To this end, transformation leaders put the interests of their team first, respect the commitments and mission, show qualities that inspire respect and pride, become role models and explore new perspectives for solving problems and achieving goals (Ruggieri, 2009). Purvanova and Bono (2009) suggest that transformational leadership in virtual teams has a stronger impact and that leaders who increase their transformational leadership behavior in such teams achieve a higher level of team performance. Ruggieri (2009) also revealed that a transformational style is more suitable for virtual teamwork than a transactional style, and that a transformational leader is better judged by the team than a transactional leader. The author found that a leader with a transformational style of leadership is associated with more positive adjectives and is perceived as more intelligent, creative and original.

Another research stream shows that in virtual teams the leadership is shared between several team members, i.e. virtual teams usually have not only one but several leaders. (Hoegl & Muethel, 2016; Robert & You, 2018; Ziek & Smulowitz, 2014). The shared leadership style is defined as “a collective leadership process, whereby multiple team members step up to take the lead or to participate in team leadership functions” (Hoch & Dulebohn, 2017). Shared leadership includes every team member in team decisions, promising more inclusion and better team experiences (Marissa L. et al., 2010). Hoch and Dulebohn (2017) have identified from existing literature that shared leadership is advocated as beneficial for virtual teams because it is associated with (1) collaborative decision making (e.g. Conger & Pearce, 2010), (2) collaborative behavior that increases trust and knowledge sharing among other team members (e.g. Hill, 2005), and (3) positive team and organizational outcomes such as performance (e.g. Hoch & Dulebohn, 2013).

12.4.4 Leadership Behavior

12.4.4.1 Presence in Virtual Worlds

The physical, operational as well as the cultural distance inherent in virtual teams confronts leaders of such teams with unique challenges such as successfully influencing team members despite computer-mediated communication (Purvanova & Bono, 2009).

To ensure that virtual team leaders are perceived as such by their team, they need to create a sense of "presence" among their team members (Hoegl & Muethel, 2016). However, the focus should not just be on creating presence in the sense of "being there" but rather "being there together" (Altschuller & Benbunan-Fich, 2010). This creates for one thing a feeling of connection and at the same time strengthens the ties and interpersonal relationships in the team. (Altschuller & Benbunan-Fich, 2010).

Literature reveals various ways in which leaders of virtual teams can create a sense of presence among their team members. First and foremost, it is crucial that the leader also in a virtual environment is always available to the team, i.e. he or she should try to communicate regularly and promptly. (Kayworth & Leidner, 2002; Morgan et al., 2014; Roy, 2012). This is especially important for global teams, since the leadership must be available for all team members regardless of time zones (Lilian, 2014). Thereby, the virtual team leaders should be sensitive to the schedules of the different team members (Kayworth & Leidner, 2002). In addition, the virtual team leader can create presence by providing continuous and timely feedback as well as suggestions for improving team activities. (Kayworth & Leidner, 2002; Mukherjee et al., 2012; Petrucci & Rivera, 2018). Furthermore, the leader should be empathetic, e.g. by being understanding and sensitive to the problems of the team members and expressing personal interest in the individual team members (Kayworth & Leidner, 2002; Roy, 2012).

12.4.4.2 Establishing a Culture of Trust

Sarker et al. (2003) describe trust as the “glue” that propels a team to the successful completion of the project. Trust within a team has a positive effect on the efficiency, effectiveness, and satisfaction levels of global virtual teams (Edwards & Sridhar, 2005). Wilson et al. (2006) defined trust as “confident positive expectations about the conduct of another”. In addition, trust also includes the freedom to test assumptions, to experiment, to make and talk about mistakes (Dixon, 2017).

Since virtual teams are often composed of individuals who have never worked together before, a trusting environment within the team is required (Altschuller & Benbunan-Fich, 2010). Trust is seen more critical in virtual environments than in traditional team settings (Cascio & Shurygailo, 2003) being the necessary condition for cohesiveness and successful work in virtual teams (Child, 2001; Sarker et al., 2003). Trust is based on the belief that team members are dependable meeting the team expectations by delivering what they promise (Cascio & Shurygailo, 2003; Malhotra et al., 2007).

Drawing on literature, Sarker et al. (2003) identified three different bases of trust applicable to virtual teams. Since, trust is significantly evoked, enhanced, developed, and influenced by one’s personality, one basis of trust in virtual teams is the innate personality of their members. The second basis of trust in a virtual team is the institutionally based trust. The institutional trust approach, which is grounded in institutional theory, assumes that norms and rules of institutions surrounding individuals guide their behavior. A third base of trust that occur during interactions between remote members of virtual teams is associated with three cognitive processes (unit grouping, reputation categorization, and stereotyping).

Leaders can foster trust by setting clear and mutual expectations, improving coherence, and inspiring and motivating team members to improve the team's performance and the organization's value creation (Cascio & Shurygailo, 2003; Jarvenpaa et al., 1998). Germain (2011) emphasizes that the leadership of virtual teams should encourage continuous communication to increase trust in the team. Encouraging continuous communication provides the reassurance that others are involved in the task, thereby increasing a member's early confidence in the team. If there is a low level of trust, continuous communication helps to constantly confirm that other team members are present and also working on the project.

12.4.4.3 Embracing Diversity

A natural consequence of global virtual teams is that individuals increasingly interact with others who are different from themselves (Martins & Shalley, 2011). Virtual teams are composed of individuals with a diverse range of stakeholders, experiences, functions, organizations, decision-making styles and interests (Malhotra et al., 2007). The leaders of virtual teams face the challenge of acknowledging this diversity (Cordery & Soo, 2008). All team members should be aware of the diversity within the team and be encouraged to engage with the diversity of the different team members (Barnwell et al., 2014).

The team's ability to succeed depends strongly on how well diversity is being understood, appreciated and leveraged (Malhotra et al., 2007). A pivotal task of team leadership is to transform existing challenges into opportunities in order to improve team success and organizational value creation (Mukherjee et al., 2012; Nunamaker et al., 2009). Literature highlights the need to promote specific team-building activities addressing the individual needs of different team members and promote a sense of belonging (Nunamaker et al., 2009). Moreover, communication within virtual teams can be complicated by dimensions such as different time zones, nationalities and cultures, working styles, and languages. It is up to the virtual leader to address these difficulties. Ford et al. (2017) propose the following approaches to address these difficulties: (1) Provide and organize language lessons for those not speaking the predominant language and, if necessary, provide translation assistance for team meetings. (2) Team members should be reminded of possible communication problems when using slang or regionalized terms. (3) Meeting times should be varied and deadlines as well as turnaround times should be adjusted to take into account the different time zones and working hours of the different team members.

12.4.5 Competencies of a Virtual Leader

Literature highlights that leaders should be competitive, self-confident, visionary and supportive at first (Raisiene et al., 2018). However, leaders of virtual teams are confronted with complex and unique environments where change is constant and group challenges, process complications, and project setbacks might be more commonplace than for traditional co-located teams. Therefore, they often need different or additional skills to effectively lead and guide virtual teams. (K. Johnson, 2010; Ziek & Smulowitz, 2014)

First and foremost, existing literature emphasizes the ability to communicate (Berry, 2011; Kayworth & Leidner, 2002; Roy, 2012; Ziek & Smulowitz, 2014). Through communication, virtual leaders take their position and status within the team (Ziek & Smulowitz, 2014). They must ensure that all communication is clear, concise, and is understandable by members of different cultures (Roy, 2012).

Furthermore, virtual team leaders should be able to defuse frustrations and be involved in conflict management (Brake, 2006; Roy, 2012). Since there are many sources of frustration in virtual teams due to national, cultural and linguistic heterogeneity, defusing frustration and conflict management skills are essential for the success of the head of a virtual team leader (Roy, 2012). Examples of sources of frustration are: Lack of non-verbal communication, technological breakdowns and cultural differences (Brake, 2006; Cleary & Marcus-Quinn, 2008; Roy, 2012).

In addition, virtual team leaders need emotional intelligent skills. Emotional intelligence, includes (1) self-awareness, i.e. the ability to understand the effects of the leader’s behavior on team members, (2) self-regulation, i.e. the ability to think prior to action, and (3) the ability to motivate team members, empathize with them and communicate with them in a skillful way and build relationships (Roy, 2012). Emotional intelligent skills promote the exchange of knowledge and information, create an environment where honest communication can thrive, and can even support problem solving.

12.5 Conclusion

Our literature review on leading virtual teams has shown the significant importance of leadership in the virtual world. It underlines how important it is, especially, but not exclusively, in times of the corona pandemic. It is the strong leader who show their employees how to switch from working on site to a digital workplace. The changeover is more likely to succeed if they act as role models and always try to support the team members as good as possible, e.g. by communicating transparently and by caring for constant involvement. Our overview shows which behavior and which traits a good virtual guide should have. Among other things, she or he should build trust, be empathetic and be open to diverse groups (starting with the tolerance for several time zones). At the same time, it is her or his responsibility to create a culture of "belonging" and "being there for one another", "caring", "listening" and empathy. What is required here is the ability to communicate and to have emotional intelligence. A virtual leader is always available, approachable, addressable, and open. She or he demands by promoting an open mindset, because she or he is a good example herself or himself.

Finally, social factors are also of central importance. If team socialization does not work, there is no trust and no culture of cooperation and support. In this case, one will miss motivation, because the employees will not feel addressed, included, and thus, responsible. If leaders lead in a transformational manner instead, possibly even together with other leaders at the same time, the leadership of virtual teams can be successful. This also includes managing conflicts and recognizing frustration in a team at an early stage. Common successes can be celebrated together and there are regular appointments, professional or casual, where team members can meet and get to know each other as a person.

12.6 Discussion

12.6.1 Implications for Theory

Our work has opened the door for a structured inventory of knowledge about leading virtual teams. It is a first step to get a theoretical overview and an impression about the state of research, but it became obvious that a structured review is needed to continue.

An initial idea for further theoretical work is a detailed examination of the characteristics and personality traits of the leaders. For instance, our work indicated how important emotional intelligence is. This can be further explored to determine the context in which this skill is particularly relevant and how it may be better learned and used.

Another direction can be to look closer at the networks within the team and at the role of trust, commitment, and ‘presence’. How to recognize and address conflicts and how to prevent frustration of individual team members would be another question.

An additional route is to consider literature from the communication sciences to get to the bottom of how to communicate effectively in virtual teams and in a way that is pleasant for everyone. In the digital world, new rules of conversation and innovative communication channels are applied. We see potential in answering how one can use this to strengthen team satisfaction and closeness, or how to prevent misunderstandings. It might be worth to take a closer look on this topic, especially when communicating in different languages and mostly asynchronously.

12.6.2 Implications for Practice

Our research is also beneficial from a practical perspective. From the perspective of effective leaders of virtual teams, our review reveals that an extensive application of management-related social skills (e.g. being empathetic and open towards employees) can be advantageous. By creating a team atmosphere that is characterized by trust, leaders of virtual teams may increase the projects’ successful completion rates (Edwards & Sridhar, 2005; Sarker et al., 2003). This can especially be achieved by performing classic team building measures, such as celebrations, virtual coffee breaks, or ‘care calls’. These measures could also lead to stress mitigation as well as an increased communication between team members. With the help of our research, practitioners might be able to increase their knowledge about the effects of information and communication technology on teamwork.

Where possible, virtual and physical collaboration should ideally be alternated and combined. Lots of measures described by literature to increase the success of virtual teams essentially comprise a return to a face-to-face work environment. Virtual team leaders are thus compelled to introduce opportunities that enable most of the team members to be physically present. A measure to compensate the missing aspects of a face-to-face work environment might be a team meeting on a non-regular basis.

As a member of a virtual team, one might benefit from this research by realizing that work unrelated communication is not considered as a bad habit. Due to missing encounters in the coffee kitchen as well as office grapevines, teambuilding is usually only supported within measures arranged by the team leader. Thus, employees should schedule regular virtual lunches or coffee breaks to keep in touch with their co-workers and exchange work unrelated information.

12.7 Limitations and Future Work

As with all research, our study has several limitations that provide promising avenues for future research. Our chosen literature review method does not offer a comprehensive overview across the virtual teams' research, as the considered literature expands across multiple lines of research including thousands of articles. Future studies could therefore use a different procedure (e.g. structured literature review) to examine a more specialized part of literature.

Although we presented an extensive range of measures that can be applied by virtual team leaders to improve their virtual team's success, we did not present a specific way to achieve the given mindset. This is a vital issue for further studies, as characteristics like empathy or trustworthiness are usually considered as traits and thus cannot easily be adopted by leaders that are not acquainted with the necessary skills.

This research focuses on leadership of virtual teams, however we did not concentrate on the main medium used by virtual teams: Communication. As communication technology usually defines an enabler of geographically divided workforces, it is important for researchers to investigate new methods of communication aside from video-telephony, online chat or teleconferencing. To address this issue, our future work will concentrate on collaboration using Virtual Reality (VR). Compared to current ways of internet-communication, VR can provide a diverging interaction where the software might be able to transfer more or different information, depending on the use case. We plan on using innovative VR hardware and software solutions to examine constructs such as social presence or trust.

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13 Happy Together - How can Virtual Leaders Foster Team Cohesion? (P8)

Paper Number	**P8**
Title	**Happy Together - How can Virtual Leaders Foster Team Cohesion?**
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Table 13.1 Fact Sheet Publication

Happy Together - How can Virtual Leaders Foster Team Cohesion?

Abstract. The impact of COVID-19 on teamwork came abrupt and transformed nearly all teams into virtual teams. A special challenge for leaders of virtual teams, not only in the pandemic, is to foster team cohesion, which positive influences team performance. However, many virtual leaders do not implement cohesion-empowering measures, which in turn can reduce team members’ feeling of belonging to both the team and the organization. Our research responds to this short-coming and presents measures which virtual leaders can integrate to strengthen cohesion. Within 40 interviews in 24 organizations, we identify a wide and comprehensible overview of measures, which can be categorized into “on the job” and “off the job”. Hereby, we not only want to help to overcome the feeling of “loneliness” and “isolation” in the pandemic, but rather contribute to develop a profound feeling of cohesion in virtual teams in the long-term.

Keywords: Team cohesion, virtual leadership, virtual teamwork, grounded theory.

13.1 Introduction

On the 11th March 2020 the World Health Organization declared the coronavirus disease of 2019 (COVID-19) a pandemic (WHO 2020). The outbreak of the virus has changed the way we live and work (AbuJarour et al. 2021). During the crisis, millions of teams worldwide transitioned into virtual teams, which led to enormous challenges (Kohn 2020). Among other things, virtual teams are confronted with social isolation and the lack of informal spontaneous opportunities to connect.

Since remote work has already increased over the past few years but was far from being the norm, the pandemic faces teams, and their leaders with tremendous challenges (Bekirogullari and Thambusamy 2020). Whereas the transformation and implementation of virtual work were often characterized by time-consuming rollout processes, solutions needed to be implemented at short notice (Zeuge et al. 2020). The preparation time was correspondingly short. Leaders transformed to virtual leaders and were forced to modify, adapt, and rethink their leadership behavior to respond to these changes (Hoch and Kozlowski 2014).

Fostering team cohesion poses a special challenge for leaders of virtual teams, not only in the pandemic (Lilian 2014; Malhotra et al. 2007). Team cohesion refers to a team member’s sense of belonging to a team and his or her feeling of morale associated with membership in that team (Bollen and Hoyle 1990). Literature demonstrates that team-building activities (e.g., work outings, lunches, or after-work drinks) improve team cohesion and thereby positive influence motivation, collaboration, and team performance (Bajaj and Russel 2008; Kwak et al. 2019; Yang et al. 2015). However, strengthening the feeling of cohesion is a special challenge for virtual leaders due to the decentralized nature of the teams, the lack of spontaneous opportunities to communicate and interact. Therefore, previous approaches cannot be pursued in virtual teams in the same way. New and innovative approaches are needed to enhance the feeling of team cohesion in virtual teams. This research aims to investigate measures to strengthen team cohesion in virtual teams. Therefore, we aim to answer the following research question (RQ):

RQ: How can team cohesion be fostered by virtual leaders in virtual teams?

To address this RQ, we conducted 40 semi-structured interviews in 24 organizations. We examined team cohesion strengthening measures which can be implemented in virtual environments. Here, we took a closer look at measures which can be applied on the job (i.e., at work) and measures which can be applied off the job (i.e., in breaks or after work). Our research therefore complements existing literature on team cohesion by identifying practice-oriented measures, which can be applied by virtual team leaders. Our findings are beneficial to both, teams that work virtually due to the crisis and teams that were already working remotely before the pandemic. Therefore, we not only add value in the short term, but also in the long term, as many organizations increasingly plan to hybridize their work.

The paper is structured as follows: In the next section we present the theoretical background regarding virtual leadership and team cohesion. Subsequently, we present our methodology. We then present the findings of our semi-structured interviews and discuss our results. Finally, we conclude by reflecting on our findings, highlight the limitations of our research and provide fruitful avenues for future research.

13.2 Virtual Leadership and Team Cohesion

There is a general agreement on the relevance of leadership for virtual teams (Hertel et al. 2005), however, they gain additional importance in the pandemic. Leadership in the context of virtual teams is defined "as the leader's incremental influence over and above general compliance with routine organizational directives" (Wakefield et al. 2008, p. 435). It is characterized as leading in an environment that is other than physical (Williams 2013). Hertel et al. (2005) describe virtual leadership as the management of distributed teams whose members predominantly communicate and coordinate their work via information systems.

Virtual leadership was already being researched intensively before the pandemic (Mehtab et al. 2017; Purvanova and Kenda 2018). However, research on virtual leadership takes on additional importance in times of the pandemic, as it has posed new challenges to leaders (Newman and Ford 2021; Torre and Sarti 2020). For example, Bekirogullari and Thambusamy (2020) investigated virtual leadership in particular for small businesses, since these organizations are less familiar with it. In a similar context, Bartsch et al. (2020) aim to investigate the effectiveness of leadership in relation to employee work performance in virtual environments caused by the COVID-19 pandemic.

Leading teams virtually is fundamentally changing the expectations imposed on leadership (Wakefield et al. 2008). Virtual leaders are confronted with highly complex and unique environments that are in a constant state of change (Roy 2012). Virtual leaders face the challenge of learning how to overcome barriers of time, space, and culture. Appropriate communication, being present, and building trust are essential in this context (Altschuller and Benbunan-Fich 2013; Jarvenpaa et al. 1998; Lepsinger and DeRosa 2015).

Acknowledging that team cohesion is one of the six key facets of “Teamwork Quality” (Hoegl and Gemuenden 2001), literature outlines fostering team cohesion as an important task of team leadership (Kakar and Kakar 2018; Lilian 2014; Malhotra et al. 2007). Bollen and Hoyle (1990) describe team cohesion as the team member’s sense of belonging to a team and his or her feeling of morale associated with membership in that team. Carron et al. (1989, p. 3) define team cohesion as “the tendency for a group to stick together and remain united”. Strengthening the feeling of “unity”, “stick together” and “identity” in virtual teams is important because virtual work, especially in times of pandemic, provides only limited social interactions within the team and lacks informal or spontaneous opportunities to connect (Lepsinger and DeRosa 2015; Yang et al. 2015). Strong relationships within the virtual team and between team members can help to overcome the feelings of isolation (Roy 2012). It is the virtual leader’s responsibility to create a culture of “belonging”, “being there for one another”, “caring”, “listening”, and “empathy” (Zeuge et al. 2020).

The literature suggests that cohesive teams achieve increased collective effectiveness and greater team success (e.g., Bajaj and Russel 2008; Beal et al. 2003; Keith et al. 2018). Team cohesion positively affects the level of objective commitment which in turn can improve team performance (Keith et al. 2018). At the same time, team members of cohesive teams feel more satisfied, have higher self-esteem, conform to group norms, make personal sacrifices for the team, and share responsibility for the obtained results (Kakar and Kakar 2018). Team cohesion strengthens mutual positive feelings toward each other, thus allowing to resolve conflicts in a supportive and trusting environment (Keith et al. 2018).

13.3 Methodology

In our study we used an explorative approach to gain insights into factors that are important for fostering team cohesion in virtual teams from the perspective of both team members and leaders (Flick et al. 2004). Within 40 digital interviews (about 60 minutes in average) we have surveyed 19 team members and 21 team leaders from our research network in Germany in the period from 2021/01/18 – 2021/02/18. Of these, 70% are male and 30% female in an age range of 20 to 61. The average age is about 38 years, with an average age of 43.4 for team leaders and 33.1 for team members. We tried to interview as many couples (team leader and team member from the same team) as possible and surveyed various industries and company sizes (large corporations, small and medium-sized enterprises, as well as start-ups) and municipalities. In the results section, we have abbreviated the different organizations as follows: groups (G), small and medium-sized enterprises, as well as start-ups (SME), and municipalities (M). In the following, for reasons of better readability, we will only speak of organizations, which includes companies and municipalities together. The team size of the interviewed organizations ranges from 3 to 28 team members. Within their organization the interviewees have different professions and hierarchies. This distribution across hierarchical levels was random, but together with the different number of years of career experience, it can be ensured that individual biases are avoided and that different perspectives are considered (Miles and Huberman 1994).

To get a wider range of answers and to give the participants the chance to speak freely, we used a semi-structured guideline with open questions (Pumplun et al. 2019). We followed Sarker's guidelines for qualitative research to avoid the pitfalls of qualitative semi-structured interviews (Pumplun et al. 2019; Sarker et al. 2013). We improved our first version of the questionnaire after three pre-interviews. As a result, we only had to make minor changes to the questionnaire. After another five couples we evaluated again adding and omitting a few questions to get the best possible results, based on the Grounded Theory approach.

The questionnaire is divided into four categories. We started with the introduction of the interviewee and general questions about their career as well as attitude and concern regarding COVID-19. Afterwards we asked how virtual teamwork is put into practice before COVID-19, during lockdowns, and the time in between. For example: "How extensively and for what reasons did virtual teamwork take place before COVID-19? How did this change through the lockdowns and in the time in between?". Furthermore, we identified opportunities and threats within the virtual teamwork with questions such as "What technologies were used for virtual collaboration prior to COVID-19? How are these technologies being used? What are the technical challenges or limitations?" Finally, we asked questions about team cohesion and how the feeling of cohesion can be fostered virtually, for example: "What cohesion strengthening events took place before COVID-19?" "How can a feeling of belonging also be created virtually within your team?". "How can personal relationships be virtually established with other team members?" We ended at the point at which all researchers agreed that the likelihood of gaining significant new insights through further interviews was low.

The recorded interviews were transcribed and analyzed with MAXQDA. We used Grounded Theory methods to analyze the interviews. Two researchers applied independently the open coding, i.e., the sentences and paragraphs were assigned code phrases that best represent the content (Corbin and Strauss 2014; Glaser and Strauss 2017). Afterwards, we compared and grouped the results (axial coding) so that we could specify superordinate measures and best practices (Corbin and Strauss 2014). In this coding paradigm, we looked for factors or challenges that affect the work in the team due to team cohesion. Different opinions were discussed with a third researcher and settled by agreement. For instance, for the subsequent citation: "Or just as I said, just to say thank you to your employees, thank you for throwing yourself into the task or thank you for working so fast, I think that's very important." (G_3_2), two independent codes ("respectful communication" and "communication patterns") were found. Finally, "respectful communication" was used as the axial code. Subsequently, the axial codes were grouped by subject areas. We ended the analysis with saturation, e.g., when no new superordinate measures and best practices were found.

13.4 Findings

Our findings highlight the relevance for virtual leaders to foster cohesion in virtual teams. Building up on these results, we present measures, which we identified in the interviews, to empower team cohesion in virtual teams. First, we outline measures enhancing team cohesion on the job i.e., during working hours. Second, we delineate measures which can be conducted off the job, i.e., in break times or after work.

13.4.1 Relevance for Virtual Leaders to Foster Team Cohesion

Virtual teams collaborate and communicate primally via digital media e.g., e-mail, video- or audioconferences. Therefore, virtual teams enable collaboration across geographical, time, and organizational boundaries (Purvanova and Bono 2009). However, nearly all interviewees stress that virtual work reduces the feeling of team cohesion. The interviewees mention the lack of physical opportunities to interact with their co-workers and leadership as the main driver for this shortcoming.

> *“I think it’s more difficult, to have this team cohesion than when you’ve seen each other every day. [...] If you now only work at home, then, I think it is more difficult to maintain team spirit.” (G_3_2)*
>
> *“You can no longer see each other, you lose contact, which reduces team cohesion.” (M_3_2)*

Team cohesion is an important factor for the success of virtual teams (Beal et al. 2003). Therefore, interviewees see it as the responsibility of the virtual leader to cope with the absence of face-to-face interactions. According to their point of view it is the leader’s responsibility to establish virtual opportunities to strengthen team cohesion, to actively demand participation from all team members, and to ensure that all team members feel integrated.

> *“I think it is part of the leader’s responsibility [...], to create opportunities to establish team spirit virtually as well.” (G_1_1)*
>
> *“[...] and the leadership has to ensure that the individual feels involved.” (G_3_1)*

When it comes to virtual teams, many leaders underestimate the importance of the interpersonal relationship and do not invest enough time in building a cohesive environment. For example, SME_4_2 states that digitization in the organization refers solely to the work context. Measures such as virtual events to foster the cohesion of virtual teams are not considered. Other interviewees state that they are not aware of any measures for empowering team cohesion in the virtual environment or are not able to bring them to action.

“So, digitization is really only there to [...] work off the tasks that existed before. That’s why digitization was implemented. But not cohesion measures.” (SME_4_2)

“I also don’t know [...] what you could do because during the pandemic you can’t plan events that strengthen the team spirit” (SME_3_2)

“We have not carried out any activities. We talk about it, but we can’t implement them.” (M_5_2)

However, the lack of measures to enhance cohesion in virtual teams can have decisive disadvantages for the individual team members. Notably, it is underlined that team members feel isolated and abandoned. SME_2_2 emphasizes that cohesion plays a crucial role in how employees self-identify with the organization and that without a sense of community, employees may not feel committed to the organization. M_2_2 confirms that employees can be lost due to a lack of a sense of belonging and cohesiveness.

“What I’ m missing more and more is personal contact, which makes me feel very lonely.” (G_2_3)

“Because in virtual times, employees can no longer be sufficiently emotionally tied to the organization. Because all this familial relationship (...) with colleagues simply become absent.” (SME_2_2)

“It was in the first lockdown when we hired a new employee who left at the end of the year. And the reason was that he didn’t manage to build up a connection with his colleagues.” (M_2_2)

13.4.2 “On the Job” – Measures

13.4.2.1 Substantive and Personal Exchange

One of the most important challenges for virtual leaders is to motivate their teams to engage in continuous exchange, which increases team cohesion (Lilian 2014; Purvanova and Bono 2009). Here, it is up to the virtual leader to create virtual touch points. In doing so, virtual leaders should ensure that there is time for both substantive and personal exchange and provide opportunities for suggestions for improvement.

“What we introduced [for team cohesion] were more new virtual touchpoints.” (G_2_5)

“To have the time to not only talk about the job, but also to bring in private aspects [...] and to ask: What do you like right now? What works well? What doesn’t? What can be improved?” (G_1_2)

Virtual teamwork requires a frequent substantive exchange among all team members for example in form

of jour fixes, dailies, or weekly kick-offs respectively close-ups. The constant exchange ensures that all team members are always up to date. Everyone is informed about who is working on what, successes and failures can be evaluated, and next steps can be planned. According to M_3_2, this can strengthen cohesion.

“On Mondays we always have a Jour Fixe, where we discuss the week, and on Fridays we review the week and discuss the lessons learned.” (SME_2_2)

“I think if you meet regularly and not only when there is something to discuss, but that you perhaps exchange every morning. And then problems are also mentioned where you can help. So that you realize, even though you are in different places, you can help each other and be a team.” (M_3_2)

For a strong cohesiveness, there has to be time for personal exchange because without a personal level, team cohesion will not be achieved. To this end virtual leaders can deliberately schedule time for a personal exchange in meetings (e.g., jour fixes). The team can inform each other about personal news, share how they are feeling and doing, or discuss topics of general interest (e.g., the latest football results). However, there should not only be a personal exchange within the team, but also bilaterally. For this purpose, the virtual leader SME_2_2 conducts care calls to regularly obtain feedback on how his team is feeling. Furthermore, chat can be used to enable informal virtual communication also spontaneously and barrier-free.

“When we meet, we first talk in general. So not directly we meet and work hard on our points. That we first talk briefly with each other and everyone gives an update on how the situation is and how things are going [...]. That creates a feeling of closeness.” (SME_1_1)

“My leader, calls and asks me even beyond my calendar entries or whatever: How was your day? He also tries to find out how I’m doing personally. […] So that personal level, I think, is very much in demand for leaders in the current times.” (SME_2_2)

“So, since we [...] returned to the home office, we actually discovered the chat function for team [...] Yes, just a spontaneous “hi” or something, just so that you know that the others are still there, and you don’t feel so lonely anymore.” (M_2_1)

13.4.2.2 Communication

The interviews highlight that communication patterns in a virtual team have a decisive effect on team cohesion. Overall, the interviewees prefer open, respectful, trustful, and friendly communication within the team (e.g., G_3_2, SME_3_1, M_2_1). In addition, especially a sensitive communication is stressed for the virtual environment. M_1_2 further underlines that in virtual teams especially, unambiguous communication is important to avoid the possibility of miscommunication. Another way to maintain cohesion in a virtual team is to copy communication patterns from the physical to the virtual environment. For example, M_2_1 has translated his communication behavior into the virtual by sending a greeting by e-mail before the weekend instead of going from office to office.

“I have noticed that often when it comes to assigning tasks, people simply talk about “we” instead of naming a specific responsibility. And I believe that in a conventional team, it would come up more quickly that no one feels addressed exactly with ‘we’.” (M_1_2)

“...then writing an e-mail and wishing the entire team a wonderful weekend, that is a way cohesion can be further maintained.” (M_2_1)

From a technical perspective a lot of interviewees recommend turning on the camera at meetings to increase the feeling of gathering. This allows one to better recognize who is speaking, which face is expressing concerns and who is perhaps waiting to finally be able to say something. In addition, it is suggested that digital backgrounds should be avoided. The insight into the personal “office” (or living room, kitchen) is more authentic and creates a feeling of closeness.

“And I think it’s also very important to turn on the camera. […], it’s important to see others, to have the feeling that you’re not just talking to a picture, but instead a real person, who still has facial expressions and gestures, and yes, that this is also part of the team cohesion.” (G_3_2)

“So, a picture, for example, as a background I find distracting. So, you have the feeling that someone wants to hide something. [...] I think you have more insights into the

privacy of the other person, which also makes working together a bit more pleasant.” (SME_8_1)

13.4.2.3 Interaction within the Team

The interviewees also mentioned several interpersonal principles to be important for cohesion in virtual teams. For virtual teams, just as for teams which do not work remotely, being punctual and keeping agreements is prerequisite (e.g., G_1_2, SME_2_2). Furthermore, the availability of team members and leaders plays a decisive role in virtual teams. At the same time, it is emphasized that availability should be limited to defined time periods to ensure a healthy work-life balance.

> *“Exactly, and because I don’t have fixed working hours, it is important that I can always reach my supervisor if I have any questions.” (SME_4_2)*

> *“Always show that you are available. The availability, as I said, must be limited, but at least within these limits you must be available. And, to communicate when one is not available.” (G_1_2)*

To maintain team cohesion in a virtual team, the leader can proactively initiate further measures: Some interviewed team members note that involving all team members in the decision-making process can strengthen team cohesion. Furthermore, interviewees stress that celebrating success and achievements jointly in a virtual format can also contribute positively to team cohesion. A further suggestion comes from the virtual leader G_2_1, who is very excited about little tokens of appreciation, e.g., sending presents such as merchandise to his team. He believes that this also contributes to the feeling of organizational loyalty.

> *“My boss is someone who likes to actively get the opinion of his employees, for example, when it comes to a pitch he asks […] And that also creates a feeling of team spirit [...]by sharing your screen even in virtual times and everyone can contribute their ideas before he pitches.” (SME_2_2)*

> *“I think something like that strengthens the team spirit when you somehow celebrate successes together […]. That also helps you in some way, in my opinion, to bring the team together”. (G_4_1)*

“I sent it to everyone in my team; eleven small parcels. [...] and they got a cup like this [showing a cup with corporate logo]. That was a big hit. These are gestures that one remembers.” (G_2_1)

13.4.3 “Off the Job” – Measures

13.4.3.1 Break Times

In addition, team cohesion should also be empowered “off the job” i.e., privately, and outside of work (Lepsinger and DeRosa 2015). This has become even more evident during the pandemic. The interviewees highlight to schedule “virtual breaks” to enable personal exchange. Here, it is not important that always all team members or leaders participate. More important is to regularly schedule virtual breaks within the team to exchange ideas, information, or thoughts (e.g., M_1_2, SME_2_1, SME_4_2). The team of interviewee SME_6_1 for example, starts the week with a virtual breakfast.

“Now we have a big virtual breakfast meeting every Monday in this team, where we sit together. What did we do on the weekend?” (SME_6_1)

Other organizations use for example lunch breaks for this purpose (e.g., G_1_1, SME_2_1, SME_6_1, SME_8_1, SME_10_2). This happens in most organizations on a voluntary basis, which is why usually a digital room is unlocked and anyone can dial in who likes as interviewee SME_8_1 explains.

“That’s actually how it’s organized now sometimes via Zoom, that we just have a short lunch break together, especially for the colleagues who are completely in the home office." (SME_8_1)

“[We] emulated our lunches [...] to do something together outside of the official agenda.” (SME_6_1)

A new and creative measure to empower bilateral exchange was described by the interviewee G_3_2. In her organization, a “coffee roulette" has been introduced, where team members are randomly assigned to break-out sessions. As a result, a regular exchange takes place between all team members.

“Our leader has then [...] organized a virtual "coffee roulette". So, just doing something together that doesn’t have to do with work, but still strengthens the team feeling a bit.” (G_3_2)

The interviews also revealed that some teams spend their breaks actively together, in the form of virtual sports sessions. In this way, the teams try to bring movement into the daily routines. G_5_1 remarks that in his organization it is important that sports sessions take place cross-departmental in order to promote the exchange between different teams even more.

> *“We have recently started office chair gymnastics, […] where a colleague of ours […] shows […] a few things, where you can take part.” (SME_10_2)*

> *“This spring there was a small set with skipping rope, rubber bands for fitness at home sponsored by the organization. The last weeks there were also 1-2 times per week three slots each, where exercises were demonstrated [...] everyone could sign up for a session, but the was obligation that the sessions are interdepartmental.” (G_5_1)*

13.4.3.2 After Work

There are also numerous measures to strengthen team cohesion after work. Linking to the last point of the previous subsection, some organizers have initiated sports events after work to strengthen the health and mobility of the team members as well as to empower team cohesion. Further measures are yoga classes, virtual walks, or the common team goal to cover the distance to Glasgow for the World Climate Summit through adding up the walked distance of each team member in a specific time frame.

> *“So, there were yoga courses etc. at the site before that were now streamed virtually.” (G_5_1)*

> *“[…] we did the virtual sponsor run, where the team appeared as a team and spent the whole night on the treadmill, while it was broadcast live to colleagues.” (G_2_3)*

> *“We also do challenges sometimes. We are currently trying out different things, such as walking together to Glasgow, where the World Climate Summit will take place. We use an app where we enter who has walked how many kilometers, and we hope that we will arrive there as a team.” (SME_6_1)*

The interviews also showed that it is possible to celebrate special events virtually, for example Christmas celebrations. Here, some leaders got very creative by sending packages to their teams, which were then unpacked together in a virtual meeting (e.g., G_3_2). At the Christmas party of interviewee G_2_5 the package content served as the basis for the evening’s activities.

“What came about around the Christmas party was actually that part of the team put extremely good thought into it and prepared something really great. Every employee got a package. There were various things in it that could be used for cooking […]. And so, all of them got together virtually that evening via Wonder. Everyone had cooked something for themselves and, yes, everyone saw each other virtually at dinner and with recipes that came out of the team. That was a very special action and who knows, maybe it will be repeated like that.” (G_2_5)

Many virtual teams also hosted virtual game nights. We were able to identify four virtual game types: a) virtual pub quiz (e.g., G_2_5, SME_4_2, M_1_1), b) virtual escape rooms (e.g., G_2_2, G_3_1, SME_6_1), c) Massively Multiplayer Online Games, (e.g., SME_1_2, SME_2_1, SME_2_2), and d) virtual board games such as ludo (e.g., SME_2_1, SME_2_2, or G_1_1). Interviewee SME_2_2 underlines that team cohesion can be fostered by having different teams or parts of the team compete against each other.

“Then this pub quiz, it is of course also an action, it takes place online. […]. You get snacks and stuff that are sent to the team members, so that so everyone feels like they’re part of it.” (SME_4_2)

“But there are other possibilities, like this digital escape room. […] And I have to say that the effects [on team cohesion] are relatively strong.” (G_3_1)

“Or that you simply create an online game that you can play against each other. Or play Ludo or whatever and let the team compete against each other virtually. Maybe also to split his team inside again. We play three against three in some online games.” (SME_2_2)

The events and virtual game nights are supplemented by virtual regulars’ tables. For example, virtual wine, gin, or beer tastings can be organized. Here, there are no restrictions on creativity; some teams order food and arrange joint virtual dinners or organize cooking evenings. However, many of the interviewed teams just host the traditional "after-work-beer" virtually (e.g., SME_1_1, SME_2_2, SME_6_1_6).

“The [...] team in my department did a virtual wine tasting last year. This works quite well, as each employee received a little wine at home and then digitally tasted this wine together.” (G_3_1)

“We baked cookies together virtually.” (G_5_1)

"I just call it "beer call" where we spend time in the evening under a certain motto and have a beer or a glass wine or whatever together." (SME_6_1)

13.5 Discussion

Our results underline the importance of fostering team cohesion for both the team and the team leader. In line with literature, we have shown that empowering team cohesion is an important task of virtual leaders to ensure the team's success (e.g., Lepsinger and DeRosa 2015; Roy 2012; Yang et al. 2015). We examined different measures and best practices to maintain team cohesion in the daily business ("on the job") as well as in break times or after work ("off the job"). Here, we can conclude that one of the most important tasks of virtual leaders is to provide time for substantive as well as time for personal exchange within the team (Zeuge et al. 2020). Furthermore, we can conclude that many traditional measures to strengthen team cohesion are transferable to the virtual environment e.g., "happy weekend"-wishes can be sent per mail, or the after-work beer sessions in a virtual meeting room. However, we also found that some organizations come up with new and creative ways to increase team cohesion, for example, introducing a virtual coffee-roulette or organizing remote sports competitions between virtual teams. In Table 1, we present the best practices found in the respective interviews as well as some exemplary measures to promote team cohesion.

Measures			Examples	Quotes
„On the Job"	Exchange	Substantive exchange	Regular virtual meetings Bilateral exchange	G_7_1; M_5_1; SME_9_1
		Interpersonal exchange	Care calls Instant personal exchange	M_4_1; M_5_2; G_2_4
	Communication	Communication patterns	Unambiguous communication Transfer physical communication patterns to virtual	M_3_1; M_6_1; SME_7_1
		Technical communication	Turn camera on Avoidance of digital wallpaper	SME_1_3; SME_3_2; M_2_1
	Team interaction	Team-Team	Availability in core hours Keeping agreements	G_2_3; SME_1_1; SME_4_2
		Leadership-Team	Celebrating achievements Merchandise by post	SME_3_1; G_2_1; G_4_1
„Off the Job"	Break Times	Socializing	Virtual coffee roulette Permanent virtual break room	G_3_2; G_6_1; M_1_2
		Sport	Virtual yoga class Virtual office gymnastic	G_5_1; SME_10_1; SME_10_2
	After-work	Sport event	Virtual run Virtual challenges	G_2_3; G_5_1; SME_6_1
		Virtual game night	Virtual escape rooms Virtual online Games	M_1_1; SME_1_2; SME_2_1
		Virtual regulars table	Virtual drink tasting and cooking Virtual concerts	G_2_2; SME_4_1; G_3_1

Table 13.2 Overview of Selected Best Practices

As we explained in the section "Virtual Leadership and Team Cohesion", leadership from a distance i.e., virtual leadership, changes expectation imposed on leadership (Newman and Ford 2021; Torre and Sarti 2020; Wakefield et al. 2008). The interviews clearly demonstrate that both team members and leaders have embraced this change. The interviews revealed the changing expectations implicitly (e.g., being punctual) and explicitly (e.g., turning on the camera). The relevance of strengthening team cohesion in virtual teams (Lepsinger and DeRosa 2015; Roy 2012; Yang et al. 2015) was also confirmed by the interviews. Strategies and best practices were developed to address the limited social interactions in a virtual team. Often, the lead leaders themselves have the intrinsic motivation to increase this team cohesion through the identified strategies and best practices. It can be assumed that these best practices, which are perceived positively by all participants, will also increase the motivation of team members (Kwak et al. 2019). The results show that the best practices can be taken up and adapted by other virtual teams, for example. Thus, on the one hand, our research contributes to providing contemporary approaches to understanding virtual teams, especially considering the current situation. On the other hand, these approaches can be understood as a kind of a kit from which virtual leaders can take individual elements for their own management of virtual teams.

13.6 Conclusion and Outlook

We conducted a qualitative study to identify measures virtual leaders can implement to foster team cohesion in virtual teams. Since the success of organizations depends significantly on the extent of team members feeling of “belonging” and “unity” (Beal et al. 2003; Huang et al. 2004; Keith et al. 2018), our research contributes tremendously to practice. By interviewing 40 employees of 24 organizations, we provide a wide and comprehensible overview of practice-oriented measures and best practices for virtual leaders to strengthen team cohesion. Virtual leaders can build up on these and integrate suitable measures into their teams. Thus, our research not only helps to overcome the feeling of “loneliness” and “isolation” in the pandemic, but also beyond the pandemic, as virtual teamwork will further increase.

As with all research, our study has several limitations that provide promising avenues for future research. Since this research is based on a qualitative study, it comes with typical limitations of qualitative studies (e.g., weak internal validation). Apart from those, it is important to acknowledge further limitations: Despite the large number of interviewees, it should be acknowledged that all participants came from Germany. Consequently, the identified measures reflect the work and leisure culture of Germans. We encourage future research to supplement these by measures and best practices of other cultures and nations. This would allow virtual team leaders to respond to the cross-national and cross-cultural nature of virtual teamwork. Furthermore, it should be mentioned that the results mainly provide a practical contribution. The theoretical contribution is limited to supporting the relevance of team cohesion and the role of the leader for team cohesion in virtual teams as demonstrated by literature. An initial idea for further theoretical work is an investigation of the characteristics and personality traits of virtual leaders for team cohesion. For instance, our work indicated the relevance of emotional intelligence. Here, further research can be conducted to determine how emotional intelligence can be learned and used to improve team cohesion.

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14 The “New Normal” of Virtual Team Cohesion (P13)

Paper Number	**P13**
Title	**The “New Normal” of Virtual Team Cohesion – a Qualitative Study to Investigate the Impact of COVID-19**
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Table 14.1 Fact Sheet Publication

The “New Normal” of Virtual Team Cohesion – a Qualitative Study to Investigate the Impact of COVID-19

Abstract. A strong sense of virtual team cohesion can have a variety of positive effects, such as increased performance or self-esteem. For several decades information systems researchers have been studying both task and social cohesion and how to maintain such cohesion in the virtual. However, since one of the major challenges of the pandemic is dealing with feelings of social isolation, research outlines that COVID-19 had and still has a significant impact on virtual team cohesion. Our study examines the “new normal” of virtual team cohesion i.e., how virtual team cohesion strengthening measures have changed in times of the pandemic. To this end, our study presents the findings of a qualitative study with 26 individuals. We were able to shed light on how such measures changed on-the-job, in breaktimes, and after work. Therefore, we provide insights in the “new normal” of virtual team cohesion, which can inform research and practice.

Keywords: Virtual team cohesion, new normal, social team cohesion, task team cohesion, COVID-19, qualitative study

14.1 Introduction

The World Health Organization declared COVID-19 a pandemic on March 1, 2020 (WHO 2020). The pandemic had and still has a lasting effect on our daily lives (AbuJarour et al. 2021). To contain further spread of the virus, multiple nations went into a lockdown and in-person contact was reduced to a minimum, colloquially known as “flattening the curve” (Anderson et al. 2020). These measures succeed in stemming the exponential spread of the virus, but at a horrendous cost to social coexistence (Tabish 2020).

The pandemic has led to a shift in teamwork from face-to-face interaction to virtual teamwork, often referred to in the literature as remote or distributed work/collaboration (Kohn 2020; Venkatesh 2020). The contact restrictions caused by the pandemic pose both temporary and permanent challenges (Hwang et al. 2020). To this end, work teams are forced to change the way they have been working (Carroll and Conboy 2020): physical meetings became virtual meetings and collaboration shifted from physical to virtual (Herath and Herath 2020).

Even though many teams already incorporated virtual collaboration to some extent, the pandemic changed and changes virtual team collaboration in a lasting way (Klonek et al. 2021; Waizenegger et al. 2020). The main reason why virtual collaboration is very different from pre-pandemic is that virtual collaboration is enforced (Richter and Richter 2020). In addition, the pandemic forced the collaboration of different types of employees, including those who previously either did not want to collaborate virtually or were not permitted to do so, for example due to organizational policies (Chamakiotis et al. 2021). Since, the pandemic has changed virtual team collaboration in a lasting way, research highlights to investigate the influence of COVID-19 on virtual collaboration (e.g., Klonek et al. 2021; Waizenegger et al. 2020).

Team cohesion is one of the six key aspects of teamwork quality and therefore a prerequisite for successful team collaboration (Bajaj and Russel 2008; Paul et al. 2016; Yang et al. 2015). Team cohesion is generally understood as the tendency of a group to stick together and stay united (Carless and De Paola 2000; Carron et al. 1989; Paul et al. 2016). Thereby, team cohesion can be divided into social cohesion, which describes the interpersonal bonds within a team and between team members, and task cohesion, which describes the degree in which team members collaborate in an integrated manner to accomplish a team task (Mikalachki 1969). Strengthening the feeling of cohesion in the virtual is even more important because the physical distance can transform into a psychological distance, resulting in demotivation, frustration, and feeling of being left alone (Garro-Abarca et al. 2021; Lepsinger and DeRosa 2015; Paul et al. 2016).

As one of the major challenges of the pandemic is dealing with feelings of social isolation (AbuJarour et al. 2021), strengthening virtual team cohesion became and becomes even more important (Whillans et al. 2021). To this end, literature emphasizes to investigate the influence of COVID-19 on virtual team cohesion (Zeuge et al. 2021). This study addresses this promising research area and examines the “new normal” of virtual team cohesion. “New normal” refers to the changed working environment caused by COVID-19 and subsequent developments (Carroll and Conboy 2020). By shedding light on the “new normal” of team cohesion in virtual teams we explore how measures of maintaining team cohesion in virtual teams have changed in times of the pandemic. To this end we address the following research question: How has COVID–19 impacted virtual team cohesion?

14.2 Virtual Team Cohesion

Team cohesion satisfies one of the most basic human motivations: the need to belong (Severt and Estrada 2015). Researchers have proposed many alternative definitions of team cohesion. For example, Festinger (1974, p. 274) defines team cohesion as “[…] the total field of forces which act on members to remain in the group. These forces may depend on the attractiveness or unattractiveness of either the prestige of the group, members of the group, or the activities in which the group engages.”. Bollen and Hoyle (1990) describe team cohesion as the team members’ sense of belonging to a team and their feeling of morale associated with membership on that team. In this study we refer to Carron et al. (1989, p. 3) and define team cohesion as “[…] the tendency for a group to stick together and remain united.”.

In 1969, Mikalachki divided team cohesion into social and task cohesion. Social cohesion describes the interpersonal bonds that exist between the team members (Mikalachki 1969). Task cohesion describes the members’ shared commitment to the team task (Zaccaro 1991; Zaccaro and Lowe 1988). This distinction has received much attention, with much research efforts demonstrating support for the notion of separate dimensions (Grossman 2015). For example, a meta-analysis by Mullen and Copper (1994) showed that task cohesion is a stronger predictor of team performance than social cohesion. Other research found that social cohesion is more strongly related to team member satisfaction, while task cohesion is more strongly related to a reduction in absenteeism (Zaccaro 1991; Zaccaro and Lowe 1988).

Team cohesion relates to a variety of positive team collaboration outcomes in a significant way: for example, team cohesion has been linked to increased individual performance and therefore to greater team performance and success (e.g., Bajaj and Russel 2008; Beal et al. 2003; Keith et al. 2018). Cohesive teams are more satisfied with the team process, and are more cooperative and coordinative (Lu 2015; Paul et al. 2016). In addition, team cohesion positively influences team members attitudes, their level of engagement, and their motivation (Carron and Brawley 2012; Keith et al. 2018; Mathieu et al. 2015). Further, team cohesion can have a positive effect on loyalty of team members and their organizational commitment (Greer 2012).

Creating a culture of “belonging” is even more important for virtual team collaboration (Zeuge et al. 2020). The distance between virtual teams may turn into a psychological distance between them (Garro-Abarca et al. 2021) because the degree of team collaboration is lessened due to the limited transmission of rich information (Huang et al. 2009). Virtual collaboration offers limited social interactions within the team compared to physical collaboration and lacks informal or spontaneous exchange opportunities (Lepsinger and DeRosa 2015; Yang et al. 2015). Therefore, strengthening team cohesion is particularly important for collaboration in virtual teams (Lilian 2014; Purvanova and Bono 2009). Cohesive relationships within the virtual team can help to overcome the feelings of loneliness and social isolation (Roy 2012).

14.3 Methodology

In our study we investigated the influence of COVID-19 on virtual team cohesion (Flick et al. 2004). In digital interviews (60 minutes on average, over a span of two month, via Zoom/Microsoft Teams), we interviewed 26 employees from 14 different organizations in Germany. In the following we highlight the distinction between the organization types as follows: 7 large-scale corporations (C) with 14 interviews and 7 small and medium-sized enterprises (SME) with 12 interviews. All interviewees had already worked in virtual teams before the pandemic. We ended our research when all researchers agreed that theoretical maturity was achieved.

To get a wide range of answers and to give the interviewees the chance to speak freely, we used a semi-structured interview-guideline with open questions (Pumplun et al. 2019). We followed Sarker’s guidelines for qualitative research to avoid the pitfalls of qualitative semi-structured interviews (Pumplun et al. 2019; Sarker et al. 2013). We revised our first version of the interview-guideline after three pre-interviews. As a result, we added and omitted some questions. After another five interviews we evaluated again and only had to make a few more changes to our guideline.

The interview guide is divided into four parts: We started with general questions about the interviewee (e.g., their age, their background). In the second part, we asked questions to understand how virtual collaboration has been put into practice before the pandemic and today (e.g., How extensive and for what reasons did virtual teamwork take place before COVID-19? How has this changed as a result of the pandemic?). The third part identified opportunities and risks of virtual collaboration (e.g., What technologies were used for virtual collaboration before COVID-19? How has this changed as a result of the pandemic?). In the fourth part, we asked questions about virtual team cohesion and how virtual team cohesion was maintained before the pandemic and today (e.g., What cohesion-building activities were implemented before COVID-19? How were personal relationships built with other team members? How has this changed during the pandemic?).

The interviews were analyzed using the MAXQDA software by means of bottom-up coding methods: in a first step, we read the transcribed interviews and applied the open coding method independently. The sentences and paragraphs were assigned code phrases that best represent the content (Corbin and Strauss 2014; Glaser and Strauss 2017). In a second step, we collected similar codes from the interviews and converted them into axial codes (Corbin and Strauss

2014). In a third step, different opinions were discussed and settled by agreement. In a fourth step, the axial codes were grouped by subject areas. We ended the analysis with saturation.

14.4 Findings

In the following, we outline how COVID-19 impacted virtual team cohesion. To structure our findings, we describe how measures to strengthen team cohesion changed on-the-job (i.e., during work), in breaktimes, and after work. We do this by first delineating what team cohesion measures took place before COVID-19 as well as how they took place, and then describing how those changed in times of the pandemic.

14.4.1 On-the-Job

Pre-pandemic, nearly all virtual teams emphasized both starting and closing the week together. The goal of the joint start of the week was to communicate what was coming up in the week and to plan out the week. At the joint closing, the week was evaluated retrospectively, and a glance was taken at the next week.

> *“So, we always had a substantive exchange on Mondays. [...] We came together and discussed things that were planned for the week. At the end of the week, [...] we have discussed the week retrospectively and maybe also the next week’s agenda.” (SME_2_2)*

The joint start and closing of the week were maintained by all virtual teams during the pandemic. However, while the focus pre-pandemic was on exchanging work-related information, the virtual teams now also take time to talk about more personal matters. For example, leisure plans for the upcoming weekend are shared or the latest sports results are discussed.

> *“We start Monday morning at nine, we always start the week together, and then we simply talk about personal stuff for 20 minutes. We wouldn’t have done that in the past, I would have pretty much said chop, chop, chop, that’s what we’re doing now. Now it’s important for us to start and end together more personally.” (C_2_4)*

Besides regular weekly kick-off and closing meetings, many virtual teams held regular jour fixes prior to the pandemic. The jour fixes had primarily an informative function. The focus was on presenting (partial) results achieved and communicating future strategies and goals. In addition, it was ensured that everybody was informed about who is working on what, next steps were determined, and tasks were assigned within the team.

> *“In our jour fix we had the freedom to discuss a task, to present the result and distribute tasks. This way we brought a structure into the daily work routine.” (C_1_2)*

Due to the pandemic, the nature of the jour fixe has changed. As before, the informative character is maintained to further ensure that all team members are up to date. In addition to the informative aspects, however, social aspects are also taken into account. The jour fixe is used to share information about the individual well-being of the team members and to talk about non-work-related topics and interests.

> *“Now we try to address more social aspects. To have the time to not only talk about the job, but also to bring in private aspects.” (C_1_2)*

> *“The jour fixe during the week is not so much about content. [...] We simply spend 20 minutes talking personally and sharing how we’re doing. We didn’t do that before.” (C_2_4)*

Prior to the COVID-19-pandemic, many virtual teams used audio instead of video conferencing for collaboration. There were several reasons for this: many teams were previously not equipped with the appropriate hardware and/or software. In other teams, organizational guidelines prevented the use of cameras. Additionally, there were also teams that did not see the need for video conferencing.

> *“Before the pandemic, we never used our webcams. We only used audio conferences. I think we didn’t need it.” (C_1_1)*

Due to the pandemic and related curfews all interviewees stated that they turn on the camera. On the one hand, the interviewees feel that this can reduce the perceived distance. On the other hand, the video transmits the body language of the other team members. This enables one to better recognize, which face is expressing concerns and who is perhaps waiting to finally be able to say something.

> *“The availability of technologies has changed. [...] Before (the pandemic), web cams were not used. And now? [...] Web cams were bought, so video conferencing was also possible.” (SME_1_2)*

> *“But with the start of the first lockdown, [...] we decided as a team that we had to turn on the camera so we could see each other. And that became a routine. [...] I think it's better if you can at least see a little bit how the other person reacts.” (C_5_1)*

The virtual teams that used video conferencing for collaboration prior to COVID-19 reported that they used digital wallpapers (e.g., with an organization logo) to avoid giving team members insights into their physical surroundings. This prevented team members from gaining insight into private rooms or their whereabouts.

> *“We always used a digital wallpaper before.” (SME_1_3)*

Most interviewees report that they no longer use digital wallpapers. For them, the insight into the personal “office” (e.g., living room, kitchen) allows team members to identify common interests or learn more about the private lives of their team members. From the perspectives of the interviewees this is more authentic and creates a feeling of closeness.

> *“So, a picture, for example, as a background I find distracting. So, you have the feeling that someone wants to hide something. [...] I think you have more insights into the privacy of the other person, which also makes working together a bit more pleasant. And I think this personal aspect is especially important […] in these times.” (SME_5_1)*

Pre-pandemic, many interviewees indicated that they used chats primally to ask and answer questions at short notice in their virtual team. Thus, a substantive exchange was the main purpose for using chats. Moreover, the interviewees reported that there are clear rules on how to use chats in their teams.

> *“We used to handle chats in the team very responsibly. We had clear rules here.” (SME_2_2)*

Since the pandemic, chats have been used more informally. Interviewees mentioned that they use chats for asynchronous social interactions such as birthday wishes or to send jokes, Graphics Interchange Formats (GIFs), or videos to their team members.

> *“We have been writing a lot more in the chat since the pandemic. And we also try to use the GIF function very extensively, [...] to make the work a bit more fun. […] So, more informal I would say.” (SME_7_2).*

14.4.2 Breaktimes

Nearly all interviewees described that before the pandemic, it was common to turn off the computer and leave the workplace during breaks (e.g., to eat lunch or to go for a jog). In addition, team members flexibly scheduled breaks based on personal preferences and/or their work.

> *“We’ve always been able to be very flexible with our lunch breaks; for example, I sometimes jog for two hours on my lunch break.” (C_3_1)*

The interviewees emphasized that the relevance of personal exchanges within breaks had increased during the pandemic. They reported that they had created opportunities for their teams to spend breaks together virtually. To that end, many virtual teams have set up virtual break rooms where anyone who wants to can dial in at any time. In this regard, interviewees emphasized that it was not important that all team members or leaders always participate. Rather, they reported that although use the break room was voluntary, the virtual break room was widely accepted and regularly used by their teams.

> *“We now have a Zoom-lunch break, which is voluntary. [...] During lunch, you can just join in and talk to your colleagues. Very informally. To create a spontaneous personal exchange.” (SME_3_2)*

> *“That’s actually how it’s organized now sometimes via Zoom, that we just have a short lunch break together, especially for the colleagues who are completely in the home office.” (SME_5_1)*

In addition, it became apparent that many virtual teams transfer the possibilities of physical collaboration to the virtual in order to promote informal and personal exchange (“office grapevine”). For example, the spontaneous coffee break at the coffee machine was virtualized by introducing a virtual “coffee roulette”. Here, team members are randomly assigned to break-out sessions and can exchange ideas over coffee. In this way, a regular informal and personal exchange takes place between all team members.

> *“Our leader has then [...] organized a virtual “coffee roulette”. So, just doing something together that doesn’t have to do with work, but still strengthens the team feeling a bit.” (C_3_2)*

The interviewees reported that not only opportunities for exchange were created. Rather, since the pandemic, virtual teams have also been actively spending their breaks with each other, for example in the form of virtual sports sessions (e.g., virtual yoga class, virtual office gymnastic). A few interviewees also mentioned that they organized virtual games in their breaks. Organizations have also organized these sessions across teams to strengthen inter-team cohesion.

> *“We have recently started office chair gymnastics, […] where a colleague of ours […] shows […] a few things, where you can take part.” (SME_7_2)*

> *“Or that you simply create an online game that you can play against each other. Or play Ludo or whatever […]. Just taking a break for half an hour in between and go for it. [...] And these are things you should do now in the pandemic.” (SME_2_2)*

14.4.3 After Work

Measures to strengthen team cohesion after work have also changed. Pre-pandemic, large-scale events such as Christmas parties or organization celebrations were mainly used to come together physically as a virtual team. In addition, internal team events such as visiting outdoor parks or participating in organization runs were also used to strengthen team cohesion. A few interviewees reported that they also hosted virtual team events prior to the pandemic, but they were less accepted and preferred. However, almost all interviewees confirmed that there were no spontaneous activities to strengthen team cohesion after work.

> *“Before COVID-19 there were Christmas parties. And then there were also a summer party and family parties [...] So it was more planned events and less spontaneous.” (SME_1_2)*

> *“My policy was always to have virtual events at least once a quarter to keep the mood high. [...] For example celebrating achievements. […] However, this was not as well accepted as physical events. Only a few people joined in.” (SME_2_1)*

In the pandemic, it became apparent that planned physical events such as Christmas parties or organization functions were virtualized to reduce the risk of infection. Here, some virtual teams got very creative by sending packages to their team members, which were then unpacked together in a virtual meeting. At the Christmas party of interviewee C_2_5, the package contents served as the basis for the evening’s activities.

“What came about around the Christmas party was actually that […] every employee got a package. There were various things in it that could be used for cooking […]. And so, all of them got together virtually that evening via Wonder. Everyone had cooked something for themselves and, yes, everyone saw each other virtually at dinner and with recipes that came out of the team.” (C_2_5)

Several interviewees reported that many additional events took place in their teams during the pandemic. These included wine, gin, or beer tastings or jointly organized cooking evenings. Some interviewees mentioned that they participated in virtual sport events with their teams during the pandemic. These sporting and physical competitions have additionally fostered cohesion in the virtual teams.

“The [...] team in my department did a virtual wine tasting last year. This works quite well, as each employee received a little wine at home and then digitally tasted this wine together.” (C_3_1)

“[…] we did the virtual sponsor run, where the team appeared as a team and spent the whole night on the treadmill, while it was broadcast live to colleagues.” (C_2_3)

In addition, many virtual teams planned virtual game nights. The interviewees feel that games (such as virtual pub quizzes, virtual escape rooms, massively multiplayer online games, or virtual board games) within or between different virtual teams could strengthen the feeling of cohesion, because they can tackle challenges that have nothing to do with work in an informal and creative way.

“But there are other possibilities, like this digital escape room. […] And I have to say that the effects [on team cohesion] are relatively strong.” (C_3_1)

It is particularly interesting that in times of the pandemic, opportunities were created to meet spontaneously virtually after work, in addition to the planned events. Here, the opportunities that arise from teams working together in the same place were transferred to the virtual space. For example, video conferences were used to meet for an after-work drink or regulars’ table.

“Now, in times of the pandemic, I ask my teammates if they feel like having a beer in front of the monitor after work and [...] chatting or whatever.” (SME_2_1)

14.5 Discussion

In this study we investigated how COVID-19 impacted team cohesion of virtual teams. By conducting 26 interviews, we were able to shed light on how team cohesion measures changed on-the-job, in breaktimes, and after work as a result of the pandemic (see Figure 1).

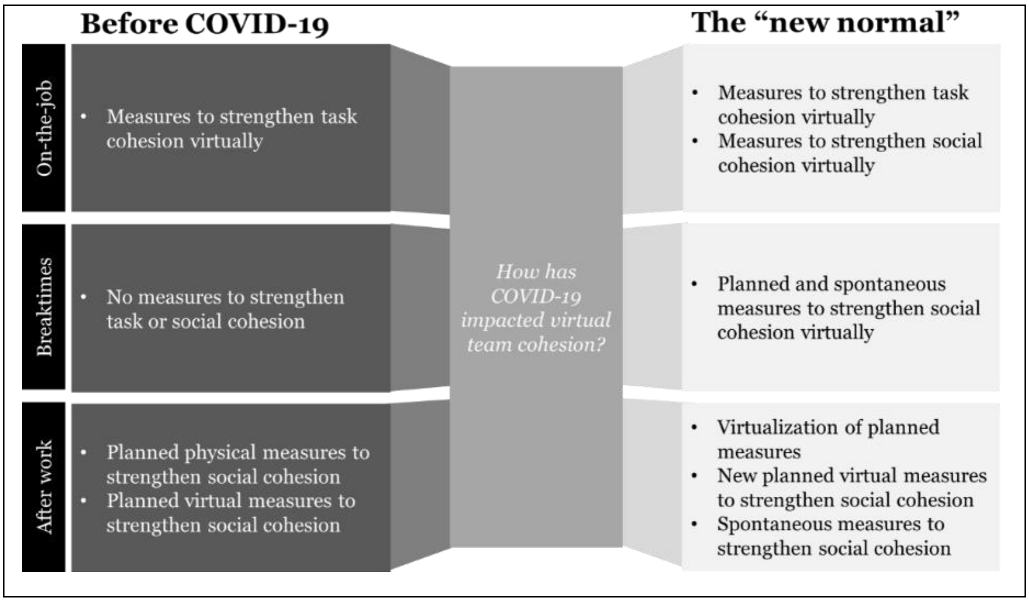

Figure 14.1 The Impact of COVID-19 on Virtual Team Cohesion in Virtual Teams

Pre-pandemic, measures to strengthen the cohesion of virtual teams **on-the-job** were mainly task oriented. The focus has been primarily on effective and efficient virtual team collaboration and hence on measures to enable planned (e.g., regular virtual meetings) and spontaneous substantive exchange (e.g., chats). Thus, the shared commitment to the team task could be strengthened (Zaccaro 1991; Zaccaro and Lowe 1988). These measures continued during the pandemic. However, due to the pandemic social cohesion in virtual teams has become more important to overcome feelings of isolation and loneliness (Whillans et al. 2021). Since continuous personal exchange increases the feeling of social cohesion in a team (Lilian 2014), many virtual teams deliberately scheduled time for personal exchange with the onset of the pandemic, even in meetings that were previously purely content-based (e.g., jour fixe). In addition, many virtual teams took measures to strengthen the feeling of being together in the virtual (e.g., camera on, avoid digital wallpapers) (Zeuge et al. 2021).

Before the pandemic, measures to strengthen social cohesion in virtual teams were mainly conducted after work. In other words, **breaktimes** were spent individually by team members. In our interviews, we could observe that breaks take on a new importance for social cohesion in the pandemic. We were able to identify measures to foster spontaneous personal exchange (e.g., virtual lunch breaks) as well as planned events (e.g., virtual sport sessions). Interestingly, both the spontaneous and planned measures were initiated as a grassroots movement by virtual teams. This may be explained by the fact that social interactions are very important for the well-being of employees (Kakar and Kakar 2018). At the same time, the feeling of being part of a team can reduce the risk of loneliness and the feeling of being left alone (Roy 2012).

Social cohesion in virtual teams was mainly maintained **after work** before the pandemic. To this end, team events or organizational events, such as Christmas parties or summer parties, were organized physically. There were also team events, which were already conducted virtually (e.g., celebrating achievements). However, due to the pandemic all planned events were virtualized (e.g., virtual Christmas parties) and were widely accepted. Indeed, with the outbreak of the pandemic, many virtual teams planned new and more regular events (e.g., virtual game nights) to strengthen social cohesion virtually. In addition, after-work events such as after-work beers were organized to get together spontaneously. This indicates that social cohesion has gained importance for many virtual teams even beyond work (Whillans et al. 2021). Working networks appear to be of greater importance in the pandemic (Marx et al. 2021).

Although virtual team cohesion has been studied for many years, the pandemic has fundamentally changed the nature and needs of virtual teams (Chamakiotis et al. 2021), making it necessary to reexamine virtual team cohesion. Our research contributes to the current state of knowledge by addressing the demand of further investigation on the “new normal” of virtual team cohesion (Waizenegger et al. 2020; Zeuge et al. 2021). Our study outlines to foster social cohesion as mandatory to overcome feelings of loneliness and social isolation. The primary cause is that people were isolated during the pandemic and craved social interaction and companionship. Social cohesion strengthening measures were brought to the forefront in virtual teams to address these needs. With our study we highlight that both planned as well as spontaneous cohesion strengthening measures, help to reduce psychological distance in times of social distancing. Future research can build up on these findings and investigate the influence of those measures on virtual collaboration outputs such as well-being, performance or organization commitment in times of the pandemic (Marx et al. 2021) in more deep. In addition, we outline that many measures for strengthening social team cohesion are translated from face-to-face collaboration to virtual collaboration. Examples include after-work drinks or virtual coffee breaks. Transferring proven measures from the real world to the virtual world to overcome the psychological distance offers a promising research area. Future research can build up on this finding and investigate if this transformation may apply to other areas of virtual collaboration, such as organization commitment.

Based on our findings, we also can derive implications for practice. For practitioners, this study is a clear indication that COVID-19 has caused a change in virtual team collaboration and virtual team cohesion. The advantages and disadvantages of the actual change are not the focus, but rather the result as such; the “new normal” of virtual team collaboration is a fact that needs to be considered and respected. If leaders and organizations accept the “new normal”, then there are many ways to shape it. As an example, the coffee roulette is a practical measure. Adapting implicit exchanges from the real world to the virtual world created improved team cohesion that did not exist in virtual teams prior to COVID-19. In addition to these measures, other measures have been described in this study that can serve as best practices for leaders and organizations for the “new normal”. The “new normal" will become indispensable in professional practice. Virtual or at least hybrid working in organization work processes will also exist in a post-COVID-19 era. In this context, leaders, and organizations in particular are called upon to actively accompany this development and support it with suitable measures.

14.6 Outlook

Qualitative studies are able to generate deep insights into a subject that quantitative studies lack. This is what our qualitative study based on a total of 26 interviews about changes in virtual team cohesion through COVID-19 can provide. In compiling the sample, we took care to ensure the greatest possible diversity of interviewees to be able to represent a multitude of perspectives. This enables our qualitative study to still have good generalizability. Like any other empirical study, this study has typical limitations of qualitative research, but they also motivate further research. In a next step, our findings can be empirically supported by quantitative research, for example. Here, it seems particularly beneficial to distinguish the effectiveness on virtual team cohesion based on the identified measures. That there is a general effect could be explored through this study, but how large these effects are compared to the other identified measures could provide further exciting insights. In such cases, it might be helpful to explore interdependence through qualitative analysis.

It is likely that national factors, such as general societal attitudes towards COVID-19 and national COVID-19 prevention measures, could have an influence. However, these factors of internationality were neglected since the focus was on the general change in virtual team cohesion. To this end the consideration of these factors could broaden the perspective on virtual team cohesion. In addition, cultural aspects were neglected. Therefore, this study offers potential for further research. It could help to develop a more general theory about appropriate measures for virtual team cohesion. This would create the possibility of including external or personal factors in the analysis.

This study examined the “new normal” of team cohesion i.e., the change of team cohesion in times of the pandemic. Since this study is a snapshot of the current situation, it is likely that as the pandemic recedes, virtual team cohesion will be further impacted. This new “new normal” (i.e., the time after the pandemic) would then have to be reexamined and redescribed. However, the discussion participants agreed that the impacts of COVID-19 will remain in the future. Further research is recommended here, including to further challenge counterproductive behaviors, negative attitudes, or details about the technology.

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15 Crisis-driven Digital Transformation as a Trigger for PVT (P14)

Paper Number	**P14**
Title	**Crisis-driven Digital Transformation as a Trigger for Process Virtualization: Fulfilling Knowledge Work Process Requirements for Remote Work**
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Publication Type	Journal publication
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Full Citation	

Table 15.1 Fact Sheet Publication

Crisis-driven Digital Transformation as a Trigger for Process Virtualization: Fulfilling Knowledge Work Process Requirements for Remote Work

Abstract. Process Virtualization Theory (PVT) describes which factors predict if a knowledge work process can be successfully virtualized, or not. However, at least in remote work, the crisis-driven digital transformation (e.g., during the COVID-19 pandemic) has shown that almost all knowledge work processes can be virtualized unexpectedly and immediately. Since the requirements of those knowledge work processes remain the same and are seemingly fulfilled in a crisis-driven digital transformation, this raises the interesting question how information technology (IT) can help to fulfill these requirements. We address this research gap by means of 40 semi-structured interviews in a multiple case approach with a critical realist perspective. Based on this approach we contribute to information systems (IS) research in a twofold way. First, we demonstrate that the crisis-driven digital transformation of knowledge work triggers a revisited perspective on PVT by turning virtualized knowledge work processes into a prerequisite. Second, we show how the IT characteristics of PVT (representation, reach, monitoring capability) help to fulfill knowledge work process requirements in remote work settings and outline two additional IT characteristics (social presence, situation awareness) that positively support the fulfillment.

Keywords: Crisis-driven digital transformation, Process Virtualization Theory, Knowledge work process requirements, IT characteristics, Remote work

15.1 Introduction

The virtualization of knowledge work processes by means of information technology (IT) has always been subject of interest in the information systems (IS) field (e.g., Fonner & Stache, 2012; Mäntymäki et al., 2019; Suh & Lee, 2017). Based on Overby (2008), the virtualization of a knowledge work process can be defined as *"the transition from a physical knowledge work process to a virtual one by means of IT"*. That is, the physical interaction between employees and/or objects is replaced by virtual interaction. This is often understood and referred to as transition to working from home instead of working from the office (Olaisen & Revang, 2017). However, this understanding does not go far enough, as it is basically includes all forms of location-independent work (Coakes et al., 2008) or remote work (Tarafdar & Saunders, 2022). Hereby, it has been shown that some knowledge work processes are better suited for virtualization, and to this end for remote work, than others (Overby, 2008, 2012). A major theoretical framework to explain this suitability is Process Virtualization Theory (PVT) that has been developed to explain if a process can be successfully virtualized (Overby, 2008, 2012). Four major requirements are decisive for the virtualizability of a process – sensory, relationship, synchronism, as well as identification and control requirements. A key premise of PVT is that IT makes a process more amenable to virtualization (Overby, 2008, 2012). To this end, PVT includes three IT characteristics that influence process virtualization: (1) representation, (2) reach, and (3) monitoring capability (Overby, 2008).

A new perspective on knowledge work process virtualization was brought up by the crisis-driven digital transformation of knowledge work induced by the coronavirus disease in 2019 (COVID-19). Research describes crisis-driven digital transformation as the immediate and unexpected transformation of non-digital organizational processes into virtual equivalents due to an internal or external crisis (Di Gangi et al., 2021; Haslam et al., 2021). COVID-19 led to a global and unprecedented crisis-driven digital transformation of knowledge work (Di Gangi et al., 2021; Kniffin et al., 2021; Waizenegger et al., 2020) and proved that almost all knowledge work processes can be virtualized, even those which were considered less amenable for virtualization (Waizenegger et al., 2020).To this end, the pandemic enforced employees to work remotely who never had any intention to work remotely or were not permitted to do so due to organizational policies (e.g., Richter & Richter, 2020). This crisis-driven digital transformation of knowledge work brings up the interesting conundrum of what has changed and how employees maintain to do their job remotely when virtualization has to take place unexpectedly and immediately.

The COVID-19 pandemic proved, that as long as digital transformation is driven by a crisis, processes of all kinds in knowledge work can be virtualized unexpectedly and immediately (Kniffin et al., 2021; Soto-Acosta, 2020; Whillans et al., 2021). In addition, the basic process requirements in PVT (Overby, 2008) are no longer decisive for the success of this virtualization, but rather, the virtualized knowledge work processes impose requirements that need to be met in remote work (Waizenegger et al., 2020). As, to the best of our knowledge, there is no research that focuses on how knowledge work process requirements could be met by means of IT in a crisis-driven digital transformation. To this end, we have conducted an explorative multiple case approach including 40 semi-structured interviews in Germany with critical realist perspective to bridge this knowledge gap. We observe this phenomenon by contextualizing PVT for the case of enforced remote work during COVID-19. To this end, we raise the following research question (RQ): *how can knowledge work process requirements be fulfilled in a crisis-driven digital transformation by means of IT?*

The paper is structured as follows: In the following section we introduce into crisis-driven digital transformation of knowledge work and outline the PVT by Overby (2008, 2012). Further, by drawing on the COVID-19 pandemic as an example of a global and unprecedented crisis, we demonstrate how this has led to a revised view on PVT. Subsequently, we present our research design and the findings of our qualitative research. Subsequently, we discuss our findings considering crisis-driven digital transformation of knowledge work and derive theoretical as well as practical implications. Finally, we conclude by highlighting some limitations of our research and providing fruitful avenues for future research.

15.2 Related Work

15.2.1 Planned and Crisis-driven Digital Transformation of Knowledge Work

Digital transformation of knowledge work is typically described as a broad organizational change enabled by technology and transforming the way knowledge work processes are carried out (Bilgeri et al., 2017; Mueller & Renken, 2017; Wessel et al., 2021). Literature suggests that digital transformation of knowledge work takes place for two main reasons. On the one hand, digital transformation of knowledge work can be driven by internal planning (Chanias et al., 2019; Nelson et al., 2017) caused by internal and external influences (e.g., employee support, customer demands, supply chain, innovation push, market pressure, and laws/government (Liere-Netheler et al., 2018; Mergel et al., 2019)). On the other hand, digital transformation of knowledge work can be driven by crisis and thus takes place unexpectedly and immediately (Finegold & Frenkel, 2006).

In recent years, research has begun to acknowledge the importance of crisis as a driver of digital transformation of knowledge work (Bounfour, 2016; Haslam et al., 2021; Heilig et al., 2017). To this end, the term “crisis-driven digital transformation of knowledge work” has been coined, which can be commonly understood as the immediate and unexpected virtualization of knowledge work processes due to an internal or external crisis (Di Gangi et al., 2021; Haslam et al., 2021). Examples for internal crisis are human resource crisis, corruption scandals or strikes (Scavarda et al., 2019). The internal crisis-driven digital transformation of knowledge work often shows itself concretely in the employees. If an employee leaves the company immediately, these processes have to be handled differently. This is then an opportunity to implement digital transformation in terms of process improvement, workplace improvement, vertical integration, management support, horizontal integration or cost reduction of this process (Liere-Netheler et al., 2018; Majchrzak et al., 2016).

Examples of external crises include crisis such as financial insecurity (Chanias et al., 2019), climate change (Majchrzak et al., 2016), political uncertainty (Finegold & Frenkel, 2006), or most recently the COVID-19 pandemic (Di Gangi et al., 2021). This form of externally triggered crisis-driven digital transformation of knowledge work can be described in the context of climate change. CO^2 emissions are regulated for organizations by the governments of many countries. This regulation in turn increases the demand for innovative methods of CO^2 reduction. The digital transformation can also indirectly minimize resource consumption and CO^2 emissions by digitally planning and optimizing changes in production and consumption patterns (Bieser & Hilty, 2018; Kunkel & Matthess, 2020).

In the last years, research has focused mainly on investigating the internal planned digital transformation of knowledge work (Henriette et al., 2016) and internal crisis-driven digital transformation of knowledge work (Kazuo Koike, 1997). However, the COVID-19 crisis, which has required an unprecedented and global virtualization of knowledge work, put further emphasizes on investigating crisis-driven digital transformation caused by external crisis (Di Gangi et al., 2021). COVID-19 has forced the immediate and unexpected virtualization of nearly all knowledge work processes (Haslam et al., 2021; Netz et al., 2022). During the pandemic, organizations were mandated to adopt to new setups where people worked remote to utilize (new) IT for communication, and to rethink their knowledge work processes in order to maintain regular business while complying with the new demands of infection protection and social distancing (Herath & Herath, 2020; Leidner, 2020; Richter, 2020). In this context, new challenges for knowledge work have emerged (Faraj et al., 2021). Access to digital infrastructures for employees and organizations is unequal (DiMaggio et al., 2004; DiMaggio & Hargittai, 2001). In addition, the pandemic has also revealed the fragility of digital transformation of knowledge work, i.e., it has shown that many processes remain vulnerable to extreme and ahistorical events. The major challenge was to virtualize knowledge work processes that were considered not ready for virtualization or not virtualizable because, for example, they still rely on analog elements (De’ et al., 2020; Faraj et al., 2021).

15.2.2 Process Virtualization Theory

Process Virtualization Theory (PVT) is a theory for mapping the digital transformation of processes and was developed by Overby (2005). The necessary basis is the virtualization of processes by IT in the first place. In context of the theory, the term "process virtualizability" takes a central role and is described by Overby as *"how amenable a process is to being conducted without physical interaction between people or between people and objects."* (Overby, 2008, p. 279). This implies that digitizability is the basis for the digital transformation. So if an organization, department, process, or task is to be digitized or digitally transformed, it must be digitizable. Then the PVT comes into use. In the literature, this has also already been demonstrated in various contexts. An overview by Balci (2014) shows that PVT with IT characteristics and requirements has already been applied in over 35 IS-related papers, mainly in information systems in general as well as communication and relationship. However, there is also concrete research that focuses precisely on the application of PVT as the part of digital transformations, for instance on the example of augmented reality solutions for security critical services (Osterbrink et al., 2021) or how consulting approaches can be digitalized (Seifert & Nissen, 2018).

PVT was introduced by Overby (2005, p. G1) and serves as a general theory to explain "*which factors predict if a process can be virtualized successfully*" (see Fig. 1).

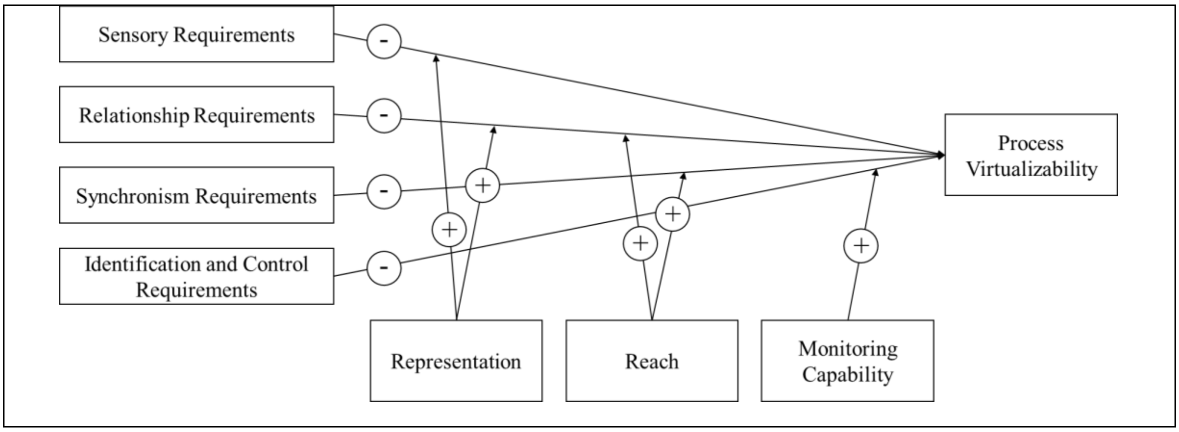

Figure 15.1 Process Virtualization Theory (Overby, 2008, 2012)

The dependent factor in PVT is "Process Virtualizability" (PV), which describes how amenable a process is to being virtualized (Overby, 2008).

The independent factors can be divided into characteristics of the process and IT characteristics of the virtualization mechanism (Overby, 2012). Characteristics of the process are: (1) sensory requirements, (2) relationship requirements, (3) synchronism requirements, and (4) identification and control requirements. Overby (2008) defines these characteristics as follows: **sensory requirements** represent process participants' need of a full sensory experience of the process, all related objects, as well as the other participants. **Relationship requirements** describe the need for process participants of interacting with each other in both professional and social contexts. **Synchronism requirements** specify the degree to which activities that make up a process need to occur quickly and with minimal delay. **Identification and control requirements** refer to the degree to which a process requires unique identification of process participants and the ability to control and influence their behavior. If everything else remain constant, those four factors negatively affect PV, i.e., as each of these requirements increases, the process becomes less amenable to virtualization (Overby, 2008).

PVT underlies the premise that IT can be used to make a process more amenable to virtualization (Overby, 2008). Overby introduced therefore three characteristics of the virtualization mechanism (“IT characteristics”) that impact process virtualization and represent moderating factors in the theory: (1) representation, (2) reach, and (3) monitoring capability (Overby, 2008). Overby (2008) defines these IT characteristics as follows: **representation** is the capacity of IT to present information relevant to a process (i.e., including simulations of actors and objects, their properties and characteristics, and how we interact with them). **Reach** is the capacity of IT to enable participation in processes across time and space. **Monitoring capability** is the capacity of IT to authenticate process participants and track their activities.

Those three IT characteristics influence the relationships between the independent factors and PV (Overby, 2008, 2012). IT can be used to stimulate sensory elements of the physical world. Thus, representation positively influences the relation between sensory requirements and PV. Since IT can be applied to capture highly representative profiles of process participants, representation positively influences the relation between relationship requirements and PV. Reach allows process participation regardless of the participants’ location and therefore, positively influences the relation between relationship requirements and PV. Moreover, reach enables synchronous process participation and consequently, positively influences the relation between synchronism requirements and PV. IT allows participants to be uniquely identified and tracks and analyzes their actions. This, consequently, positively influences the relation between identification and control requirements and PV.

15.2.3 A Crisis-Driven Revisited Perspective on Process Virtualization Theory

The COVID-19 pandemic has led to a global and unprecedented crisis-driven digital transformation of knowledge work (Di Gangi et al., 2021; Kniffin et al., 2021; Waizenegger et al., 2020). The shift from working on-site to working remotely fundamentally changed the nature of work and led to new challenges e.g., shifting to virtual work, battling a new set of distractions, or experiencing an unprecedented fusion of work and private life (Deloitte, 2020). To this end, COVID-19 represents an appropriate example to outline how a crisis-driven digital transformation of knowledge work leads to a revisited perspective on our initial theoretical understanding of virtualization of knowledge work processes based on PVT. Prior to the outbreak of the pandemic, the overwhelming majority of knowledge work processes were not conducted remotely because many knowledge work process requirements could not be met as previous research has shown. For example, remote work settings were problematic for sensory requirements because with it knowledge work transforms work from a sensory activity to a computer-mediated activity therewith preventing people from interacting in a personal and intimate way (Eisenberg & Krishnan, 2018). Also, the requirements for relationships in the context of knowledge work processes posed a particular challenge in virtual teams, and the likelihood of developing trust was regarded to be significantly lower (Robert et al., 2009). Differences in time, distance, organization, and culture also made the building of trust particularly fragile in virtual teams (Watson-Manheim et al., 2012). In particular, synchronism requirements of knowledge work processes could not be met in remote work during these days because virtual collaboration tools (e.g., audio or video conferencing) reached their limits when it came to synchronous, interactive collaboration, such as required for prototyping (Nor'a & Ismail, 2019). Difficulties in meeting the synchronization requirements of knowledge work processes were also confirmed for remote workers when resources and knowledge are to be shared across project boundaries in a virtual environment (Coakes et al., 2008). Further, working remotely was problematic for control requirements of knowledge work processes because, on the one hand, employees were not visible face-to-face for their leaders and, on the other hand, the organization cultural engineering exercises were undermined due to the lack of employees' presence on-site (Felstead & Henseke, 2017). However, the pandemic has enforced the virtualization of almost all knowledge work processes unexpectedly and immediately and, thus, has reshaped taken-for-granted day-to-day business (e.g., Almeida et al., 2020; Faraj et al., 2021; Kniffin et al., 2021). Nearly all knowledge work processes were virtualized overnight, and those that could not be virtualized as immediately followed in the subsequent weeks (Lal et al., 2021). To this end, COVID-19 turned PV into a prerequisite in COVID-19 studies (Kniffin et al., 2021; Soto-Acosta, 2020; Whillans et al., 2021). Thus, regarding PVT, we argue that PV turned from a determined into a determining factor (labeled as: Established Process Virtualization in Fig. 2) for the fulfillment of knowledge work process requirements.

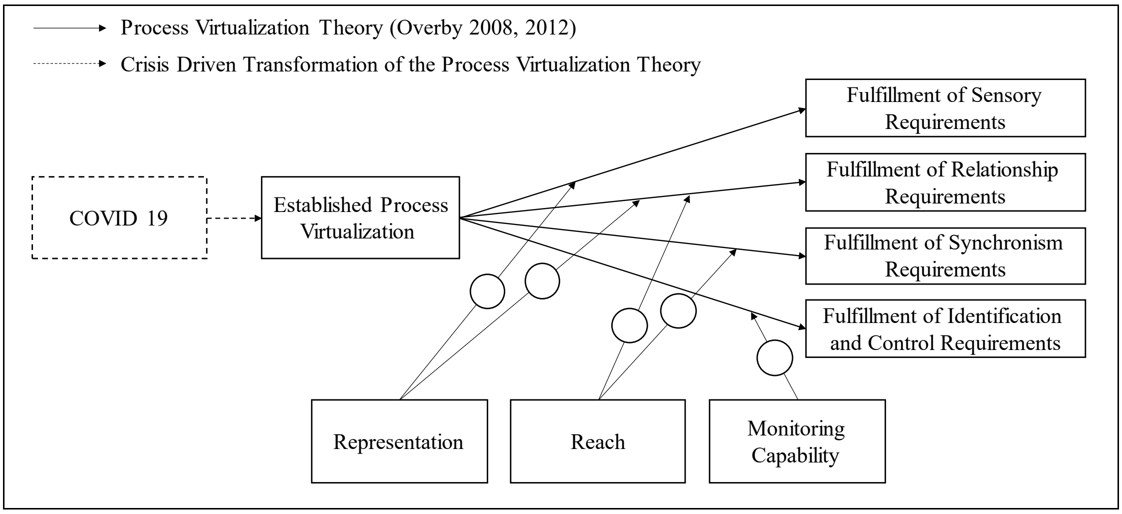

Figure 15.2 A Crisis-Driven Revisited Perspective on Process Virtualization Theory

As knowledge work process requirements were stable and seemingly fulfilled during this crisis (Waizenegger et al., 2020), this raises the question of 'how' knowledge work process requirements were met in these new remote work settings. On this verge, Overby argues that IT can be used to fulfill process requirements (Overby, 2008, 2012). Therefore, we aim to understand in our research how the knowledge work process requirements (sensory, relationship, synchronism, as well as identification and control requirements) from PVT are fulfilled by means of different IT characteristics (representation, reach, monitoring capability) in a crisis-driven digital transformation of knowledge work.

15.3 Research Design

In this research paper, we follow a critical realism approach (Mingers et al., 2013). That means we want to understand how knowledge work process requirements are fulfilled by means of IT in remote work settings in the "real world" (changed by crisis). Since the "real" world (understood under critical realism approach) is only observable and is composed of the different perspectives, we have conducted a multiple case approach with different organizations (Kilani & Kobziev, 2016; Yin, 2009).

Therefore, we used a qualitative multiple case approach (Flick et al., 2004) to investigate 'how' different knowledge work process requirements (*sensory*, *relationship*, *synchronism*, as well as *identification and control requirements*) have been fulfilled by means of IT characteristics proposed by PVT (*representation*, *reach,* and *monitoring capability*) and explored whether further IT characteristics positively impacted the fulfillment of the requirements.

As part of the multiple case approach, we conducted virtual interviews (60 minutes on average) with 40 employees from German organizations. The interviewees were selected as part of a research project, supplemented by colleagues of the participating individuals and volunteers were acquired via social media. So, they fit in total very well to our multiple case approach with different organizations to observe the different perspectives and get as close as possible to the new real setting. To assure the highest possible degree of contextual similarity, we conducted all 40 interviews within a brief period of one month (18 January and 18 February 2021). The interviewees were between 20 to 61 years old, and the average age was 38 years. 30% of the interviewees were female and 70% were male. Regarding the organizational sectors in which we conducted interviews, we opted for covering a broad variety (e.g., mobility & logistics, banking, insurance, municipalities, press & media, consulting, telecommunications, or manufacturing) to be robust against industry-specific aspects. For better readability, we will use the term "organization" in the following, which encompasses both, enterprises, and municipalities. Nevertheless, in the findings section we also highlight the distinction between the organization types as follows: large-scale corporations (C) with 14 interviews, municipalities (M) with 10 interviews, and small and medium-sized enterprises (SME) with 16 interviews. For an overview over the interviewees, please refer to Appendix A.

To get a wide range of answers and to give the participants the chance to speak freely, we used a semi-structured interview guide with open-ended questions (Sarker et al., 2018a, 2018b). We followed the guidelines for qualitative research by Sarker et al. (2013) to avoid pitfalls of qualitative semi-structured interviews (Pumplun et al., 2019; Sarker et al., 2013). We revised the first version of our interview guide after three pre-interviews and made some minor changes to our interview guide. After additional ten interviews we reevaluated our interview guide again but did not uncover any necessity for additional changes. The interview guide can be found in Appendix B.

The interviews were recorded in German, transcribed non-verbatim and translated into English for the purpose of analysis. Subsequently, the interviews were analyzed using the MAXQDA software by means of the deductive and inductive content analysis methods by Mayring & Fenzl (2014). For this purpose, we took a crisis-driven revisited perspective on PVT as basis for the deductive content analysis. We independently analyzed the interviews by coding for IT activities that helped to fulfill knowledge work process requirements (*sensory*, *relationship*, *synchronism*, as well as *identification and control requirements*). These activities were mapped to the IT characteristics (*representation*, *reach*, and *monitoring capability*) identified by Overby (2008, 2012). Those activities that could not be clearly assigned to one of the IT characteristics were noted down. Following inductive content analysis (Mayring & Fenzl, 2014), these activities were discussed after ten interviews and combined to form a new, undefined IT characteristic. After agreeing on the new and undefined IT characteristic as part of the extended coding scheme, the authors reviewed their already coded interviews and coded ten more. In line with Mayring & Fenzl (2014), this formed an second loop and leaded to a revised coding scheme. This process continued (four times in total) until all 40 interviews were coded. At the end of the 40 interviews, the new and undefined IT characteristics were discussed. We found that the activities that could not be mapped to the IT characteristics of PVT had some commonalities. Thus, we were able to split them into two new IT characteristic. Considering literature, we have labeled these new IT characteristics as *social presence* and *situation awareness*. Subsequently, the authors independently re-coded all interviews again with the final coding scheme in order to have coded all inductively found IT characteristics (Mayring & Fenzl, 2014). Differing opinions were discussed with the author team and clarified by consensus. We ended the analysis with theoretical saturation, i.e., when no new aspects were found. For the final coding scheme, please refer Appendix C.

15.4 Findings

In the following section, we present our findings on how knowledge work process requirements were met in times of COVID-19 by means of IT in remote work settings. To present our findings in a structured way, we organized them along the IT characteristics identified by Overby (2008, 2012): *representation*, *reach*, and *monitoring capability*. In addition, we were able to identify two further IT characteristics (*social presence* and *situation awareness*) that positively impacted the fulfillment of the requirements. Thereby we only provide examples of the identified activities that helped to fulfill the requirements. For an overview of all identified activities, please refer to Appendix D.

15.4.1 Representation

Although physical encounters in the office have almost been entirely eliminated due to the pandemic, for many knowledge work processes it is still or even more necessary to see and hear colleagues, leaders, or externals (Waizenegger et al., 2020). IT can be used to fulfill these *sensory requirements* by *representing* the sensory elements of the physical world (Overby, 2008, 2012). For example, nearly all interviewees stated that they used e-mails or chats mainly for short questions or coordination tasks before the pandemic. They barely called their colleagues spontaneously to reduce interruptions from work.

> *"I always sent an e-mail. Or a short message via Skype. Otherwise, I don't know: am I disturbing the other person or not? And that's what everyone did." (C_1_1)*

By working solely remotely during the pandemic, more than three quarters of interviewees stressed that they now made more phone calls because what they had previously written emails for they now did on the phone, due to the lack of spontaneous contacts. The reason was that they need to hear each other's voices and the emotions that resonated. They believed that this made it possible to convey information more efficiently and comprehensively.

> *"Just keeping in touch. Just make a call. In the past, I would have written an e-mail, but now I call [...]. I do that a lot more so that I can also hear the other person's voice sometimes." (SME_1_2)*

Before the pandemic, most interviewees preferred audio to video conferencing while working remotely. One reason was, that the employees were not equipped with the appropriate hardware and/or software. Other interviewees wanted to protect their privacy. In addition, many of the interviewees felt that they did not need video because of the regular physical encounters in the office.

> *"Even before the pandemic, we always used Zoom to work together. However, we as a team didn't turn on the webcam. So, the voice was on. We didn't need it because we met regularly." (C_5_1)*

With the outbreak of the pandemic, however, almost all interviewees indicated that they used video conferencing exclusively. On the one hand they felt that turning on the video helped to fulfill the need of seeing each other. On the other hand, the video transmitted the body language of the counterparts, which made it easier for them to see which face was currently expressing concerns and who might be waiting to finally say something.

> *"And I think it's also very important to turn on the webcam. […], it's important to see others, to have the feeling that you're not just talking to a picture but instead to a real person, who still has facial expressions and gestures." (C_3_2)*

Since IT allows to *represent* rich personal profiles, *relationship requirements* can also be fulfilled (Overby, 2008, 2012). To this end, IT strengthens relationships among colleagues as well as bonds to the organization. For example, the interviewees that used videoconferencing prior to the pandemic reported that they used virtual wallpapers to avoid giving colleagues insights into their physical surroundings. They highlighted that this prevented colleagues from gaining insights into private rooms or their whereabouts.

> *"We always used a digital wallpaper before." (SME_1_3)*

Nearly all of the interviewees reported that they no longer use virtual wallpapers during the pandemic. For them, the insight into the personal "office" (e.g., living room, kitchen) allowed to identify common interests or learn more about the private lives of their colleagues. The interviewees emphasized that this allowed employees to present themselves and their personalities more authentically.

> *"So, a picture, for example, as a background I find distracting. So, you have the feeling that someone wants to hide something. [...] I think you have more insights into the privacy of the other person, which also makes working together a bit more pleasant. And I think this personal aspect is especially important when exclusively working from home." (SME_8_1)*

Prior to moving exclusively to remote work, an important part of the work had been carried out on the premises of the organization. This enabled the interviewees to clearly identify with the organization, its culture, and values, and made them feel they were part of it.

> *"Before the pandemic, I was on a regular basis in my office. This gave me the feeling of belonging to the organization. Just walking through the entrance with the big organizational logo made me feel like I was part of the organization." (C_2_3)*

By moving the work from the organizational premises to remote work, the interviewees felt that their ties to the organization could be lost. To ensure the organizational identity, many interviewees suggested, for example, to use the organization-related desktop wallpapers (e.g., photos of the department members and/or organizational logo) or the same background in networks (e.g., LinkedIn). Thus, the sense of organization identity could be virtually created as well as maintained.

> *"But we try to formulate a common vision because I think we need something we can unite behind. […] For example, by using the same logo in our Linked-In profiles. […]*

> *In addition, our leader created a picture with photos of our department and our organization's logo. We all use that as our desktop background." (C_2_1)*

15.4.2 Reach

Unrestricted participation (*reach*) is prerequisite to fulfill *relationship requirements* in remote work (Choudhury, 2020). All interviewees reported that remote work made communication among colleagues challenging, as not all colleagues used the same communication platform. The interviewees who had a platform stated that the platform should at least be equipped with chat, telephone, and video functions. But before the pandemic, these platforms were unfortunately not always sufficiently used and maintained.

> *"Document management, cloud services and the like were not used for the most part. Therefore, the exchange of data and communication is not quite as simple [...] and the colleagues then have to use our infrastructure, which we already had before. Using a platform means certain hurdles for the colleagues. If not, it makes communication very difficult." (SME_1_3)*

Since the pandemic, communication platforms have been used much more intensively for short exchanges for business and private purposes. Within the organization, interviewees reported that there were too many different platforms, so that there was lacking awareness about who to reach where. Therefore, many organizations decided to use one platform for internal communication.

> *"So, I would say that first our tools had to be rethought because we had too many. [...] We had WebEx, Teams, Jabba. Zoom was used in some cases. [...] We unified that since we depended on regular communication through these tools." (C_2_2)*

Another aspect that implied participation in remote work was that all employees were involved in decisions. Before the pandemic, this was done in a classic way, as interviewee SME_2_1 aptly stated.

> *"Quite normally, by e-mail, on-site, in meetings, or on the phone. The classic way." (SME_1_2)*

The pandemic has complicated this process, which was why many leaders have worked on how to enhance employee participation in decision-making. Summing up, it can be stated that the leaders first captured the mood in group rounds and individual discussions and then picked up the majority in small surveys. These options were then used to make decisions.

> *"When it affected, let's say, every structure or every employee, we also built small surveys in Microsoft Forms, where you could then decide for or against it." (SME_2_1)*

A quick and delay-free participation is prerequisite to enable *reach* and requires a stable process at the technological level, i.e., availability of hardware and software, so that all systems and functions run smoothly for every employee working remotely. To fulfill these *synchronism requirements*, all employees in an organization should have access to (shared) data at the same time. Before COVID-19, initial drives or even partially online drives were provided, but these could usually only be accessed via VPN. The interviewees reported here that these basic prerequisites were not always provided within their organizations, which is why a lot of work was done by using local versions that were subsequently sent by e-mail.

> *"Documents were mostly not done via any SharePoint or so but actually just went back and forth with e-mail. If it was something internal, i.e., no customers or anything had to do with it, then there were corresponding shared folders even back then." (C_1_2)*

Since COVID-19, shared data access has taken a more present role because frequent transmissions via e-mail have not been possible any longer. Also, many interviewees reported that they often obtained a lot of important information during spontaneous conversations. This is now lost but is gathered through their own research in the shared data. In the interviewees' organizations, platforms such as SharePoint or OneDrive were therefore set up to store data and to edit it simultaneously.

> *"Of course, I'm using OneDrive and SharePoint, that's essential. I'm always amazed at how it works, that you can share individual files, folders, or other things outside the company and grant permissions and so on. For example, with our customers or our tax office. I keep the accounting on the drive here and then I just give them the folder. I don't have to move anything back and forth; they can pull it out of there. That saves an incredible amount of work." (SME_9_1).*

Another aspect of smooth participation, according to nearly all interviewees, was that knowledge work processes run as they would do in presence. For example, pre-pandemic meetings took place with the necessary tools in the room. If a colleague wanted to show a presentation or a document, the laptop was connected to a projector, or a screen where everybody was looking at.

> *"So technically it was easy. If you wanted to show a presentation, it was thrown on the projector on-site." (C_2_3)*

With COVID-19 this aspect has changed significantly because meetings did not take place in an office room but virtually. In this environment, screen sharing crystallized as a new key function for smooth work and participation. The interviewees described some features such as screen sharing as well-known, but many did not use it for their daily business. With the help of this tool, activities from the presence, such as drawing on the flipchart or showing on one's own screen, could be implemented virtually and it enabled a simultaneous virtualization of the meeting or any similar without having to write it down afterward. This also led to a simplified way of working.

> *"In the past, everything was sent around, and everyone gave their comments. Everyone had their change mode turned on in Word, for example, and you clicked through there. Now you throw it up on a screen, discuss the common thing to change, and someone changes the central thing. Of course, that's all much faster, I think. And no one is lost by the fact that you share screen. You are talking about one and the same. There are fewer misunderstandings. Before, you had a lot of misunderstandings. As I said, outdated statuses or you didn't talk about the same thing because maybe you only did it over the phone or by e-mail. So that's already easier now with video conferencing and you can throw everything on the table somehow. I find the way of working already considerably easier." (C_1_3)*

15.4.3 Monitoring Capability

IT enables monitoring of process participants and their activities (Overby, 2008, 2012), which is essential to fulfill identification and control requirements of remote work. For example, by working in the office before the pandemic, it was easier to notice if employees are in fact working. Even if one did not know what colleagues were working on, one could see that they were present and busy.

> *"Previously in the office, my supervisor and my colleagues were able to see that I was really doing my job, that I was really delivering and performing." (SME_2_2)*

Since individuals do no longer work together in the same physical workplace, work inevitably became spatially and temporally separated. The interviewees emphasized that when working remotely, it has become difficult for them to perceive if their colleagues are actually working. Therefore, they need ways to see who is present at the very moment. Many interviewees reported that they have implemented various tools to monitor the availability status of others. For example, the traffic light systems of communication tools were assigned with clear connotations (i.e., red: in a meeting, yellow: working/no calls, green: available for calls).

> *“We use a traffic light system. This makes me feel more confident that it’s not just me working. [...] Once on red, then the “door is closed”, then you should also not “come in”. Green then the “door is open”, and then everyone is also welcome.” (C_6_1)*

In this context, the interviewees elaborated that before the pandemic it was also very easy for them to follow the activities of their colleagues. By working on-site, they had the opportunity to spontaneously exchange information about who was working on what, what the state of progress was, which (partial) results had already been achieved, and which problems had occurred. If they did not know what a colleague was working on or what the status of a task was, they could just step into the colleague’s office, tip on their shoulders, and ask.

> *“I don’t want to use the word “control”. But basically, this is what I mean. [...] It is not as simple as in the classic sense in the office and where you can just open the door and see what he or she is working on, what the progress is and if everything is okay, and if everyone is coping with his or her tasks.” (M_5_1)*

When working remotely, many interviewees lacked this possibility to monitor availability and project progress. Therefore, project management tools were increasingly introduced (e.g., Kanban boards). This gives both, leaders and colleagues, an overview of who is working on what, who has free capacity, or who has achieved which results and therefore compensated for the physical monitoring capabilities.

> *“So, what’s important is documentation. [...] Since we’ve been working from home, we’ve been using digital Kanban boards to maintain a level of monitoring. We know who is working on what and what the current status is, and we know who to contact if we have any queries. That way we avoid wasting time or heading in the wrong direction.” (SME_2_1)*

15.4.4 Social Presence

IT enables the presence of process participants and thereby supports the interaction between employees in a professional and social context (Alghamdi et al., 2016). Presence refers to the feeling of being present in a virtual environment (Schultze, 2010). Thereby, social presence is not only about the feeling of "being there" in a virtual environment but the feeling of "being there together" (Ma & Agarwal, 2007).

Social presence can help to fulfill *relationship requirements* of remote work. Nearly all interviewees emphasized that they did both, starting and closing the week together, in the pre-pandemic period. The goal of the joint start of the week was to communicate what was coming up in the week and to plan the week upfront. In the joint closing, the week was evaluated retrospectively, and a glance was taken at the next week.

> *"So, we always had a substantive exchange on Mondays. [...] We came together and discussed things that were planned for the week. At the end of the week, [...] we have discussed the week retrospectively and maybe also the next week's agenda." (SME_2_2)*

The joint start and closing of the week were maintained virtually during the pandemic. Instead of holding physical meetings, they were (mainly) held via videoconference. However, while the focus before the pandemic had been on the exchange of work-related information, in the pandemic the employees came together and took time to talk about more personal matters. For example, plans for the upcoming weekend were shared or sports results were discussed.

> *"We start Monday morning at nine, we always start the week together, and then we simply talk about personal stuff for 20 minutes. We wouldn't have done that in the past, I would have pretty much said chop, chop, chop, that's what we're doing now. Now it's important for us to start and end together more personally." (C_2_4)*

Many interviewees emphasized that joint lunch or coffee breaks with colleagues were a very important social factor in everyday working life. In their opinion, breaks offered the chance to exchange news ("office grapevines") or chat about tasks or customers, which could strengthen the feeling of togetherness.

> *"Before the pandemic, of course, we had lunch together. [...] We simply spent the lunch break with colleagues in a restaurant or somewhere else. [...] Or had coffee breaks. Just a regular get-together." (M_4_1)*

To facilitate joint breaks when working from home, most organizations have opened permanent virtual break rooms. The virtual break rooms have offered employees the opportunity to dial in at any time and spend their breaks with their colleagues. The interviewees believed that this strengthened the feeling of togetherness. They highlighted that the virtual break rooms did not only replace the previous coffee and lunch breaks but also offered new possibilities: for example, break rooms could be used to set up topic-specific exchange rooms (e.g., traveling).

> *"Yes, we call it a virtual break room. And you can exchange thoughts and ideas there. [...] You ask what topics are on your colleagues' minds, what's new, and so on. Outside of normal work, more of a personal exchange. Then there are different groups, break-out rooms. Here you can find different topics. I must say that this is actually very well accepted and brings us together." (C_7_1)*

15.4.5 Situation Awareness

IT can also be the means of transmission so that people know each other or perceive each other situationally (i.e., IT creates situation awareness) (Malhotra & Majchrzak, 2014). In the literature, situation awareness is defined as "*the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future.*" (Endsley, 1995, p. 36). Since this research is set in the context of remote work, we narrow down the definition to virtual team situation awareness: "the degree to which every team member possess the SA [situation awareness] needed for his or her job" (Endsley, 1995, p. 39).

Situation awareness can help to fulfill *relationship requirements* of remote work. Before COVID-19, employees simply had to walk through the office to get to know each other personally, to know how the other person is doing and who they are in order to work well together. For example, the team leader could see when an employee was unwell because of a broken leg.

> *"This was a regular exchange and presence on-site. People just got together for meetings, and sometimes chatted personally and privately. So, it wasn't just limited to the specialist topics, to the work, but of course it was interesting what might be going on in your private life, right?" (C_4_1)*

With COVID-19, this has not been possible anymore. Extra care-calls or care-chats were thus needed. This has offered employees and colleagues the feeling that they know each other and are aware of each other's current status. Additionally, to know the status of a task has helped to involve others.

> *"In everyday life, how are you? Where is the status? How far have we come? What's up? Is there anything we still need to discuss? What is the next step? It can also be that we just talk on the phone twice a day and realize that everything is great and then the phone calls are short." (SME_8_1)*

Many interviewees also reported that informal exchanges about work-related issues before COVID-19 were incidental and unobtrusive. They often took place during lunch, evening events, or at large conferences, where time and space were given for exactly this kind of exchange.

> *"Well, before Corona we already made sure that we met once a quarter. I simply went to lunch with the people. [...] I picked up people on a one-to-one basis to find out sometimes how they were doing... did you really understand the task?" (C_2_4)*

With COVID-19, a virtual opportunity had to be created because this informal exchange was considered very important. Many organizations have created new activities, here, such as coffee roulette. In coffee roulette, there is a defined time in the afternoon where you take a virtual coffee break with colleagues for approximately 30 minutes. However, the pairs are always randomly assigned so that you always take a break with different colleagues.

> *"We have introduced this coffee roulette, simply talking to colleagues also simply about work because that is sometimes very rigid." (C_3_2)*

Just as important as knowing each other in person, is to learn what working skills colleagues have (Prasad & Green, 2016). This means that an employee knows whom to call or ask for certain questions or tasks These *synchronism requirements* can be fulfilled by *situation awareness*. For example, before COVID-19, this was achieved by informal exchanges or meetings.

> *"Before Corona, you just knew who was good at what. I just worked with him or asked my office neighbor, and he could tell me who to go to at the latest." (C_1_1)*

But the virtuality of remote work led to an invisibility of skills. For this purpose, for example, the employees' profiles have been used as a kind of information sheet, where competencies and strengths are mentioned, or special get-to-know rounds have been initiated.

> *"I believe that we should make individual appointments with all team members to introduce the new team member, what am I working on at the moment, what am I doing, what is important, or simply to pass on a bit of precise know how or, yes, to find out what the strengths and weaknesses are. So work-related, just getting to know the team member a little bit." (C_3_2)*

Building on the knowledge of the skills, COVID-19-initiated cross-thematic exchanges so that informal exchange at the professional level had a place. This also is a process that was not considered necessary to virtualize prior to COVID-19, but the interviewees said that information leakage resulted in significant additional work. In this regard, the interviewees mentioned that some organizations also have initiated cross-departmental rounds.

> *"We also have an exchange round at the specialist level, where everyone from the specialist department reports briefly on what they are doing, so that we can also find out what the other departments are doing because this kind of exchange that takes place briefly in the office, no longer takes place." (SME_10_2)*

15.5 Discussion

In this research, we outline a crisis-driven revisited perspective on PVT by Overby (2008, 2012). We indicate that when virtualization of knowledge work processes has to take place due to crisis-driven digital transformation (e.g., COVID-19 pandemic) the perspective on what can be considered independent and dependent in terms of virtualization flips. In more concrete terms, the dependent factor "Process Virtualizability" in PVT turns into a prerequisite and thus from a determined into a determining factor (now labeled as: Established Process Virtualization) for the fulfillment of knowledge work process requirements (see Fig. 3). Since, the knowledge work process requirements remain stable (Waizenegger et al., 2020) and therefore need to be fulfilled, we investigate in 'how' knowledge work process requirements have been fulfilled by means of IT within a crisis-driven digital transformation (Whillans et al., 2021).

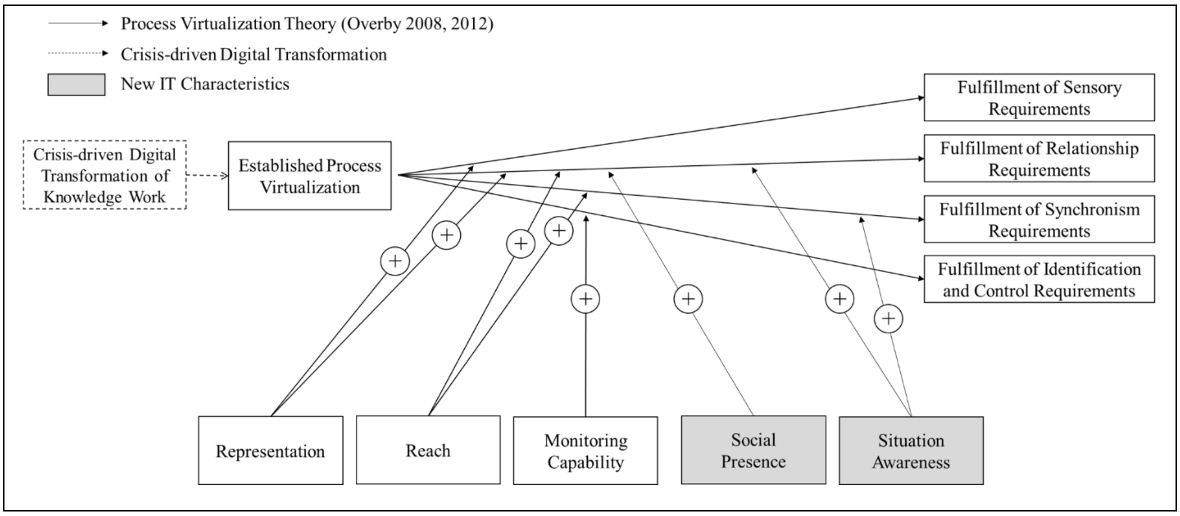

Figure 15.3 An Expanded Crisis-Driven Revisited Perspective on Process Virtualization Theory

With our research, we are able to show that those IT characteristics enabling PV (Overby, 2008, 2012) (*representation*, *reach*, *monitoring capability*) do also positively contribute to fulfilling knowledge work process requirements, when the virtualization has to take place, unexpectedly and immediately. This means, to be able to work remotely, it is conducive to be able to present or perceive relevant information ("representation"), to be able to participate at any time ("reach"), and to be able to authenticate process participants and track their activities ("monitoring capability"). In this regard, IT enables these aspects in the following way.

First, IT enables **representation** of information including the representation of employees and objects (Overby, 2008, 2012). By replicating senses through IT use, sensory requirements of knowledge work processes can be fulfilled (e.g., by choosing talking on the phone in preference to writing messages ["hearing"], or by turning on the webcam ["sight"]). Further, representation strengthens relationships among colleagues (e.g., by avoiding virtual backgrounds) and bonds to the organization (e.g., use of organization-related backgrounds). In this way it contributes to meeting relationship requirements while working remotely.

Second, IT facilitates **reach**, which allows employees to participate in knowledge work processes across time and space (Overby, 2008, 2012). Reach enables interaction with colleagues (e.g., using participative decision-making tools, or a unified communication platform) and, thus, complies with relationship requirements. In addition, reach paves the way to perform knowledge work processes quickly and with minimal delay (e.g., providing shared data access or using real-time collaborative file editing), this way it contributes to meeting synchronism requirements.

Third, IT allows the **monitoring** of employees (Overby, 2008, 2012). Monitoring facilitates the identification of employees and their activities, thus complying with the identification and control requirements. So, IT can be used to monitor both, who is working (e.g., consistent use of availability status), and what everyone is working on (e.g., by using project management tools).

We also uncovered additional IT characteristics namely social presence and situation awareness, which can also positively support the fulfillment of the knowledge work process.

IT supports the feeling of **social presence** among the employees, i.e., the feeling of being together in a virtual environment (Ma & Agarwal, 2007; Schultze, 2010). Thereby, social presence supports interaction among employees (e.g., by implementing a joint start/closing of the week or by a virtual permanent break room), and, thus, contributes to the fulfillment of relationship requirements.

IT enables **situation awareness** of the work environment while working remotely (Endsley, 1995; Seebach et al., 2011). On the one hand, situation awareness helps employees to be aware of the colleagues' needs and emotions (e.g., by implementing care-calls or -chats or coffee roulette). Thus, situation awareness helps to fulfill the relationship requirements imposed on remote work. On the other hand, situation awareness enables employees to be aware of the competencies and knowledge of their colleagues, and to know whom to ask regarding an issue to work efficiently together (e.g., by implementing virtual substantive gatherings or virtual cross-departmental exchanges). Thus, situation awareness contributes to meeting synchronism requirements.

Overall, our findings have three main theoretical contributions. First, we contribute to research by providing an expanded crisis-driven revisited perspective on PVT (Overby 2008, 2012). We demonstrate that the crisis-driven digital transformation of knowledge work triggers a revisited perspective on PVT. Therefore, this revisited perspective of PVT can be applied to any research approach which takes the theoretical lens of PVT and investigates the crisis-driven digital transformation of knowledge work. For example, research looked at user resistance to virtual execution of a process (Balci et al., 2013). Here, the expanded crisis perspective on PVT offers an approach to discuss the implications for changing user resistance in the event of unexpected and quick virtualization. The enforced situation may even enhance user resistance to technologies as IT becomes even more important in remote work settings to stay connected with colleagues and leaders. However, the enforced virtualization of knowledge work processes may also have an opposite effect and lower resistance towards technologies, as this also offers new benefits regarding the users' increasing flexibility to deal with private issues during working time, thus enhancing their work-life balance accordingly.

Second, we contribute to research by extending the crisis-driven revisited perspective on PVT (Overby, 2008, 2012) with two new IT characteristics – *social presence* and *situation awareness*. The first additional IT characteristic uncovered that positively impacts the fulfillment of knowledge work process requirements is social presence. Especially in times of insecurity, internal crisis communication and personal exchange among leaders and employees is of great importance (Johansen et al., 2012). However, in times of enforced remote work real social interactions between employees are limited and informal or spontaneous opportunities to connect are missing. This can have a negative impact on the employees' wellbeing (Kniffin et al., 2021), and therefore negatively affect work e.g., productivity, intrinsic motivation, or collaboration behavior (Kwak et al., 2019; Yang et al., 2015). To reduce the feeling of loneliness and isolation, strengthening the feeling of "being there together" (social presence) by means of IT has gained in importance. Future research may therefore explore how the feeling of the colleagues' virtual social presence helps to reduce negative feelings threatening the employees' wellbeing, while at the same time fostering their productivity and team cohesion. The second additional IT characteristic uncovered that has a positive impact on meeting knowledge work process requirements in crisis-driven digital transformation is situation awareness. Initial research has already underpinned the relevance of situation awareness: for example, research has shown that employees need to know about the emotional state of their colleagues in order to be able to access the individual, which in turn leads to effective collaboration (Seebach et al., 2011). It has also been shown that situational awareness is critical for the success of virtual teamwork (Endsley & Robertson, 2000). Here, research examined how virtual teams use IT to specifically facilitate situation awareness and the effects on team performance (Malhotra & Majchrzak, 2014). Our research indicates that situational awareness must be ensured in remote work in times of crisis-driven digital transformation and demonstrates how situational awareness can positively support the fulfillment of knowledge work processes.

Third, we can conclude that, regarding remote work during crisis-driven digital transformation, IT became increasingly important to fulfill relationship requirements. This can be explained by the fact that the physical distance between employees can eventually turn into a psychological distance between them (Garro-Abarca et al., 2021). Psychological distance can affect the way individuals perceive their colleagues, leaders, or externals, leading to inaccurate perceptions of those individuals based on categorizations and/or stereotypes (Wilson et al., 2006). This may also be due to the fact that crises make people feel more anxious and lonelier and therefore require more social contact, which can also be satisfied by the work context (Johansen et al., 2012). In addition, working with a physiological distance is more impersonal, distant, and task-focused (Hiltz et al., 1986; Sproull & Kiesler, 1986), and therefore can negatively affect the interpersonal trust between employees (Altschuller & Benbunan-Fich, 2010, 2013). To bridge the psychological distance when working remotely, i.e., compensating for limited social interactions with colleagues and spontaneous opportunities to informally connect (Lepsinger & DeRosa, 2015; Yang et al., 2015), IT has been used to strengthen a sense of unity, togetherness, and collective identity. This is in line with the work of Roy (2012), who postulates that strong relationships between employees can help to overcome feelings of isolation. Many studies on remote work demonstrated that one of the biggest challenges in dispersed work settings is to overcome psychological distance (e.g., Bailey & Kurkland, 1999; Tietze & Nadin, 2011; Wilson et al., 2006). With our crisis-driven revisited perspective on PVT we represent new ways to fulfill relationship requirements in remote work settings and, thus, help to reduce psychological distance in times of crisis-driven digital transformation.

The expanded crisis-driven revisited perspective on PVT is also beneficial from a practical perspective. Our findings are valuable to any organization that needs to transition unexpectedly and immediately to remote work (due to COVID-19 or any other crisis). In times of crisis-driven digital transformation, one main challenge many organizations are facing, is maintaining knowledge work processes. Thus, first, our findings contribute to practice by providing a wide and comprehensible overview of practice-oriented measures to help to fulfill sensory, relationship, synchronism, and identification and control requirements of knowledge work processes. Organizations can build up on our findings, implement suitable measures and adapt those measures to their knowledge work processes. Second, our research addresses the special challenge for organizations to maintain relationships among employees and retain them, even when they work remotely. This research provides insights into how relationship requirements can be met even at a distance and times of great insecurity. It is not a given that these relationships will work well without further action. For example, organizations in the pandemic situation have started to implement a digital start and/or end of the week. It is unique in a way that every employee actively schedules time for it and the sense of belonging is strengthened. Another example is that the interviewees' organizations have introduced communication platforms (Mäntymäki et al., 2019). These are not only useful for structuring knowledge work processes but do also allow direct exchange (business and private) via (group-) chat with emojis. While this is easy for organizations to implement, it creates a greater sense of belongingness. Moreover, it is important for organizations to celebrate success (e.g., closing new contracts) and special occasions (e.g., birthdays or organization anniversaries) virtually, and to actively provide room for this. This has to turn into a regular practice by the management because it motivates employees in the home office even more if these events are appreciated despite the crisis. Finally, we are confident that this research will contribute to a sustainable change in organizations that is less concerned with the "if" and more with the "how" of knowledge work processes, thus making a positive contribution to the crisis resilience of organizations in the future.

15.6 Limitations and Future Research

We conducted a qualitative multiple case approach to examine the fulfillment of knowledge work process requirements in times of crisis-driven digital transformation. Although we tried to be as thorough as possible in our research approach, this multiple case approach has some limitations that provide promising avenues for further research. First, our research focuses on COVID-19 as an example of a crisis-driven digital transformation. Therefore, further research is needed to clarify if our findings on how knowledge work process requirements were fulfilled can be transferred to other crisis (e.g., natural disasters, social disasters, wars) or if PVT needs further revision. Second, our research focused on knowledge work processes, we cannot be sure if there are further influencing IT characteristics for other work processes involving external stakeholder (e.g., sales processes) that we did not uncover. We strongly encourage future research in remote work settings to use our research as a starting point and explore how process requirements for other work processes involving external stakeholders (e.g., selling goods to customers) are fulfilled by means of IT. Third, we focused specifically on knowledge work processes and neglected individual feelings such as anxiety or stress in times of crisis- unless they impact the knowledge work process (e.g., through an increased need for social contact that can also be satisfied by the work context). Since these factors are important to understand crisis-driven digital transformation more holistically, we encourage future research to shed light on them. Furthermore, our research is limited by the fact that all interviewees are working in national work contexts with colleagues of the same nationality and cultural background. Therefore, we encourage future research to exclude possible cultural influences by examining the fulfillment of knowledge work process requirements in and across different countries and cultural contexts. In addition, since this research is based on a qualitative multiple case approach, we cannot (yet) substantiate our findings with quantitative data. Future quantitative studies would allow us to validate the expanded crisis-driven revisited perspective on PVT. Lastly, our research focused on remote work, so we can hardly draw conclusions about the generalizability of our findings to other process visualization contexts, and, thus, encourage further research also with particular attention to other possible influencing factors in other contexts.

15.7 References

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15.8 Appendix

15.8.1 Overview over Interviewees

No.	Interviewee	Organization Sector	Age	Gender
1	C_1_1	Mobility & Logistic	27	m
2	C_1_2	Mobility & Logistic	35	m
3	C_1_3	Mobility & Logistic	53	w
4	C_2_1	Telecommunication	35	m
5	C_2_2	Telecommunication	32	w
6	C_2_3	Telecommunication	56	w
7	C_2_4	Telecommunication	34	m
8	C_2_5	Telecommunication	28	m
9	C_3_1	Banking & Insurance	32	w
10	C_3_2	Banking & Insurance	32	m
11	C_4_1	Banking & Insurance	61	m
12	C_5_1	Consulting	54	m
13	C_6_1	Banking & Insurance	38	m
14	C_7_1	Mobility & Logistic	55	m
15	M_1_1	Municipalities	32	m
16	M_1_2	Municipalities	30	w
17	M_2_1	Municipalities	28	w
18	M_2_2	Municipalities	42	m
19	M_3_1	Municipalities	59	m
20	M_3_2	Municipalities	33	w
21	M_4_1	Municipalities	31	m
22	M_5_1	Municipalities	28	m
23	M_5_2	Municipalities	44	m
24	M_6_1	Municipalities	40	m
25	SME_1_1	Manufacturing	24	w
26	SME_1_2	Manufacturing	51	m
27	SME_1_3	Manufacturing	20	m
28	SME_2_1	Technology	24	m
29	SME_2_2	Technology	25	m
30	SME_3_1	Manufacturing	43	m
31	SME_3_2	Manufacturing	39	w
32	SME_4_1	Manufacturing	38	m
33	SME_4_2	Manufacturing	26	w
34	SME_5_1	Mobility & Logistic	40	m
35	SME_6_1	Consulting	49	m
36	SME_7_1	Consulting	48	m
37	SME_8_1	Press & Media	46	w
38	SME_9_1	Mobility & Logistic	39	m
39	SME_10_1	Innovation	33	w
40	SME_10_2	Innovation	35	m

15.8.2 Interview guide “Remote Work in Times of COVID-19”

Please note that this interview guide is an excerpt from a longer version. We have provided all sections required for this research.

1. Focus: Person

- Age, gender
- What organization do you work for?
- What is your current profession?
- What professional education do you have?
- How would you rate your IT-competencies?
- To what extent has COVID-19 affected you personally or your environment?

2. Focus: Knowledge work processes

- Can you describe your workplace?
- Why is it necessary for you to work from home?
- How extensive was the work in the home office?
- How were knowledge work processes [collaboration, coordination, communication, decision-making] organized on-site and how are they organized in home office settings? What are the most important changes? Where do you see challenges and opportunities?
- How would you describe the role of working from home for your organization?
- What work constraints have you encountered in the transition from working on-site to working from home?

3. Focus: Requirements of working from home and the implementation of home office

- Which requirements (technical, organizational, collaborative, other) do you have for your work [knowledge work process]? Which effects does it have if these requirements are fulfilled or not fulfilled?
- What are your requirements (technical, organizational, collaborative, other) for working from home? Which effects does it have if these requirements are fulfilled or not fulfilled?
- How have your requirements for work changed in times of COVID-19? Which new requirements do you have?

- What technologies have been implemented for the collaboration when working from home?
- Which new technologies have been implemented?
- How are these technologies being used?
- What are the technical challenges or limitations?

4. Focus: Social Aspects

(a) Before COVID-19

- What do you do to foster feelings of togetherness [cohesion, belonging, organization identity]?
- What events have taken place in your organization?
- How do you get the feeling that your leader and other employees are present?

(b) With the outbreak of COVID-19

- How can a feeling of togetherness [cohesion, belonging, organization identity] be created when all employees are working from home?
- How do you build virtual relationships to your leader and colleagues?
- How are you virtually present when you are at home?
- What measures do you take to improve the atmosphere among your colleagues?
- To what extent do you think it is a challenge for new colleagues to get to know each other and integrate into the team when everyone is at home?
- Which events take place virtually?
- What technologies do you use to strengthen social presence / trust / mood?

15.8.3 Coding Scheme

Part	Content	Codes	
I	Demographics	*Age*	
		Gender	
		Organization sector	
		Organization size (C, SME, M)	
II	Representation (Before COVID-19, with the outbreak of COVID-19)	*Sensory Requirements*	*Seeing*
			Hearing
		Relationship Requirements	*Privacy insight*
			Organization identity
			Representation of person
			Representation of feelings
III	Reach (Before COVID-19, with the outbreak of COVID-19)	*Relationship Requirements*	*Communication platform*
			Participative decision-making
		Synchronism Requirements	*Data access*
			Editing
			Collaboration
			Collaboration tools
			Short term communication
IV	Monitoring capability (Before COVID-19, with the outbreak of COVID-19)	*Identification and Control Requirements*	*Transparence of availability*
			Transparence of progress
			Transparence of activity
V	Social Presence (Before COVID-19, with the outbreak of COVID-19)	*Relationship Requirements*	*Joint start/closing of the week*
			Joint Breaks
			After-work events
			Celebration of success and achievements
VI	Situation awareness (Before COVID-19, with the outbreak of COVID-19)	*Relationship Requirements*	*Personal exchange*
			Spontaneous exchange
		Synchronism Requirements	*Substantive exchange*
			Cross-departmental exchange

15.8.4 Overview of the Findings

IT Characteristic	Fulfillment of Requirements	Activities	*Example Quote*
Representation	Sensory Requirements	Phone calls instead of massage/mail	"Just keeping in touch. Just make a call. In the past, I would have written an e-mail, but now I call [...]. I do that a lot more so that I can also hear the other person's voice sometimes." (SME_1_2)
		Video- instead of audioconference	"And I think it's also very important to turn on the webcam. […], it's important to see others, to have the feeling that you're not just talking to a picture, but instead a real person, who still has facial expressions and gestures." (C_3_2)
	Relationship Requirements	Avoid virtual wallpapers	"So, a picture, for example, as a background I find distracting. So, you have the feeling that someone wants to hide something. [...] I think you have more insights into the privacy of the other person, which also makes working together a bit more pleasant. And I think this personal aspect is especially important when working from home exclusively." (SME_8_1)
		Integration of virtual organization identity	"But we try to formulate a common vision, because I think we need something we can unite behind. [...] For example, by using the same logo in our Linked-In profiles. [...] In addition, our leader created a picture with photos of our department and our organization's logo. We all use that as our desktop background." (C_2_1)
		Use of Graphics Interchange Format (GIF) and Emojis	"We have been writing a lot more in the chat since the pandemic. And we also try to use the GiF function and emojis very extensively, […] to make the work a bit more fun and to virtualize our personal level." (SME_10_2).
		Use of profile photos in user accounts	"It starts with, for example, a profile photo. [...] We used to have dummies. Now we have all the profile photos in Outlook, so you know who you're writing to, so it's at least a little more personal." (C_1_1)
Reach	Relationship Requirements	Use a unified communication platform	"So, I would say that first our tools had to be rethought because we had too many. [...] We had WebEx, Teams, Jabba. Zoom was used in some cases. [...] We unified that since we depended on regular communication through these tools." (C_2_2)
		Use of participative decision-making tools	"When it affected, let's say, every structure or every employee, we also built small surveys in Microsoft Forms, where you could then decide for or against it." (SME_2_1)
	Synchronism Requirements	Provide shared data access	"Of course, I use OneDrive and SharePoint, that's essential. I'm always amazed at how it works, that you can share individual files, folders or other things outside the organization and grant permissions and so on. For example, with our customers or our tax office. I keep the accounting on the drive here and then I just give them the folder. I don't have to move anything back and forth; they can pull it out of there. That saves an incredible amount of work." (SME_9_1).
		Use of real-time screen sharing	"In the past, everything was sent around, and everyone gave their comments. Everyone has their change mode in Word, for example, and you clicked through there. Now you throw it up on a screen, discuss the common thing to change, and someone changes the central thing. Of course, that's all much faster, I think. And no one is lost by the fact that you share screen. You are talking about one and the same. There are fewer misunderstandings. Before, you had a lot of misunderstandings. As I said, outdated statuses or you didn't talk about the same thing, because maybe you only did it over the phone or by mail. So that's already easier now with video conferencing and or you can throw everything on the table somehow. I find the way of working already considerably easier." (C_1_3)

		Use of real-time collaborative file editing	“So, I was totally excited when Office 365 was finally introduced in our organization, where the function was finally introduced that allowed us to work together on a document. I found that to be a very, very big improvement when working from home. [...] You unlock the document, can work on it together and see the result immediately.” (C_1_3)
		Use of real-time collaboration tools	“Well, I’ve been using Miro since the beginning of the pandemic. It’s a kind of digital whiteboard, and with it I’ve found what I was missing in digital meetings, that is, this interaction. You can really do brainstorming sessions. Just like in the office in the past. You can develop and record content directly together [...] And at the end you know what you have said and created. That becomes directly visible.” (SME_10_1)
		Use of chats for short term communication	“We use the chat function for the short-term exchange of information. About the latest news, what is important, so it is definitely and just also appointment coordination as well as, I’ll be there in half an hour or things like that. [...] To communicate in real time.” (SME_7_1)
Monitoring Capability	Identification and Control Requirements	Consistent use of availability status	“We use a traffic light system. This makes me feel more confident that it’s not just me working. [...] Once on red, then the “door is closed”, then you should also not “come in”. Green then the “door is open”, and then everyone is also welcome.” (C_6_1)
		Use of virtual project management tools	“So, what’s important is documentation. [...] Since we’ve been working from home, we’ve been using digital Kanban boards to maintain a level of monitoring. We know who is working on what and what the current status is, and we know who to contact if we have any queries. That way we avoid wasting time or heading in the wrong direction.” (SME_2_1)
		Use of shared calendar	“Yes, now since the home office we have access to all calendars, and we manage and maintain it accordingly. And we also use blockers when we are not in meetings. So, I know that the others are working and what they are working on. That creates transparency and trust.” (SME_7_1)
Social Presence	Relationship Requirements	Implement joint start/closing of the week	“We start Monday morning at nine, we always start the week together, and then we simply talk about personal stuff for 20 minutes. We wouldn’t have done that in the past, I would have pretty much said coop, coop, coop, that’s what we’re doing now. Now it’s important for us to start and end together more personally.” (C_2_4)
Situation Awareness	Relationship Requirements	Care Calls	“This was a regular exchange and presence on-site. People just got together for meetings, and sometimes chatted personally and privately. So, it wasn’t just limited to the specialist topics, to the work, but of course it was interesting what might be going on in your private life, right?” (C_4_1)
		Informal exchange	“Well, before Corona we already made sure that we met once a quarter. I simply went to lunch with the people. [...] I picked up people on a one-to-one basis to find out sometimes how they were doing... did you really understand the task?” (C_2_4)
	Synchronism Requirements	Knowing colleagues’ competencies	“I believe that we should make individual appointments with all team members to introduce the new team member, what am I working on at the moment, what am I doing, what is important, or simply to pass on a bit of precise know how or, yes, to find out what the strengths and weaknesses are. So work-related, just getting to know the team member a little bit.” (C_3_2)
		Interdisciplinary exchange	“We also have an exchange round at the specialist level, where everyone from the specialist department reports briefly on what they are doing, so that we can also find out what the other departments are doing because this kind of exchange that takes place briefly in the office, no longer takes place.” (SME_10_2)

III FUTURE TECHNOLOGY MANAGEMENT

16 A Design Journey (P5)

Paper Number	**P5**
Title	**A Design Journey: Towards a Virtual Reality Simulation and Training Application.**
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Table 16.1 Fact Sheet Publication

A Design Journey:
Towards a Virtual Reality Simulation and Training Application

Abstract. Through digital transformation and new technologies such as virtual reality (VR), employees can benefit from enormous advantages within the corporate context. In industrial computer-aided design (CAD), there are complex workflows that have a great influence on the maintenance processes. However, designers may not be fully aware of potential benefits of these influences. To sharpen this awareness, for such scenarios the demonstration of CAD objects in VR can be a solution. Virtual testing of a design is inexpensive and can be realized quickly. In addition, maintenance can already be trained virtual in detail on the VR image of the machines. This topic is taken up representatively and implemented in an information system (IS) based on VR and a design science research approach. The needs of the employees are strongly considered in this study and the developed software can be applied to a broad class of related problems. Finally, the demonstrator and the underlying processes will be evaluated to gain insights and knowledge about the design of a VR system.

16.1 Introduction

In the course of digital transformation, the virtual and real worlds of work are increasingly merging (Friess, 2016). Products and services are equally subject to this process. The contribution, especially of highly specialized technical products, can be significantly increased by combining them with accompanying services (Vendrell-Herrero et al., 2017). Accordingly, it is necessary for products and services (such as construction and maintenance processes) to merge. To this end, the necessary competencies on the part of both producers and service providers must be identified and jointly expanded.

The value chain is the term used to describe various stages of production that can be described as an ordered sequence of activities. These activities create value, consume resources and are linked together in processes (Porter & Advantage, 1985). However, nowadays value chains are usually modified to hybrid value chains. This means that not only the product but also the services associated with the product are defined as hybrid value chains (Leimeister & Glauner, 2008).

This research aims to address the development process for an interactive VR demonstrator for the mediation of competencies over hybrid value chains (construction processes and workflows around maintenance) (Weigel, Hoffmann, et al., 2020). In addition to the conception of a digital environment for experience-based and subject-related competence development, the exchange of knowledge between maintenance personnel and other relevant employees (constructors, management, sales, information technology (IT), etc.) across departments and companies should be supported.

In the research process, both theoretical and practical elements in the VR demonstrator are illustrated in order to promote the transfer of knowledge along hybrid value chains. To better define this VR demonstrator, the relevant requirements and practices of the employees should first be determined empirically. Subsequently, the competence development is conceptualized in organizational terms (Weigel, Heger, et al., 2020). The aim is to provide employees with the best possible support in their competence development through the use of VR and to transfer this support into operational practice on a pilot basis.

This research is structured as follows: First, an overview of the related work on hybrid value chains, technology-supported perspective taking and VR will be given. Next, the research methodology based on the research framework of design science will be described (Peffers et al., 2007). Third, the results will be discussed and the limits of the research to date will be pointed out. Finally, a recommendation for future research will follow.

16.2 Related Work

In hybrid value chains, the alignment of corporate strategies is particularly important. Often, several organizations are represented in these hybrid value chains (Santos et al., 2015). They pursue different goals and strategies. However, good cooperation is characterized by the fact that these different organizations pursue similar goals. IT-Business Alignment considers the alignment of IT and business, (Reich & Benbasat, 1996). IT-Business Alignment will become increasingly important considering hybrid value chains between organizations (Ryan et al., 2013; Weigel, Hoffmann, et al., 2020).

One way to strengthen this IT-Business Alignment can be the technology-supported perspective taking (Weigel, Hoffmann, et al., 2020). The perspective taking originally comes from psychological research. It is an attempt to enable one person to take the perspective of another person (Boland Jr & Tenkasi, 1995). The literature often describe this empathy as a reflection of our own point of view. Customer and user orientation can be understood as a form of adopting a perspective that has a positive effect on the development of new products (Salomo et al., 2003). But also in the context of services, the ability to adopt the perspective of another client, has a positive effect on the ability to help (Axtell et al., 2007). Classically, perspective taking can be triggered by the explicit request to put oneself in the perspective of another person (Boland Jr & Tenkasi, 1995). However, digital technological developments in particular increasingly show that the adoption of the perspective can also be influenced by technical measures (Lee et al., 2018; Peng et al., 2017).

VR has enormous potential when it comes to teaching skills and processes. This has already been researched within the framework of VR research in the educational sector. (Wohlgenannt et al., 2019). Objects and even individual process steps can be displayed with a very high level of detail. In addition, a closed VR room enables a focused interactive experience (Martín-Gutiérrez et al., 2017). However, VR technologies can also be used to close a gap in the transfer of information (Jayaram et al., 1997). Nevertheless, research on the use of VR in the context of technology-supported perspective taking is limited (Weigel, Hoffmann, et al., 2020). There are only a few articles dealing with use cases in a business context. For example, it is argued that the combination of avatar manipulation and role-playing in the virtual world can also lead to the development of empathy (Jestice, 2016). This avatar manipulation was also considered in another experiment. Here, the conventional method of taking perspectives by means of mental simulation was combined with the immersive virtual environment. Different effects were observed depending on the group. For example, the negative effect of age discrimination was less pronounced if one was placed in the role of an older person in VR (Oh et al., 2016).

In summary, hybrid value chains are a decisive factor in our today's economy. The better they function, the better the objectives of the various organizations are aligned. But not only the general objectives plays a role, but also the IT-Business Alignment. This IT-business orientation can be supported by technology-supported perspective taking, and VR can be a manifestation of this support.

16.3 Methodology

Design science research has become increasingly important in the research field of IS since the 1990s (March & Smith, 1995). But even today, the importance of design science research remains undiminished (Niehaves & Ortbach, 2016; Peffers et al., 2007). There are two areas of design science. One deals with the creation of a new IT artifact. The other one deals with the manipulation of an existing IT artifact. This current research shows that theoretical approaches to the influence and effects of e.g. IT artefacts only emerge after their development and use (Hevner et al., 2004).

This research follows the six phases of the design science research methodology for information systems research (Peffers et al., 2007). These are:

1. Identify problem and motivate

2. Define objectives of a solution

3. Design and development

4. Demonstration

5. Evaluation

6. Communication

First, an analysis of the existing processes was carried out to determine the exact procedures. An important part at this point was the understanding of the process knowledge. At the same time, the search for existing best practices was carried out. The technical possibilities for implementing a VR environment were explored. After an overview of the initial situation and the feasibility of the VR environment was available, the requirements for the demonstrator were determined.

Furthermore, a concept was developed how the VR environment should represent the researched approaches and the collected data. This step was followed by the actual development of the demonstrator. It was evaluated at regular intervals whether the demonstrator meets the requirements and the concept. This evaluation can be included in the further development. The steps of development and regular evaluation are currently repeated until the development goals are achieved. As a final step, the development of this prototype or a further application is discussed.

To date, phases one and two have been completed. Phases three and four are currently active, phases five and six will follow in the future.

16.3.1 Problem Definition

In this research two organizations are considered, which are connected in a hybrid value chain. First, the producing organization and second an organization that offers accompanying services for the products. In order to define the problem situation precisely, interviews were conducted with six employees of the production organization and five employees of the service organization. The interviews provide good insights into the current situation. For example, maintenance work on a technical machine requires a head for heights and enormous skills. However, the person who maintains a machine is usually not the person who designs the machine. This means that there are knowledge gaps in the value chain between the services of assembly, maintenance, repair and product development. Therefore, important aspects for maintenance cannot be taken into account in the design.

It is obvious that this workflow offers the potential for improvements through digital transformation, more precisely through the VR demonstrator under consideration. On the one hand, competence development along the hybrid value chain has not been consistently pursued so far. On the other hand, there is no real evaluation of the service processes in relation to the actual construction of the product. There is uncertainty for all involved employees about the possibilities of the employees of the other organization.

16.3.2 Objective of Solution

The interviews from phase 1 were used to develop the objective of solution. This was pursued extensively, since previous research on VR environments has only marginally addressed the industrial context. Therefore the solution is planned in a cooperative, employee-centered approach. One example is a service employee who was accompanied on two days. During these two days, maintenance work on two different machines could be observed and scientifically documented. For this purpose the individual steps were recorded photographically. Due to the industrial environment and the applicable regulations, it was not possible to record the process on video. A maintenance manual was created from the documentation and photos, which was later discussed again with the service personnel to check for possible misunderstandings. The product development process was also documented in detail. A product development process was accompanied, from the integration of the standard parts to the static calculation of the designed product the steps could be traced.

The identified requirements can be specified as follows. This specification provides the basis for the next section, in which requirements can be generalized and implemented in the VR demonstrator.

RQ1: Requirement: Simulation environment

A simulation environment should be created to enable developers to evaluate their design in this process. This supports possible improvements to the machines.

RQ 2: Requirement: Training environment

A training environment must be created so that skills can be further developed and trained. This is mainly for the service organization to train service on new products. However, new employees from both organizations can also be trained accordingly.

The demonstrator therefore aims an interactive VR simulation for the visualization of maintenance work in order to make work processes and conditions tangible and to train interdisciplinary skills. This is intended to digitize and make the cross-organizational exchange of knowledge between maintenance personnel and designers comprehensible.

From the combination of these arguments the problem definition can be derived as follows. The two areas of construction and maintenance are not yet sufficiently coordinated. Consequently machines are developed, which are not optimally maintainable.

16.3.3 Design and Development

Access to the VR demonstrator is guaranteed by the consumer technology HTC Vive Pro Eye and the Unreal Engine. The goal is to provide a solution that can be used in numerous situations and different scenarios. Thus, an abstraction step of the constructures is performed before implementation. This will give us a more flexible approach that will be easy to use. Subsequently, with the help of the "Business Process Model and Notation" (BPMN) models are created, which will reproduce the recorded process steps in general and clearly for the software developer.

The maintenance relevant process steps should be presented as detailed as necessary but as general as possible. Not every specific detail needs to be simulated and interactively designed in VR. This will allow the transfer to different machine types.

The simulation of machines designed in CAD will allow the developer a high degree of creativity. A pipeline is being developed for this purpose. This pipeline will convert CAD design files that are exported as STEP files to VR. The interaction with these transformed objects, however, is not possible. However, the designer can determine which CAD objects are replaced by interactive VR objects. This follows a previously defined naming scheme and enables the execution of simulated maintenance work on these VR objects.

16.3.4 Demonstration

The VR demonstrator is created as a hardware-software demonstrator. This development is done in an agile way to be able to flexibly take up the results of the parallel running evaluation. The VR demonstrator represents the technical solution comprehensively and focuses on the immersion of the user and the experience within the VR environment.

In the future, implementation strategies will be developed to anchor the VR demonstrators in the organizations. These implementation strategies determine how the processes are designed, how the target groups are integrated for productive use and how accompanying organizational measures (e.g. guidelines and workshops) are implemented. Based on these strategies, the VR demonstrator is implemented in the organizations in the form of a pilot project. The experience gained will be analysed and used to further develop the VR demonstators.

16.4 Future Steps

16.4.1 Evaluation

The VR demonstrator will be continuously evaluated. In the future, this evaluation will take place with regard to the extent to which the respective status of the demonstrator can be used for competence development and for teaching in work processes along the hybrid value chain. In addition, it is examined whether the solution offers significant added value for networked working. A field evaluation with users will be planned. This will take place in the form of several field studies with the demonstrator. In the run-up to the demonstrator, individual aspects (e.g. VR simulation environments, learning/ supportability or applicability) will be evaluated in laboratory studies.

In the context of the quality assurance of the VR demonstrator, a formative evaluation is aimed at, which continuously checks technological (e.g. usability tests) and technical aspects (e.g. process step integration). Furthermore, the development will be discussed and reflected upon, e.g. in workshops with all project participants. The goal will be an iterative development with the results of the evaluation.

16.4.2 Communication

Project coordination is carried out continuously. At the beginning of each month there is a digital jour fixe using a web conference system with all persons and organizations involved in the project. The project organization is agile in order to incorporate possible feedback into the development of the demonstrator in a timely manner. The immediate communication via the web conference system ensures that the defined goals are achieved on time and according to plan. Problems can be detected early on due to the continuous exchange of information. A continuous exchange between the project partners helps to ensure the consolidation of the project results. All these measures are then additionally supported by regular physical project meetings. This exchange will form the basis for future communication about the project and its results.

16.5 Discussion

This research deals with the development of a VR demonstrator for the simulation of partly dangerous maintenance procedures. Inspired by developmental research method a problem-oriented research design was presented (Peffers et al., 2007). The requirements were then derived on the basis of the problems identified. On this basis, qualitative interviews were conducted with the organizations' practitioners. Afterwards, the resulting findings were evaluated by all participants in a workshop and learning scenarios were developed to solve the original problem of the lack of competence development along the hybrid value chain.

In the demonstration phase the VR demonstrator will be presented and explained to the employees of the organizations. Special attention is paid to the applicability, to the respective configuration and the simulation of the workflows. Subsequently, further feedback and evaluation phases are planned in the form of further workshops, qualitative interviews and experiments. According to the results obtained, the unique simulation properties of VR lead to an improvement in product quality as well as to an improvement in service quality. Especially, the pipeline management, which allows an immediate simulation of the CAD data, was highlighted as a key feature and an important contribution.

Another decisive factor is the hardware used. In the field of VR Head Mounted Displays the best possible immersion is a big discussion. The reduction of the CAD data with simultaneous possibility of interactive with components was solved by a hybrid approach.

As with any practice-oriented research study, there are some limitations: First, the empirical basis for the developed VR demonstrator is based only on the development and service scenario. In order to overcome this limitation, it is intended to transfer the VR demonstrator to further use cases. The research have verified the benefit of the VR demonstrator in a service scenario and development scenarios in two organizations. According to the interviews it is helpful to transfer at least the service scenario to other organizations. This way, the employees of other service organizations, who also maintain the machines of the organization, could be addressed. Second, the evaluation so far is limited, because on the one hand the project is not finished yet. On the other hand the participants of the evaluation could only test the VR demonstrator for a short period of time. Therefore this study intends to carry out a long-term evaluation in the future in order to gain a detailed insight into the effects of the demonstrator on the work of the employees.

Nevertheless, a demonstrator should be created that can be used in practice for the development of many products.

This paper has also introduced technology in an organizational context, which helps employees in the service sector to get to know their work processes better. This helps organizations keep pace with the competition by better training employees and saving resources. In the field of research, this study have made a scientific contribution to the design science research methodology for information systems research (Peffers et al., 2007)

Guidelines could be developed which could be extended to other use cases through extension, application and evaluation. The collected knowledge can further help to understand how VR can be integrated into the industrial context. It can be determined which concrete artifacts a VR needs to be better designed to support employees in their work processes.

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17 Competence Transfer in Virtual Realities (VR) (P12)

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Table 17.1 Fact Sheet Publication

Competence Transfer in Virtual Realities (VR): Can VR Bring Products and Services Together?

Abstract.

Background

The virtual and real worlds of work are increasingly merging through digital transformation. This also applies to products and services. Virtual Reality (VR) with all its learning opportunities is a promising technology to improve workflows and enable transparency between different departments and organizations. This transparency is particularly important when it comes to preventing potentially dangerous work situations.

Objective

We investigate weaknesses in competence transfer processes between computer-aided designers and service employees connected in a hybrid value chain. On the one hand, designers receive only little feedback, hence are missing necessary evaluation to adjust their designs to empirical specifications. On the other hand, service employees, therefore, work with sometimes impractical machine designs which makes their work on-site unergonomic, dangerous, and more difficult.

Methods

We present a design science-driven, empirical approach to provide enhanced competence transfer with the help of VR. Thereby, we evaluate a self-developed VR demonstrator with an iterative approach consisting of 60 qualitative interviews.

Results

The developed VR demonstrator supports interorganizational sharing of (tacit) knowledge by enabling designers to take the service perspective and ensuring collaboration across organizational boundaries. By intentionally using VR technology as an interruption to the work, the design can be viewed from a service perspective and evaluated for occupational safety and health issues.

Conclusions

The work process improvements achieved by the VR demonstrator enable early consideration of design issues that are particularly relevant to safety, thus ensuring greater occupational safety and health protection in the processes for service employees.

Keywords: Design Science Research. Perspective Taking, Tacit Knowledge Transfer, Interruption, Collaboration

17.1 Introduction

Prevention, avoiding a dangerous situation in the first place, is often better than aftercare when a dangerous situation has already occurred. This applies to back pain, stress, and also the risk of injury [1,2]. Digital transformation can also contribute to this, often not at first glance, but all the more so when you look at the connections. For example, in the course of the digital transformation, the virtual and real worlds of work increasingly merge [3,4]. Products and services are equally subject to this process. The contribution, especially of highly specialized technical products, can be significantly increased by combining them with accompanying services [5]. Accordingly, it is necessary for products and services (such as design and maintenance processes) to blend seamlessly. To this end, the necessary competencies on the part of both manufacturers and service providers should be identified and jointly expanded. A common understanding of the respective competencies and tasks enables the entire value chain to be viewed from the perspective of safety for each individual.

Nowadays, value chains are usually modified to hybrid value chains [7]. Hybrid value chains do not refer exclusively to the manufactured product but include associated services into the value chain in order to provide a better service offering for the product [8]. This research examines the development process of an interactive Virtual Reality (VR) demonstrator; its main function being the mediation of competencies across hybrid value chains (i.e., design processes and workflows related to maintenance) [9]. The developed VR demonstrator is intended to enhance the crane design process and is being evaluated with a total of 60 employees. Due to the local separation of the organizations and the resulting lack of situational exchange opportunities between individual employees, there is less continuous exchange of knowledge and competencies. This means that avoiding potentially hazardous conditions can only be considered to a very limited extent. In addition to the conception of virtual space for experience-based and subject-related competence transfer, the exchange of knowledge between maintenance personnel and other relevant employees (designers, management, etc.) within organizations should be supported. This is particularly important for a sustainable alignment of construction and service work, which is crucial for making products easier to maintain. In addition, the transfer of knowledge and the associated improved alignment also play a central role in the area of workplace safety and the prevention of occupational accidents [10,11].

For our research process, we illustrate both theoretical and practical elements in the VR demonstrator to promote the transfer of competencies across hybrid value chains. Therefore, relevant requirements and practices of the employees are first empirically determined to better define the demonstrator. Subsequently, the competence transfer is conceptualized in organizational terms [12]. The research aims to provide employees with the best possible support in their competence development and to transfer this support into operational practice on a pilot basis. In this way, we contribute to shaping future work practice. The mapping of overarching processes in VR enables mutual understanding and competence transfer between organizations. This allows future development of better products customized to subsequent services. The knowledge imparted serves, in particular, to raise awareness of the topic of work safety and, thus, contributes to the prevention of dangerous situations in the workplace.

VR has already been studied in product development and ergonomics of products in terms of speed, quality, flexibility, and others [13]. VR has also been researched as support for assembling work [14], but there is a lack of consistent linkage between these topics across the value chain that this work identifies as a gap and explores below. As previous literature shows, VR is highly integrated into the learning context and shows a supportive function for learning processes [15]. Additionally, the significant development of multi-user VR solutions enables an interactive and simultaneous experience across different departments and organizational boundaries [16]. To fully benefit from the (learning) potentials of VR [17] in a practice-oriented context, we apply a design science research (DSR) approach strongly related to Peffers et al. [18]. According to Gregor and Hevner [19], we extend design science literature by providing further contributions. Relying on our artifacts, we address the following research question (RQ):

RQ: How can the potentials of VR technologies be used to ensure the transfer of competencies across organizational boundaries?

To answer the RQ, we structured our research as follows: First, we provide an overview of the related work on hybrid value chains, technology-supported perspective taking, VR in the context of tacit knowledge transfer, VR usage as an interruption to the design process, and the possibilities of digital collaboration through VR. Second, the research methodology is described based on the research framework of design science. Third, the results are discussed based on interview extracts and the contributions are highlighted. In summary, a table is presented that breaks down the findings. The limitations of the present research are addressed and further recommendations for future research are made.

17.2 Theoretical Background

In hybrid value chains, machines and services are offered in combination and often represented by multiple organizations [20]. Aligning the organizations with each other becomes particularly important as the different organizations often have divergent aims [21]. Although the organizations' operations are linked to the same product via a value chain, they differ fundamentally in their work processes [22,23]. Competence transfer between organizations can support a better understanding of each other and coalescence [24]. Thus, the consideration of hybrid value chains between organizations is becoming increasingly important [9,25] because optimal competence transfer can only be achieved if the different organizations are well aligned [26]. In the course of digital transformation, digital competencies have been developed that enable employees to cope with technological progress and the associated changes in the workplace [27]. In this context, flexible and digital technologies are of particular importance, enabling constant assessment and redesign of work. Digital competence is a dynamic capability that can be primarily supported by technologies that enable evaluation. This can provide insights into what is potentially possible [28]. The possibilities for evaluation through technologies (in our case VR) represent a core component of digital competence.

As technology has evolved in recent years, new ways to enter and experience VR are emerging [29]. Current trends, as well as solutions, are highlighting the possibilities created by VR. Issues related to possible difficulties in the use of VR, including side effects and the transfer of competencies to the real world, have been explored in prior literature [4]. Particularly noteworthy are immersive VR solutions that provide users with a three-dimensional experience in a closed virtual space shown on a head-mounted display [30]. Furthermore, a closed VR space enables a focused interactive experience [17]. Thus, we argue that VR technologies offer great potential to combine perspective taking and further competence transfer aspects (in this case, previously tacit knowledge transfer and digital collaboration) along the value chain and to make them usable for work contexts. Optimal process design is considered, as research addresses aspects of interruption.

17.2.1 Perspective Taking

Originated from psychological research, perspective taking is an attempt to enable one person to take the perspective of another person [31]. While literature often describes this process as a reflection of our own point of view [32], perspective taking is researched in different contexts. For instance, customer and user orientation can be understood as a form of adopting a perspective that has a positive effect on the development of new products [33]. In the context of services, the ability to adopt the perspective of the client has a positive effect on the ability to help [34]. Classically, perspective taking can be triggered by the explicit request to put oneself in the perspective of another person [31]. However, digital technological developments increasingly show that perspective taking can also be influenced by technical measures [35,36]. To this end, perspective taking has been, for instance, used as a de-escalation tactic to reduce the product managers' commitment to an original product launch date when they were confronted with serious software deficiencies in the product [35].

In the context of perspective taking, VR can be a key technology. The user can be virtually put “in the shoes of another person” and be confronted with this person’s views or challenges. However, research on the use of VR for technology-supported perspective taking is limited [9]. Only a few articles deal with use cases in an organizational context. For example, researchers argue that the combination of avatar manipulation and role-playing in a virtual space can lead to the development of empathy [37]. In terms of hybrid value chains as a decisive factor in the avoidance of occupational hazards in today’s economy, the integration of VR might be beneficial. The better the hybrid value chains function, the better the objectives of the various organizations are aligned. This can be fostered by technology-supported perspective taking; one form might be VR. One way to strengthen competence transfer is the technology-supported perspective taking [9].

17.2.2 Tacit Knowledge Transfer

Tacit knowledge describes knowledge that accumulates over a period of time in form of experience in organizations [38]. Due to its characteristics, the transfer of tacit knowledge constantly remains a challenge for organizations [39]. In contrast to explicit knowledge, tacit knowledge is characterized by the fact that it is difficult to capture or document, and particularly deeply anchored in individual employees [40]. In the organizational context, tacit knowledge includes, for example, experiential and expert knowledge as well as competencies of employees [41].

The focus of this research is on the tacit knowledge that is created during assembling and maintenance processes and is embedded in the minds and work steps of service employees. Tacit knowledge comes from managing the daily work and is the result of technical exposure to regular challenges in maintenance and assembling situations [42]. For instance, Hejduk et al. [11] recognized a significant correlation between the employees’ management of tacit knowledge regarding safety and hazard prevention at work. Nevertheless, to date, there has been little literature that addresses the use of IT for interorganizational tacit knowledge transfer in hybrid value chains.

A classification of tacit knowledge according to its degree of tacitness is made by Chennamaneni and Teng [39]. Thereby, they developed and assigned appropriate knowledge transfer mechanisms and communication media types. For capabilities of rather low tacitness, asynchronous, and lean media such as e-mails or asynchronous groupware are sufficient. In turn, the transfer of knowledge with a particularly high degree of tacitness requires the observation and imitation of expert behavior, which depends on a communication technology that enables synchronous face-to-face communication [39]. Haase et al. [42] emphasize that technology-enhanced tacit knowledge transfer requires a learning environment that can map work processes while maintaining a narrative character. They justify that storytelling methods are required for the extraction of tacit knowledge. The mapped stories consist of facts as well as tacit knowledge. VR technologies meet these requirements and provide a suitable learning environment [42].

17.2.3 VR Interruption of CAD Processes

Interruptions are a common occurrence in modern work practices and can affect work performance. Particularly due to digital transformation, workers increasingly rely on the usage of technology to accomplish their working tasks [43]. Work interruptions are defined as "incidents or occurrences that impede or delay organizational members as they attempt to make progress on work tasks" [44]. When interruptions are caused by, or attributable to the use of technology (e.g., e-mail notifications), research refers to them as interruptions that are induced by technology [45]. While common technologies, such as phone calls or e-mails, can interrupt office workers up to 70 times a day [46,47], they lose a third of their workday as a result [48,49]. Therefore, interruptions are mostly considered as negative events which can impair the performance of work activities [50] by reducing productivity, adding load due to additional tasks, or disrupting ongoing work processes [51].

Besides the negative nature, research from a technological perspective indicates different types of interruptions that show different effects on performance [e.g., 46,50]. How interruptions appear is critical to assessing their impact on worker performance [52]. According to Trafton and Monk [53] from an ergonomic perspective, the occurrence of an interruption initiates a process that directs attention from a primary task to be performed to a secondary task initiated by the interruption. Regarding the common use of a multitude of technologies to perform work tasks, Addas and Pinsonneault [46] identified three different stages of the influence of technology-induced interruptions on the process of primary task performance. First, interventions as secondary tasks provide relevant information for primary task performance. Second, intrusions provide irrelevant information. And third, hybrid interruptions as a mix of both. By directing workers' attention to a secondary task, they are partially irrelevant to the primary task, however, relevant information is generated through interaction with the secondary task. This makes hybrid interruptions a special type of interruption that contradicts the very definition by combining both positive and negative influences on the primary task performance [46].

Using VR within the Computer-Aided Design (CAD) could be considered as a hybrid interruption for construction processes. Since CAD is a common standard, the way of construction can be supported with the usage of modern technology like VR [54] and results in influences on conditions (i.e., technology switch) of task execution regarding the job context [55]. While considering the involvement of VR in the construction process as a hybrid interruption, we refer to the technologies used within the design process (i.e., CAD and VR), which can be adapted to the constant sequence of the interruption process [53]. Therefore, we consider the crane design process as an overall task, while considering CAD as the primary task of the process in terms of the technology commonly used and VR as a secondary one as an innovative technology in terms of digital transformation for CAD-model consideration. For the process, first, the primary task is performed. Regarding the interruption process, the secondary task occurs which initiates the interruption and interrupts the initial primary task process. Conceivable approaches for VR usage could be either fixed verification points anchored in the design process or an interim check by the designers themselves (e.g., at a certain design progress, it is necessary to use the VR for detecting interfering edges). By doing this, the attention and work processing shifts from using CAD to using VR, which represents an interruption of a design process that has been standard so far. Meanwhile, the designer can collect valuable information and impressions (e.g., identification of interfering edges or consideration of the components in their original size), supporting and positively influencing current and future CAD constructions as the primary task in crane design. After using VR, CAD construction is continued. The switches between the tasks are called interruption lag and resumption lag [53] and refer to the technology switch between a computer workstation for CAD construction and VR.

Considering the implementation of VR and the adaptation of the interruption process indicates the characteristics of a hybrid interruption within the construction process. On the one hand, the CAD work on a computer workstation is interrupted due to the change to VR and its usage. This implies a negative impact on the process in the sense of an intrusion since no relevant information for the construction is provided [46] and the CAD process is stopped. On the other hand, VR as the secondary task within the construction process allows considering the construction in new angles and environments as well as different types of interaction than on CAD workstations [56]. Thereby, in the sense of an intervention, relevant information for the construction can be created [46], which does not influence the current construction as the primary task in an only positive manner but can sustainably enrich future constructions with increased knowledge and can accelerate processes, as errors are eliminated during the construction.

17.2.4 Digital Collaboration

Collaboration is generally understood as a process in which two or more people share knowledge and resources to jointly achieve a common goal [57–59]. While the terms cooperation and collaboration are often used interchangeably, literature delineates these two terms [58,60]. Cooperation is a process in which individuals work on different subtasks of the intended result [60,61]. Collaboration, however, is a process in which individuals work together to create value that members cannot create through individual efforts [62,63]. Therefore, collaboration is characterized by task-related and social interactions as well as communication to share resources and knowledge [64].

Digital collaboration is a collaboration process in which collaborators primarily use IT to interact and communicate [65–67]. To make digital collaboration particularly effective, it is important that the user's focus is not on the functions of the application [68]. Collaboration software and tools enable collaboration that transcends spatial and temporal boundaries [69]. However, traditional collaboration tools, such as video conferences, meet their limits when it comes to interactive collaboration (e.g., prototyping), since the functions are not sufficient for three-dimensional space and facial expressions, and the body language is lost to a great extent [70].

Literature suggests that multi-user VR is a promising new technology for digital collaboration [71–73]. Multi-user VR technology makes it possible for multiple users to meet and interact with each other as well as with virtual objects in virtual spaces [74–76]. Multi-user VR enables interactive collaboration by supporting social presence, rich non-verbal communication, and immersive realistic interaction [74]. In addition, the concurrent use of images and speech supports decision-making and improves communication among collaborators [71]. So far there is only limited research on how VR solutions can be designed in such a way that they can be used effectively in collaboration with multiple stakeholders [77]. Our research aims at supporting employees in their competence development by including a VR scenario into operational practice for assembling and maintenance. Various factors have to be considered for using VR in the operational context. In addition to adopting a different perspective and transferring knowledge, also the integration of innovative technologies (i.e., VR) into previously common design processes (i.e., CAD) and collaboration in such virtual environments are important.

17.3 Methodology

DSR has become increasingly important in the research field of information systems (IS) since the 1990s [78]. The importance of DSR remains undiminished [18,79]. Two research streams of design science are distinguished: one deals with the creation of a new IT artifact, the other deals with the manipulation of an existing IT artifact. We use an inductive strategy [80] to develop an artifact for a specific problem that has occurred in practice, and then generalize it to address a class of problems. We expect that theoretical approaches to the influence and effects of, e.g., IT artifacts only emerge after their use and research [81]. In doing so, this research follows the six phases of the DSR methodology for IS research [18], including: problem identification, the definition of the objectives of a solution, design and development, demonstration, evaluation, and communication.

First, the existing processes were analyzed to determine the exact procedures. An important part at this point was the understanding of the process knowledge. At the same time, existing best practices were examined. Moreover, the technical possibilities for implementing a VR environment were explored. After an overview of the initial situation and the feasibility of the VR environment had become available, the requirements for the demonstrator were determined. Furthermore, we developed a concept to specify how the VR environment should represent and address the researched approaches as well as the collected data. Afterward, the actual development of the VR demonstrator started. We regularly evaluated if the demonstrator met the requirements and the concept, and the results were included in the further development. As a final step, the development of this prototype and its further application was discussed.

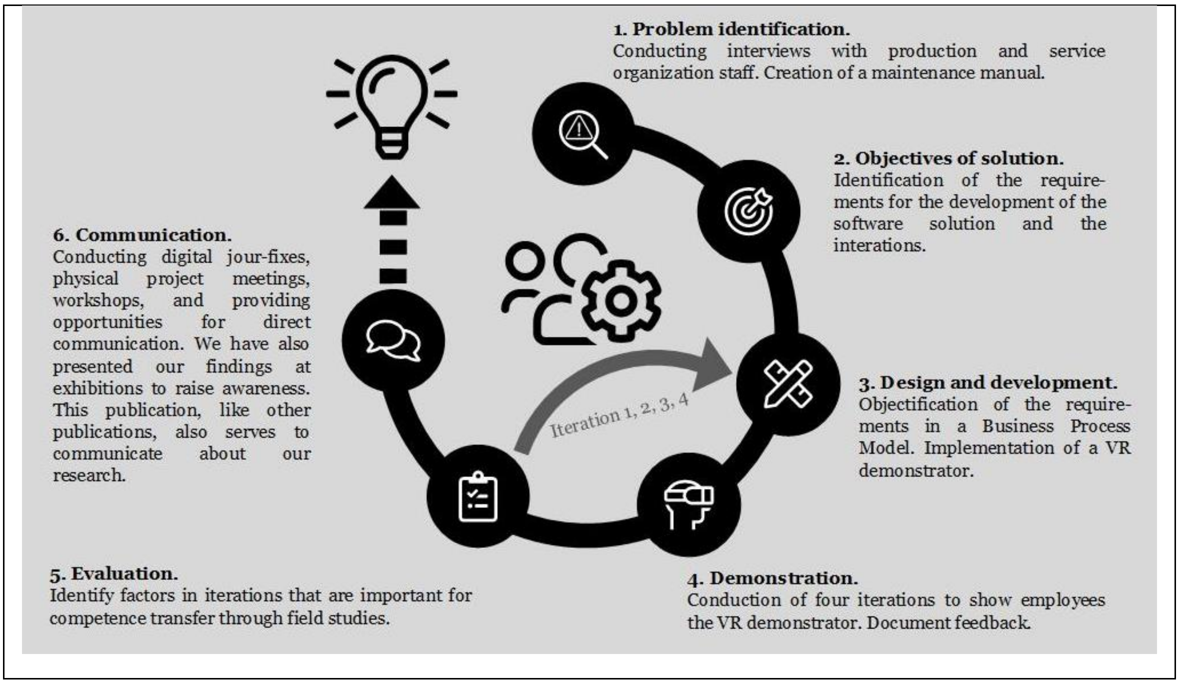

Figure 17.1 Overview and Application of the Design Science Phases

We completed our DSR with a total of four iterations. An overview of the single phases is given in Figure 17.1, followed by a detailed explanation below. Each of these iterations consisted of developing or refining the VR demonstrator. This demonstrator was then tested with a total of 60 participants in an experimental setting. The interviewees were employees from two German small and medium-sized enterprises (SMEs) – both, employees and managers. A total of 11 women and 49 men were interviewed. This approximately corresponds to the ratio of men and women in the mechanical engineering sector in Germany. The participants had an average age of 34 years and an average work experience of 12 years. After the tests, qualitative interviews with the participants were conducted. For a table of the four iteration steps, see below (Table 17.2).

Iteration	**Production participants**	**Service participants**	**Method**
1	6	5	Qualitative content analysis
2	9	5	Grounded theory
3	7	8	Qualitative content analysis
4	9	11	Grounded theory
Σ	**31**	**29**	

Table 17.2 Overview of Interviewees

The interviews were recorded and subsequently transcribed. Qualitative content analysis methods were used to analyze the qualitative data in Iteration 1 and 3 [82]. These analyses aimed to identify patterns in the interviews that deal with the objects of research. We wanted to learn more about how perspective taking on the one hand, and interruptions, on the other hand, are experienced and how this experience affects the transfer of competencies. To this end, we used an open coding approach in the interviews. The data was coded independently by two researchers. Afterward, these codes were discussed together. For example, it happened that the same text passage was coded differently. These conflicts were resolved by identifying one of the existing codes as the best or by merging the two codes into a new code. This process was repeated until all text passages were successfully coded and both researchers agreed on the outcome.

Grounded theory methods were used for iterations 2 and 4 [83]. The coding methods used include open coding, axial coding, and selective coding. Initially, open coding was used, i.e., in iteration 2 and in iteration 4, factors and situations of tacit knowledge transfer were searched for once, and conditions of collaboration were searched for once [83,84]. This process was conducted independently by two researchers to gather as many findings as possible. The findings were then compared and grouped (axial coding) to identify relevant aspects of the research [84]. Different perspectives of the researchers were discussed, and a common solution was sought in the interest of all researchers. The analysis was stopped at the saturation point, i.e., when no new higher-level measures were found. If there was disagreement between the two researchers on any point, a third researcher was brought in to discuss and establish an axial code.

17.4 DSR Steps

17.4.1 Problem Identification

In this research, we consider two organizations that are interconnected via a hybrid value chain; first, a producing organization and second, an organization that offers accompanying services for the products. In order to analyze the deficits in the competence transfer process, we conducted pre-interviews and observed the processes. The interviews and the observations presented several insights valuable for the development process. For example, maintenance work on a technical machine requires a head for heights as well as a defined skill set. This skill set includes the assembling of complex components, fault detection, and repairing machines in case of failure. However, the person maintaining a machine is usually not the person designing the machine. This means that there are knowledge gaps in the value chain between the services of assembling, maintaining, repairing, and developing a product. The difficulty is that important aspects of maintenance are not considered in the design process. (e.g., accident risk, accessibility of components, and ergonomics). The designers often only know the details of their products from the CAD program (Figure 2).

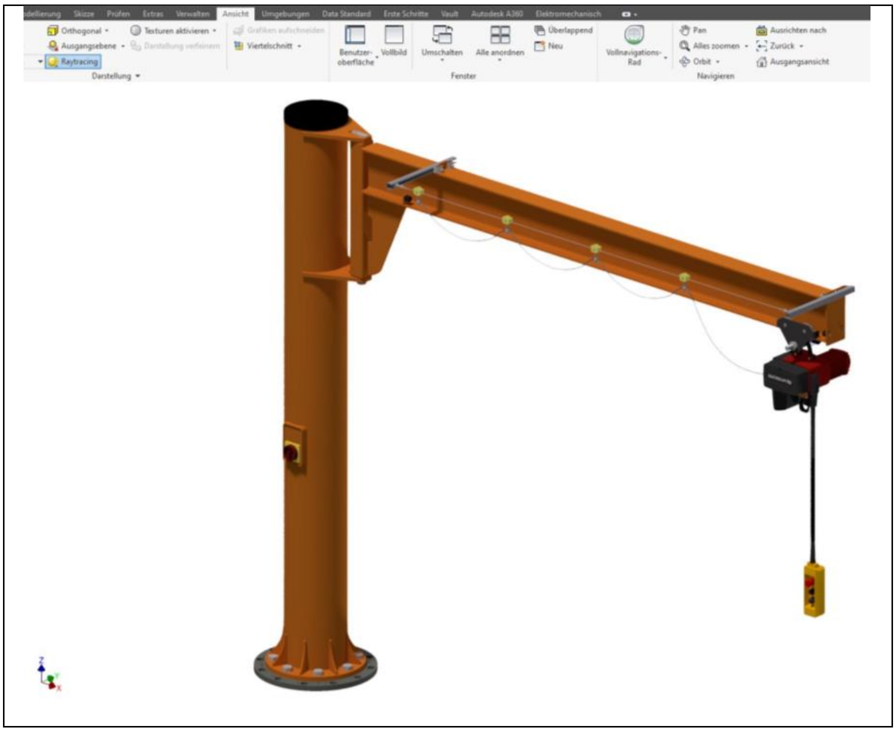

Figure 17.2 Screenshot of the CAD Environment

As a solution, a new, cooperative, and employee-centered approach is planned. To this end, we use the concept of influencers to apply digital transformation projects in the organization [85].

The concept states that influencers can help by demonstrating the benefits of digital transformation projects and convincing the end users of these projects. This concept is characterized by the fact that the focus of influencers is on the transformation process as such. Influencers are still primarily concerned with day-to-day work, but they have an intrinsic motivation to make a positive difference in their workday and that of the organization.

To incorporate this, we accompanied a service employee for two days. During this time, we observed and documented maintenance work on two different machines. For this purpose, we documented the individual steps with photos. Due to the industrial environment and the applicable regulations, it was not possible to record a video. However, based on the documentation and photos, we created a maintenance manual which was later discussed with the service personnel to ensure validity. By accompanying the product development process, we were furthermore able to trace the steps of the integration of the standard parts to the static calculation of the designed product. This workflow offers the potential for improvements through digital transformation, more precisely through the VR demonstrator.

17.4.2 Objective of Solutions

Based on the interviews and documentations, we were able to identify requirements that provided a basis for the design and development of the software solution. To enable an improvement of the products, a simulation environment should be created to enable designers to evaluate their design during the design process.

Therefore, the interactive VR demonstrator aims at visualizing the maintenance work to make work processes and conditions tangible and to improve interdisciplinary skills. This is intended to digitize and facilitate the cross-organizational exchange of knowledge between maintenance employees and designers. From the combination of these arguments, the problem definition can be derived as follows. The two areas of design and maintenance are not yet sufficiently aligned. Consequently, machines are designed that do not meet the optimal requirements for service processes to the extent as they could. This leads to problems during assembling, maintenance, and repair which can also have an impact on safety aspects (e.g., accessibility of components and ergonomics). The goal of the VR demonstrator is to address this area of tension by enabling an optimal transfer of know-how between the two areas. To this end, various approaches are being explored in the iterations of the VR demonstrator which address the prevention of hazards at work.

17.4.3 Design and Development

After the findings of the interviews and the definition of the objectives, the VR demonstrator was designed in iterative steps. The requirements were objectified using the Business Process Model and Notation (BPMN). This enabled the software developers to develop the VR demonstrator in a structured and comprehensible manner. The VR demonstrator is based on well-known technologies, such as the HTC VIVE Pro Eye and the Unreal Engine. The objective of the demonstrator is to provide a solution that can be used in a variety of situations and different scenarios.

Figure 17.3 Screenshot of the VR Demonstrator

It emerged from the interviews that the level of detail is important because on the one hand it is presented as detailed as necessary, but on the other hand, it is also presented as generally as possible. This resulted in the fact that not every specific detail had to be simulated and interactively designed in VR. Therefore, a reduction of complexity was realized to enable a simplified implementation of different product types.

The development was executed in an agile way to provide for flexibility when taking up the findings of the evaluation running in parallel. The VR demonstrator comprehensively presents the technical solution and focuses on user immersion and experience in the VR environment (Figure 3). To support user participation, the concept of influencers was used [85].

17.4.4 Demonstration

We conducted four iterations, where participants from the production organization (e.g., designers, IT staff, sales staff), as well as service employees (e.g., service technicians, service engineers, and commercial staff), were able to try out and evaluate the features of the VR demonstrator. In each experimental setup, the participants were randomly selected from the aforementioned organizations and confronted with the same scenario, namely the assembling process of a crane in VR. The scenario was divided into eight process steps (site inspection and safety, assembling preparation, assembly plate assembling, prop assembling, boom assembling, chain hoist assembling, functional test, and acceptance), with each process step itself consisting of subtasks. Depending on the iteration, only single process steps or the entire process were carried out. As an example, process step 1 "Checking and securing the construction site" is described here which consists of the subtasks surveying the construction site, comparison with construction plans, checking the soil thickness, and securing the assembling site. The participants were continuously observed and any comments or feedback during the experiment were documented. In the next phase, the interviews were conducted. Regarding the experiment, it should also be noted that the participants were always supervised by experimental supervisors, who, for example, made sure that the participants did not collide with the physical walls of the room.

In the future, implementation strategies will be developed to anchor the VR demonstrators in the organizations. These implementation strategies determine how the processes are designed, how the target groups are integrated for productive use, and how accompanying organizational measures (e.g., guidelines and workshops) are implemented. Based on these strategies, the VR demonstrator will be implemented in the organizations in the form of a pilot project. The experience gained will be analyzed and used to further develop VR demonstrators.

17.4.5 Evaluation

The VR demonstrator was continuously evaluated in terms of usability and competence transfer capabilities. Insights can be used for competence transfer and for teaching work processes along the hybrid value chain. In addition, it was examined whether the solution offers significant added value for collaborative working. Several field evaluations were conducted with users and the demonstrator. Prior to the demonstrator, individual aspects (e.g., perception of VR simulation environments, learning/supportability, or applicability) were evaluated in laboratory studies.

In the context of the VR demonstrator's quality assurance, we aim for a formative evaluation that continuously checks technological (i.e., usability tests) and technical aspects (i.e., process step integration). Furthermore, the development was discussed and reflected in workshops with all project participants. The objective was an iterative enhancement of the VR demonstrator based on the evaluation findings. The starting point of the evaluation was research on perspective taking; tacit knowledge transfer was then added as another research area in this iteration. In addition to technical changes based on the findings from Iteration 1, the next evaluation iteration focused on tacit knowledge transfer. We repeated this approach in the following iterations and next discovered the interruption of CAD work processes as an issue to be investigated. In the following Iteration 3, VR collaboration was discovered as a topic to be investigated. In Iteration 4, the technical development was completed, and no further points were raised in this context in the interviews.

Below we present the findings of the four iterations of the DSR process. These relate to technology-enabled perspective taking, tacit knowledge transfer, interruption, and collaboration through the VR demonstrator. In this context, the technology-supported perspective-taking, the transfer of tacit knowledge, and the assurance of collaboration through the VR demonstrator have a direct impact on the transfer of competencies between organizations. By allowing both organizations to interact with the simulated processes in the VR space and gain an understanding of each other's processes, competence transfer is enhanced. The consideration of interruptions represents an indirect effect on competence transfer. Designers will only use the VR demonstrator consistently if they do not feel negatively influenced by the VR solution in the future, e.g., in their work efficiency.

17.4.5.1 Technology-Supported Perspective Taking

Immersive VR technologies allow users to view a wide variety of situations from many perspectives. VR can give the user the feeling of being in the perspective of another person (employee) and experiencing the situation from their point of view in a particularly realistic way [86]. The problem becomes clear in the spatial, temporal, and social separation of the organizations' activities. This separation makes it impossible to align one's actions with the intentions and actions of others throughout the process.

The analysis of the interviews shows that there were mostly alignment conflicts between design and assembling/maintenance. Often these were not gross errors, but the fact that the products were designed to be difficult to assemble or maintain. For example, service technicians would assemble parts in a different order or change components/assembling steps at certain points to simplify the process. Some products later turn out to be not easy to maintain if repairs require disassembly of the entire product or components are difficult to access. In the case of custom products, the design idea often does not match the assembling conditions. In addition, the designers are often unaware of the manufacturing conditions. Why assembling and maintenance procedures are not considered in the design seems to be due to both the designers' lack of experience in real assembling and the lack of exchange. What the manufacturing and service organization needs is an (IT) concept that focuses on the process of interaction. Therefore, designers need to experience not exclusively the pure assembling of a product but also the existing working conditions. The lack of consideration of the assembling situation in the design often led to problems later on. One designer describes that if he had been able to assemble a product, he could have made assembling improvements that the assemblers could not even imagine.

> *Iteration 1 – Participant 2: "It may be that I can greatly improve the product with simple changes and save my colleagues' time, the mechanic may not even know these possibilities. [...] But of course, one could try out such assembling virtually, as it is best because I don't think that every colleague always thinks about maintenance."*

> *Iteration 3- Participant 2: "But of course I've always thought about how, for example, if you lift the things in there now, the boom or something, how would that work in reality, how would others do it."*

At that moment, the designer understands this interaction situation as the result of a previous situation for which s/he may be responsible. Without the interaction in VR, s/he would not interrupt the designs and would not realign them in the future. By taking the perspective, s/he is in an exchange process with the (virtual) environment of his/her colleagues, in which s/he can adapt actions reflectively and, thus, contribute to a change of the environment. The VR simulation of an assembling situation is not only suitable for the designers, but also the assemblers themselves, especially if the assembling of new products or new components is to be tested or trained. The training would make the assembler feel better prepared.

17.4.5.2 Tacit Knowledge Transfer

In the course of the evaluations, the transfer of tacit knowledge in a multi-user VR application was investigated. The participants had to perform individual assembling steps in a defined sequence until assembling was successful. They had the option of dividing up the various assembling steps among themselves and of supporting each other in completing the individual steps. The interviews revealed that the mutual perception of the users and the parallel communication significantly influence the social interaction with each other. Social interaction, in general, is decisive for a successful transfer of tacit knowledge in VR environments. Participants could perceive when the second user was having trouble processing the next steps. Without having to communicate the difficulties explicitly, they could be detected by pure observation and, thus, encouraged exchange.

During the VR simulation, questions arose among the participants about the assembling process. They thought about more complicated situations and wondered how individual assembling steps could be carried out by a service technician alone. The VR encouraged them to rethink the processes by experiencing them first-hand. At this point, the aforementioned process of rethinking reflects the generation of tacit knowledge. Rethinking would not have taken place in this effort if the participant had not experienced the situation him-/herself.

> *Iteration 2 – Participant 1: "In VR, I thought about how, for example, some tasks would be in reality. For example, when you work with heavy things, it's very easy in VR, but how would that work in reality and how would the real service mechanics do it?"*

Even if the assembling process depicted in VR did not correspond to reality in terms of time, the degree of abstraction was sufficient for a participant to become aware that the time previously calculated for assembling is too short for a sole service worker. The knowledge gained encouraged them to rethink their time calculation and change it for the future. Overall, it was found that experiencing the VR situation contributed to cross-organizational tacit knowledge sharing in the form of experiences and made employees more aware of the service process.

> *Iteration 2 – Participant 5: "I'd say that I understand the rationale for often doing assembling in pairs, namely because of the activities that can only be done in pairs. I also understand the problem with our assembling time calculation. We would have to set up the calculation differently because I would say that these idle times, when only one colleague can assemble something, are not considered in a meaningful way. And yes, that makes you think about this."*

17.4.5.3 VR Interruption of CAD Processes

Evaluations also included incorporating assessment of VR usage into the design workflow. Here, especially in the context of hybrid interruptions, we investigated how the additional use of VR within the CAD process is perceived by the workers. The assumed adverse effect on work performance which often comes from the definition of interruptions, could not be identified exclusively. Instead, in terms of the hybrid form, a positive view of the additional workload due to VR usage was identified for the overall construction process. However, the additional effort within the process was perceived as a disruption, as the hardware to be used (i.e., CAD workstation or VR) and the way the crane is viewed in the virtual space had to be changed. This change away from the usual office environment generates new knowledge about the crane parts and their position. It also supports for instance the assumption that additional effort has a positive impact when a clear added value is recognized.

> *Iteration 3 – Participant 13: "Well, that's a media break for sure because, before, you sit there with the keyboard and the mouse and then you sit there with the glasses and you're really in the tunnel, but that's not negative. It's more positive that you get a new perspective and have a haptic experience. But I don't see it as an interruption in the sense that it would distract me from my work."*

> *Iteration 3 – Participant 6: "I would say, totally out of it in no case. Maybe a little more distracted for a moment, but that's because you're really in a different environment. But I find it much more complementary than that it interrupts anything, i.e., the workflow."*

Interrupting the design process by using VR generated valuable information that also positively influenced assembling and maintenance afterward. CAD design represents objects in three dimensions, but this only takes place on a screen in a design program. VR, however, creates a three-dimensional environment that can be experienced, allowing the construction of the CAD program to be viewed in an environment that mimics reality. Although this leads to additional work for the designer and interrupts the common process of designing, the resulting experience outweighs this. The VR usage leads to a transfer of competence for the current and especially for future projects and crane designs by generating additional information (e.g., accessibility). With representation in VR, gained knowledge can be used to avoid any trouble spots and, thus, support assembling and maintenance and, consequently, additional steps within the value chain.

Iteration 3 – Participant 7: "If you say okay, for example, you have a type of crane and now you have to construct something and then check the accessibility for the fitter, […] then you can, of course, reproduce this directly in such an environment and then see directly where you have faults or collisions or perhaps areas not readily accessible and you can see that very quickly, you don't have that if you don't have that possibility."

Iteration 3 – Participant 1: "I could actually imagine the representation in VR being helpful because you don't have that form of experience now. The CAD models lack the reference to the environment. Of course, it becomes a bit more complicated, but I think that would be more pleasant in virtual space."

17.4.5.4 VR Collaboration

Collaboration between organizations, i.e., manufacturers and service providers, is essential in the real world to ensure the design of products easy to maintain and sustainable alignment across organizational boundaries. The new opportunities to collaborate in a VR environment raise new questions about how people collaborate and how the intention to collaborate can be encouraged [87]. Thus, during the evaluations, it was investigated which conditions influence the co-workers' intention to collaborate in the VR environment. Here, the technology (i.e., hard- and software), the user (i.e., the collaborators), and the task (i.e., different steps of the assembling process) were considered. We were able to identify necessary and sufficient conditions, influencing the intention to collaborate in VR.

A prerequisite for the use of VR for collaboration is the technology used which makes the experience and the implementation of VR possible. One technology-related condition is the handling of the hardware (e.g., controller) as well as the handling of elements in the VR environment (e.g., objects). If the way of handling is not known or not yet internalized, this affects the collaboration, since the interaction with the partner, the VR environment as well as the VR itself is interrupted. Another technically necessary condition for collaboration in VR is immersion. The feeling of collaboration arose primarily from the fact that the VR environment felt like real life to the participants, and they were able to completely block out the real world.

> *Iteration 4 – Participant 7: "What was difficult? Well, the controls in general at the beginning. I would say that if it's completely unfamiliar, then it's not easy from the beginning. But I'd say the variety of keys is limited, so if you're a bit practiced, you'll be able to handle it."*

> *Iteration 4 – Participant 9: "It felt like he was in the room with me. So, the real rooms [...] [were] completely blanked out for me, I really thought we were standing there together."*

On the task-level, it turned out that there are necessary and sufficient conditions influencing the intention to collaborate in VR. A necessary condition for collaboration is that the task allows the participants to collaborate [77]. This means that the tasks should be designed in such a way that the users have to work together instead of sharing the tasks and working on them individually (i.e., cooperating). A sufficient condition that fosters the intention to collaborate in VR is a realistic design of the task. Some tasks in the assembling process could be performed by one user in the VR environment but would require the collaboration of two in reality (e.g., reading the plumb line). Instead of working collaboratively, the participants split up these tasks. By designing the tasks more realistic, the intention to collaborate can be fostered.

> *Iteration 4 – Participant 4: "We checked the tasks and then one of us did the first and the other prepared the next one. So, you knew you weren't alone, but you were doing something together. But when it comes to the task itself, you're working alone because you can't do it together."*

> *Iteration 4 – Participant 10: "Anyway, there was less collaboration necessary than in real life, starting with the plumb line, for example. In reality, I can't read the plumb line from the ground [...]. That means in real life I have to look at it from above and then have to tell the colleague who is on the ground which screw he should turn."*

On the user level, it revealed that the user attributes influence the intention to collaborate in VR adequately. One sufficient condition that influenced the intention to collaborate is the familiarity of the collaborating partners. If the collaborating partners already had known each other before, this positively influenced the intention to collaborate in VR, since a more personal level of collaboration was achieved. The familiar basis compensated for the lack of facial expressions and gestures of the avatars and made it possible to derive non-verbal signals from the partner's voice and the avatar's body language. Another sufficient condition that positively influences the intention to collaborate in VR is knowledge transfer between the collaborating partners. The knowledge transfer occurs when one partner has less knowledge or less experience than the other one ("teacher-pupil" exchange). By conveying contexts and discussing special situations the intention to collaborate can be fostered.

> *Iteration 4 – Participant 10: "Well, because you knew who the other person was, it actually supported it. But I would say that if you didn't have any relationship at all, i.e., if anyone would be there, then it would be impersonal because you could not recognize his face."*

> *Iteration 4 – Participant 3: "If someone tells you what to look for, then that's what you learn. Just like that, based on the information from a manual, I don't think it would really have that success."*

17.4.5.5 Summary of Findings

Iteration	**Research object**	**Key finding**
1	Perspective taking	VR can help designers add a service perspective to their general understanding of how their designs work. Environmental conditions or specific designs can be simulated and tested virtually. The lack of understanding of these specific conditions is reinforced by VR and perspective taking across organizational boundaries.
2	Tacit knowledge transfer	VR offers potentials to support the transfer of tacit knowledge in organizations. While in the past the transfer of tacit knowledge was often considered at the level of individual employees in an organization, these research results now enable the consideration of interrelated value creation processes across organizational boundaries.
3	Interruptions	To fully exploit the potential of VR use, one must also address the threatening side effects. Only if VR use is seen as beneficial, it will be used in reality. The research shows that work processes (in our case CAD processes) can be intentionally interrupted by VR use to gain an advantage, provided that the use of VR adds value.
4	Collaboration	Collaboration in VR is a promising method to share experiences between designers and service technicians. This could be defined in terms of technology, task, and user-related aspects.

Table 17.3 Summary of the Most Significant Findings from the Four Iterations

17.4.6 Communication

Project communication was carried out continuously during the duration of the project. Due to the agile nature of the project organization, it was possible to incorporate feedback promptly into the development of the demonstrator. The immediate communication ensures that the defined goals are achieved on time and according to plan. Problems can be detected early due to the continuous exchange of information. Moreover, a continuous exchange between the project partners helps to ensure the consolidation of the project findings. This exchange will form the basis for future project-related communication. We also presented our interim findings in the form of the demonstrator on exhibitions to raise awareness for the issue. Any feedback or comments were collected and shared among project partners to further improve the demonstrator.

17.5 Discussion and Future Work

This research deals with the development of a VR demonstrator for the simulation of partly dangerous maintenance procedures. The work process improvements provided by the VR demonstrator enable early consideration of particularly safety-relevant design issues and, as a result, provide increased occupational safety and health in service processes for service employees. Inspired by a developmental research method, a problem-oriented research design was presented [18]. The requirements were then derived based on the problems identified. On this basis, qualitative interviews were conducted with the organizations' practitioners. Afterward, the resulting findings were evaluated by all participants in a workshop, and learning scenarios were developed to solve the original problem of the lack of competence transfer along the hybrid value chain.

To answer our research question "How can the potentials of VR technologies be used to ensure the transfer of competencies across organizational boundaries?" we used the demonstration phase of the DSR approach. In this demonstration phase, the VR demonstrator is presented and explained to the employees of the organizations in four iterations. Special attention is paid to the applicability, to the respective configuration, and the simulation of workflows. Subsequently, feedback and evaluation phases were conducted in the form of further qualitative interviews. The findings obtained show that the unique simulation properties of VR lead to an improvement in product and service quality across organizational boundaries. To this end, the aspects of technology-supported perspective taking, tacit knowledge transfer, interruption, and collaboration in VR were investigated.

As a contribution to practice, we have created a VR demonstrator that can be used for the development and training of various products. The VR demonstrator helps workers become aware of the maintenance and assembling conditions and imparts knowledge about circumstances that represent common hurdles in maintenance and assembling processes. It can additionally contribute to workplace safety by imparting knowledge about the mentioned circumstances and, thus, sensitizing for potential risks at work [10]. Along with this research and along the VR demonstrator, it is possible to further develop the future of work. This concerns both, the working conditions for the maintenance personnel determined by the products and the alignment of organizations with each other. The findings to date highlight the unique simulation opportunities of VR that can lead to improvements in product and service quality in the environment studied. Recommendations and guidelines could also be developed that can be extended to other use cases through extension, application, and evaluation. The collected knowledge can help to understand how VR can be integrated into the industrial context. Future research could also quantitatively assess how VR can be better designed to support employees in their work process and skill development.

As a contribution to theory, we applied methods from design science literature to provide level one and level two contributions [19]. The level one contribution has been provided by the design, implementation, and instantiation of the VR demonstrator. On level two, we provide our version of a design science application in an organization characterized by a hybrid value chain. Thus, we established a connection between an immersive VR design and the development process. Likewise, previous VR research in the area of product development [13] and also in the area of supporting assembling [14] could be consistently thought of further and extended in the area of hybrid value chains. Future research steps could include the creation of additional constructs, methods, design principles, and calculation rules.

As with any practice-oriented research, there are some limitations: First, the empirical basis for the developed VR demonstrator is based exclusively on the design and service scenario. In order to overcome this limitation, we intend to transfer the VR demonstrator to other use cases, such as management and purchasing departments. Our research has verified the benefit of the VR demonstrator in a design and service scenario in two organizations. According to the interviews, it is helpful to transfer at least the service scenario to other organizations. Thereby, the employees of external service organizations, who also maintain the machines of the organization, could be addressed. Second, the findings to date include results from a total of four iterations. In the future, additional influence constructs can be identified, and further development can be sought based on them. Third, the participants of the evaluations could only test the VR demonstrator for a short period of time in the experiment. Future research should also carry out more long-term evaluations to gain more detailed insights into the effects of VR on the work of the employees. Last, we have to limit the results of the tacit knowledge transfer within VR to experience knowledge transfer which is done by taking the perspective of the service worker. We were able to identify this in the analyses of the interviews, but at the same time, we know that especially the documentation of tacit knowledge is a challenge. Therefore, our results are limited to the transfer of experience knowledge through the VR application, as the designers experience difficult situations during assembling and are confronted with the need to find a design solution to avoid these problems beforehand. Future work could develop design science guidelines for the implementation of software projects within organizations connected by a hybrid value chain. The collected knowledge can further help to understand how VR can be integrated into the industrial context. In the course of that, it could be determined which concrete artifacts a VR environment needs to improve the design and support employees in their work processes.

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18 Can VR Reduce the Gap Between Organizations? (P4)

Paper Number	**P4**
Title	**Can Virtual Realities reduce the Gap between Organizations? Insights from a Case Study on the Potential of VR-Supported Perspective Taking.**
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Table 18.1 Fact Sheet Publication

Can Virtual Realities reduce the Gap between Organizations? Insights from a Case Study on the Potential of VR-Supported Perspective Taking.

Abstract. Despite the advancement of information technologies (IT) in organizations, there is still an immediate risk of misaligned processes between them. An important reason for this relates to the fact that entities are primarily aligned within organizations and not across organizational boundaries. Since organizations increasingly integrate their processes, this issue becomes more relevant. A fundamental aspect to better align processes is the mutual understanding of both parties, which is oftentimes not sufficient. Here, virtual reality offers the possibility to interactively connect and align perspectives in a virtual context. To better understand the role of perspective taking in terms of better social and cultural IT-Business Alignment between organizations, we conducted a case study with eleven employees from two organizations that are connected in a value chain (manufacturer/service partner). The findings provide insights on how to design virtual realities to reduce the gap between organizations. We discuss our findings in light of their impact on organizations and for future research.

Keywords: IT-Business Alignment, Perspective Taking, Virtual Reality, Case Study Design

18.1 Introduction

IT-Business Alignment has been an important topic for scientists, IT practitioners and managers (Sledgianowski and Luftman, 2005), because well-aligned processes can increase organizational performance. To better align organizational entities such as business and IT departments, various strategies, concepts and technologies have been developed (Baets, 1992; Henderson and Venkatraman, 1993). One of the most well-known concepts is the Strategic Alignment Model (SAM), which can be used for that purpose. While models like SAM provide a comprehensive perspective on internal processes, they are also limited when it comes to the alignment between different organizations.

Today, the alignment between organizations is becoming more relevant, because many organizational processes exceed the boundaries of organizations. Hybrid value chains and product-related services are also exceeding organizational boundaries. This includes the assemblance, maintenance, inspection and repair of machines and industrial plants. Commonly, these processes are only possible with the participation of all value-adding actors. For example, the maintenance of industrial machines is not carried out by the manufacturer, but by external service providers at the customer's premises (Sundin et al., 2009).

Consequently, the knowledge gained from the maintenance process cannot be reflected and cannot be considered in future development processes. In particular, due to a significant lack of insights related to the processes and the users' expectations and experiences, the other stakeholders (such as developers) have only limited possibilities for further development of the software. Against this background there is potential to better align organizations that are involved in the same value chain. However, it is still unclear how the alignment between two organizations differs and how technology can be used to improve the external alignment. We seek to address this gap by investigating the role of perspective taking in virtual realities (VR). Thus, our study is guided by the following research question (RQ):

RQ1: How can the concept of perspective taking be used to improve the external alignment?

Communication, mutual trust and cross-functional knowledge of social and cultural alignment involve the creation and adoption of perspectives within and between their communities of knowledge and practice. Much social and cultural alignment is based on assumptions that one actor makes about the knowledge, beliefs and motives of others. This is the process of "perspective taking" and is fundamental to communication. Perspective taking, which is the ability to put oneself in another person's thoughts, feelings, goals or spatial perspective (Erle and Topolinski, 2015), plays a crucial role for cooperation in hybrid value chains. In any communication, knowledge of what others know is a necessary component for coordinated action (Bakhtin, 1981; Clark, 1985; Krauss and Fussell, 1991).

For the perspective taking between organizations to be realized, the diverse knowledge of individuals in the respective knowledge and practice community must be represented in its uniqueness and made available to others in order to bring them into a process of perspective taking. The appreciation of the diversity of knowledge and practice, in that each employee of the two organizations makes unique representations of his or her experiences and in that actors with different backgrounds are supported in better recognizing and accepting the different ways of knowing about others, is the basis for the perspective taking. While previous literature has provided strong arguments in favor of the importance of perspective taking in general and in the relationship with technology (Oh et al., 2016), it remains unclear how it can leverage the alignment across organizations. We address this issue based on our second RQ:

RQ2: How can VR-supported perspective taking be used to initiate and support alignment processes between these organizations?

The remainder of this paper is structured as follows: We provide an overview of the related work regarding IT-Business Alignment and technology-supported perspective taking. Next, we describe our cases and the methodology used in this study. Thereafter, we present our findings considering our research questions. We discuss our insights by deriving practical and theoretical implications. Finally, we indicate the limitations of our study and recommendations for future research.

18.2 Related Work

18.2.1 IT-Business Alignment

Studies suggest that IT-Business Alignment is one of the most relevant issues for organizations (Langdon, 2000). Alignment is a measure by the tasks, goals and plans contained in the business strategy that are shared or supported by the IT strategy (Reich and Benbasat, 1996). Many scientists have already worked on formalizing this phenomenon. Examples include the SAM (Henderson and Venkatraman, 1993) or more generally the MIT90s-Framwork (Morton and Thurow, 1991). The SAM, which is often referred to, consists of two main dimensions: strategic fit and functional integration. Strategic fit refers to the correspondence between business strategy and IT strategy with organization and IT. Functional integration refers to the strategic integration between business strategy and IT strategy, as well as the operational integration between organizational infrastructure and process, and IT infrastructure and process (Henderson and Venkatraman, 1993).

IT-Business Alignment is an essential factor, especially when it comes to creating the best possible added value for an organization (King et al., 2000). As a result, IT-Business Alignment has often been associated with the performance of an organization (Masa'deh and Kuk, 2007). Subsequently, the relationship between business development and IT-Business Alignment was examined in various areas such as banking and healthcare (Wagner et al., 2006; Schult and Wolff, 2012). Over the years, however, this alignment and its effects have been continuously researched, applied and optimized. To this end, several dimensions of alignment have been defined in previous literature (Chan and Reich, 2007).

The most common dimension of alignment is strategic alignment, which puts emphasis on the alignment between corporate strategy and IT strategy. Another dimension is structural alignment. This is reinforced by architectural, organizational and process-related perspectives.

Informal structures are not ignored in this dimension, such as social alignment as well as interpersonal cooperation and understanding between IT employees and the employees of other departments. Ultimately, the cultural alignment that defines the corporate culture—the support provided by management—remains. The following table summarizes the dimensions and definitions.

Dimension	**Definition**
Strategic	"the degree to which the IT mission, objectives, and plans support and are supported by the business mission, objectives, and plans." (Reich and Benbasat, 1996, p. 56)
Structural	"the degree of "structural fit" between IS and the business." (Chan, 2008, p. 100)
Cultural	"is concerned primarily with the relationship between IS and the rest of the firm, and the communication between the senior IS manager and the top management team." (Pyburn, 1983, p. 3)
Social	"the state in which business and IS executives in an organizational unit understand and are committed to each other's mission, objectives, and plans." (Reich and Benbasat, 1996, p. 57)

Table 18.2 Dimensions of IT-Business Alignment and their Definitions

Whereas in the past a mechanical engineering organization carried out repairs only within the scope of its statutory warranty obligations, it is becoming more common that in certain business models (e.g., hybrid value chains) this extends to the entire life cycle of a product (Richter et al., 2010). This means that external partner organizations are enabled to provide services for the product or that the manufacturers set up their own service structures. This creates entire value chains right up to the customer (Velamuri et al., 2011). As a result of these developments, customers increasingly expect accompanying services for a manufactured product. Cooperation between services organizations for a customer is therefore becoming increasingly important. A review of the existing literature shows that previous literature has already identified different dimensions of IT-Business Alignment and various perspectives (see Table 2 for an overview). Nevertheless, there is a strong emphasis on the strategic dimension. In many studies, the strategic and structural dimensions are considered within a specific organization. Some studies also considered an alignment-perspective across organizations. It is striking that previous research has ignored the social and cultural alignment between organizations so far.

Dimensions of IT-Business Alignment	**Internal (within an organization)**		**External (between organizations)**	
	No.	**References**	**No.**	**References**
Strategic	5	(Wagner, 2006; Wolf et al., 2010; Loeser et al., 2011; Ryan et al., 2013; Wetering et al., 2017)	3	(Wolf et al., 2010; Loeser et al., 2011; Ryan et al., 2013)
Structural	3	(Beimborn et al., 2008; Beimborn et al., 2009; Thorogood et al., 2012)	1	(Schult and Wolff, 2012)
Social/cultural	1	(Wagner et al., 2010)	0	/

Table 18.3 Examples of the Dimensions of Alignment and Differencing to Internal/External

While IT-Business Alignment across organizations is becoming more and more important, it has so far not been the focus of research. One possible reason is that in practice, it is often difficult to carry out IT-Business Alignment between organizations when, for example, machines are maintained at very high altitudes or under other hazardous conditions, so that the maintenance personnel must be specially trained. One possible solution to this problem would be that employees who are not involved in the service processes can experience and evaluate them safely and virtually. The ability to simulate physical representations and create environmental situations allows users to gain experiences they cannot experience on site.

18.2.2 Technology-Supported Perspective Taking

The concept of perspective taking can be used in technology-related settings. In contrast, a commonly applied psychological perspective, where perspective taking is stimulated with instructions like "Imagine you are in the position of the other...," technology offers the potential to put one person in the position of another (e.g., in virtual environments). This is also not completely new but is similar to the principle of "job rotation," which is the practical application of perspective taking. An overview of current research that has used the concept of perspective taking in various technological settings is shown in Table 3. A promising approach to implement perspective taking is virtual reality. For example, Jestice (2016) argues that the combination of avatar manipulation and role playing in the virtual world should also lead to the development of empathy.

Technology	Design	Description and Essential Findings
Social networks	Quantitative research	Social network users find themselves in a continuum between their desire to experience private pleasure in self-improvement and their fear of being judged negatively by others. This has an impact on the intention to self-disclose (Wagner et al., 2018).
Software	Laboratory experiment	The willingness to launch a product on the market as planned was underlined. If the product manager takes the perspective of someone who might be negatively affected by the introduction of a software product with known bugs, then this significantly influences his decisions (Lee et al., 2018).
Online reviews	Experiment	It is examined that the inclusion of perspective taking is positively connected with the perceived helpfulness in the review and that this connection can be explained by the volume of information and information objectivity (Peng et al., 2017).
Online product reviews	Experiment	The perceived helpfulness was investigated. The results show the role of language competence and the perspective taking of consumer ratings of online product reviews and their impact on consumers and online retailers (Chen and Sakamoto, 2016).
VR	Interview	A project for the perspective taking in virtual worlds was designed (Jestice, 2016).
Online communities	Case study	This paper presents a retrospective case study of an online collective. It is noted that the collective over time forms a perspective through three archetypal challenges: perspective taking, perspective shaping, and perspective defending (Kane et al., 2009).
Technology	**Design**	**Description and Essential Findings**
IT functionalities	Experiment	The study shows that the impact of cognitive heterogeneity on innovation performance is due to existing knowledge. Coordination and perspective taking are influenced. Furthermore, it can be assumed that the relationship will be moderated in the future by the essential performance of IT (Schutz et al., 2009).
Wiki	Experiment	It was investigated that "backchannel contributions" to wikis during a conference can help to avoid process losses. For this purpose, perspective taking and perspective making mechanisms were used (Majchrzak et al., 2008).
Chat communities	Textual analysis	Chat messages were examined, and if the coordination of perspectives failed, this was attributed to three factors: the inability of one communication partner to communicate successfully, the lack of a common understanding of what was discussed, and/or the interpretation of other's identities (Dickey et al., 2007).

Table 18.4 Overview of Technology-Related Perspective Taking

There are specific problems of perspective taking, which can only be addressed in virtual settings. The different knowledge communities are often not able to recognize that they start from different knowledge and different cognitive reference systems. Thus, they are neither able to present their own perspectives nor to take other perspectives, which dramatically limits the possibilities for successful knowledge work. The easy availability of one's own perspective, schemata, stereotypes and interpretations can lead the actor to overestimate the probability that the perspective is shared by others. This is a false consensus effect, in which the actors assume that others are more similar to themselves than is actually the case (Ross et al., 1977). This form of bias is particularly relevant to the process of perspective making. Steedman and Johnson-Laird (1980) note that the speaker assumes that the listener knows everything the speaker knows about the world and about the conversation, unless there is evidence to the contrary. Expertise also means having perceptual filters. Knowledge is absorbed within one's own field of expertise, but experts are often closed to important and relevant events outside their own limited field (Star-buck, 1992). When actors think about the same thing, they look at other aspects of the matter.

Another difficulty in perspective taking concerns the actors' understanding of the development process itself. Each department focuses on different parts of the overall process. Not only do people ignore the activities of others and fail to argue about relative priorities, but they completely gloss over the concerns of others and tend not to appreciate their complexity (Boland and Tenkasi, 1995). The different "worlds of thought" of the actors is also a problem, which leads to ignoring information that is equally crucial for improving existing products or developing new ones. This limits the possibilities for creative perspective taking, as the members of a department might think that they already know everything (Dougherty, 1992). Each expert emphasizes different aspects of development and presents the whole in a completely different way. It is not the combination, exchange or joint provision of data that poses the problem, but the perspective taking, in which the unique worlds of thought of different knowledge communities must be made visible and accessible to others. Creating and exchanging representations of one's own knowledge and understanding enables others to better anticipate the different types of knowledge and skills of others when they try to develop or improve products. The diversity of knowledge must be highlighted, and perspectives must be sufficiently differentiated and distinguished. In the past, most technological solutions were text-based, so they were based on the mental adoption of perspectives. In the result part of this thesis, concrete problems in the align-ment of the processes are shown and finally it is pointed out why VR-based perspective adoption can be a suitable solution.

The combination of IT-Business Alignment across organization boundaries and the possibility of using IT as a possible enabler for technology-related perspective taking has not yet been considered in IS. In particular, new technologies such as virtual realities offer the possibility of simulating the perspective (Jestice, 2016). It is unclear whether an increased level of perspective taking has the potential to improve the alignment between organizations.

18.3 Methodology

18.3.1 Method Selection

Our research project corresponds to an embedded single case design of a case study (Yin, 2017). The focus of the research interest is a group of organizations consisting of a manufacturer and a service organization. These two organizations, which are connected by a value chain and yet organizationally separated from each other, form the context of our case. The flowing case con-sists of the real and holistic analysis of their business processes as a common process (single case). The analysis of the process contains systematic data from interviews of individual employees with the assumption that the business processes consist of a collection of individual activities. Thus, the smallest units of the case are the interviews with the individual employees (embedded). The theoretical implication of perspective taking and process alignment is used to interview both production and service employees. The boundaries between our phenomenon of the common business process as the connecting element and the context conditions given by the manufacturing and the service organization are fluid.

The study presented in this article is part of a research project that aims to investigate how virtual realities can be used to transfer competencies and align processes between organizations. In this case study, one organization produces machines and technical equipment (Name: “Production”) that are installed and maintained by another organization (Name: “Service”). In the past, service organizations belonged to the manufacturer as one department. Due to the division of tasks and specializations, it was decided in the 1980s to outsource all service activities to a separate organization. The dangerous situations of installations, the spatial separation and the lack of time of-ten prevent an active exchange of employees across organization boundaries. Due to the limited exchange possibilities, an evaluation of the design and the service processes is only possible to a limited extent. Therefore, both organizations were considered in this case. The added value for customers is usually only achieved when both partners have taken advantage of their services for the product.

18.3.2 Data Collection

The participants in this study are selected from employees of the “Production” organization with approximately 190 employees who are involved in the development, production and sale of cranes. The other participants are selected from the “Service” organization with approximately 50 employees specializing in crane services. The interview partners were chosen from the fields of design and technical service. Care was taken to ensure that both managers and employees were involved in the interviews. Due to the proportions of the organizations, approximately 40% of the designers and 10% of the service employees were interviewed. Details of the selected interview partners can be found in Table 4.

Org.	Position	Background	Tenure (years)	Age	No.	Duration (in hours)	Codings
"Production"	Technical manager	Mechanical engineering	10	30	P1	1:16:13	90
	Documentation employee	Technical draughtswoman	11	50	P2	1:07:34	26
	Technical development manager	Mechanical engineering	12	33	P3	1:05:33	60
	Technical engineer	Technical draughtsman	31	61	P4	1:05:35	18
	Technical engineer	Technical draughtsman	3	24	P5	59:08	34
	Technical engineer	Technical draughtsman	5	38	P6	43:54	23
"Service"	Service manager	Industrial engineering	23	45	S1	1:14:23	83
	Service fitter	Electrician	12	50	S2	54:02	83
	Service fitter	Electrician	9	45	S3	52:02	40
	Quality manager	Steel fitters	44	59	S4	56:57	32
	Service fitter	Electrician	6	36	S5	41:54	36

Table 18.5 Overview of Interviewees

18.3.3 Data Analysis

Our approach to coding and analyzing the interviews in this study is a qualitative content analysis (Mayring, 2004). The main objective of the evaluation was to identify patterns in the inter-views which revolve around the mutual relationship between the organizations. We wanted to learn more about how information about the product is implicitly or explicitly exchanged be-tween organizations. Each statement in the interview was coded along a category system. The category system was developed in advance together with the interview guide. Based on the literature research, the topics Alignment and Perspective Taking were identified as possibly relevant for our problem. Thus, the results of earlier studies could be used. This was considered both in the development of the interview guideline and in the creation of the category system. Alignment examples for this category system are:

Alignment -> Strategy -> Understanding strategic priorities (Segars et al., 1998)

Alignment -> Human factors -> Expectations (Tiwana, 2010)

Perspective taking (PT) examples for this category system are:

PT -> Types of PT -> Perceptual perspective taking (Shantz and Watson, 1971)

PT -> Apply PT -> Trying to view "both" sides (Kamdar et al., 2006)

The data were independently coded by two researchers. Afterwards these codes were discussed together. For example, it happened that the text passage “*This would of course be an innovation if the designer could initially assemble the product virtually, but realistically, because then he could, for example, discover an interfering edge or something similar during assembly in advance. This would save us a lot of time during assembly. S1*” from one researcher receives the code "*PT -> Types of PT -> perceptual perspective taking*" and from another researcher receives the code "*PT -> Insight into the work of the other*." These conflicts were resolved by either adding a new code, identifying one of the existing codes as the best, or merging the two codes into a new code. This process was repeated until all the digits were successfully coded and both re-searchers agreed on the result. In the example just mentioned, the researchers agreed that the code "*PT -> Types of PT -> Perception perspectives*" best fits the text passage. In addition to these structured questions and codes, the researchers also recorded the results of open questions regarding possible technologies. Here, the open coding method was used.

18.4 Findings

18.4.1 Alignment: From Isolated Units to a Differential Process

The quality manager from whom this interview excerpt comes was already part of the organization when there was no division between technology and service. He describes organizational forms that are increasingly based on delegation and division of labor.

> *"Today we create resource lists and packing lists, today we have many small departments, in the past you knew a product completely. When I started back then, we sawed, welded, painted the product and we went together to the assembly. [...] What is important today is of course the electronic media we have so that our colleagues know exactly what to pack during the shipping process. But these are the todays problems, the employee who only packs the carton, he has the parts, but he doesn't know, is the part right or wrong with the product in question, they can't judge it anymore." S4*

Around certain core activities, communities of practice (Lave and Wenger, 1991) and specializations have developed so that the different work processes are invisibly inscribed and solidified in a few bodies. Other processes have entered representations such as lists. At this point the problem arises that employees are temporally, spatially and socially separated from the original production process, so that it is not possible to orient one's own actions towards the intentions and actions of others in the entire process. For their actions, the actors can only start from the representations they have received from the upstream positions and from what they suggest or make possible—or even prevent—in relation to the respective problem-solving situation. For stability effects, structures are digested in materiality, bodies and techniques. The consolidation of competences—be it through their incorporation into the body or their incorporation into technology—also means a de-qualification and creates practical uncertainties in the actions of the whole process. If the quality manager notices that the connection to the product is lost, he understands the product as a continued experienced problem of action, as a process, in which one is nothing without the other. But other employees also recognize the need to put themselves in other people's shoes, not only in a position, but also in their opinion and thus also in their horizon.

> *"So especially when I write instructions, I must put myself in the shoes of the service technician and think about how he would take it." P2*

The case of the manufacturer and the service organization is particularly suitable for this, since the practice of one organization is uncertain for the other, but the practices are based on one another.

18.4.2 Error Work – Gaps in the Process

Practice is a place of mixing bodies, techniques, materiality and mental processes. It cannot be reduced clinically to isolated units. Through the relationships between the entities, the practice becomes fundamentally ambiguous. In this way, the focus shifts to the conflict with problematic situations. Most of the alignment conflicts were between design and assembly/maintenance. Of-ten it is not a matter of gross errors, but of products that are not designed to be easy to assemble or to maintain.

> *"Yes. So, when it comes to assembly processes, I would only think of ad hoc, we have some designs where we then have three different screw sizes. […] Of course, it's easy, yes, it's not a drama, but that's just annoying, because we have to go down there again, get the corresponding key and stuff like that." S1*

The more different parts are used in construction (e.g., different screw sizes), the more tools the fitters must carry with them. This could be difficult when assembling at great heights, because you must take the whole tool with you to the working platform. If the fitters only take what they need with them, they must plan beforehand. But all this also leads to a psychological strain, either to have to plan more than necessary or to procure other tools again because an expectation was not fulfilled.

In theory, the process of montage is partly different from that of montage in practice. The fitters would, for example, assemble the parts in a different sequence or modify components/assembly steps at one point in order to simplify assembly at another point in the assembly process.

> *"Well, there was more feedback from the service conference, so that one really said that the part could be done differently from the assembly sequence. [...] The suggestion then, how can you do that so that it doesn't fall through? So, to secure it with a washer, to make a locking nut at a different location or to leave the bolt web length longer, simply to react to manufacturing tolerances." P3*

There are also cases in which the assembly instructions or the components have to be adapted because they are difficult or impossible to implement in practice by the fitters.

> *"Exactly, it's in there, it's illustrated, but sometimes it's also the case that a clue comes, okay, go ahead, put another spacer in between, make our work easier, and then we let it flow in like this. So, in any case there is always, or I say, 30, 40% of the cases it is in another place in the assembly instructions, and the 60, 70% is really feedback." P3*

Further problems are maintenance-unfriendly products, if the whole product has to be dismantled during a repair and components are difficult to access.

> *"We have a problem, if we must repair a pressure roller box, then the whole product has to be dismantled. This is a bad solution from a repair point of view. It is a closed construction part that can only be achieved by completely dismantling the product. Maintenance is therefore only associated with an enormous cost factor." S4*

> *"So, there is an official answer, which of course complies with the EC Machinery Directives, that maintenance and servicing must be considered when designing a machine. This is the official version, and the unofficial version is indeed the one that will certainly be considered from experience." S1*

Incorrect pre-assemblies or unclear components provoke incorrect installations. Furthermore, the conditions on the customer's construction site are not considered. In the case of custom-made products, it is often the case that the design ideas do not coincide with the assembly conditions. In addition, designers are often unaware of the manufacturing conditions.

18.4.3 Process and Perspective - Decomposability of a Tricky Practice

Why assembly and maintenance practices are not considered in design seems to have something to do with the concept of "experience."

> *“A designer has learned design, but he has never assembled products before. The designer simply lacks the background knowledge to assemble products.[…] There would have to be an exchange in advance of the design, so that they simply communicate more with each other.” S4*

Situated experience is something like an overboiling practice that leads to a continuous process of verification: "Experience, as we know, has always a boiling over, and making us correct our present formulas" (James, 1907, p. 150).

> *“Yeah, no, facts aren't always everything. You also have to see whether that is ultimately so feasible. You can then prove everything, but in the end, experience plays a role, and you learn from things that didn't work out, maybe where you had improvements, and then you say directly, no, it won't work out like that.” P1*

So why can't the designers benefit from the experience gained in assembly or maintenance? One problem is how to put into words experiences that are tacit, aesthetic and embodied. There are assembly cards and other places where employees of the service can name problems. On the other hand, experts are very flexible and adaptable, so that processes associated with massive problems are recorded.

> *“Yes, a feedback might not be wrong from time to time, if one would say that this and that fits or better said does not fit. As I said, sometimes you don't get any feedback at all. All you hear is that the product is standing and that's all.” P6*

> *“But that wouldn't even stand out if I wasn't there and looked over people's shoulders a bit or at least talked to them about it afterwards.” P5*

In addition, only a few designers could exchange ideas with the service staff. For large projects or new developments, the exchange is strongest, as there are mostly deviations from the standard. The least exchange is with those designers who design standard products or only minor variations. Closer cooperation between the designer and the customer also usually only takes place in the case of new developments or custom-made products. Problems are also solved more strongly in mixed teams.

> *"I always like it when you're close to the practice with people. Because you can check and look at things beautifully at your desk in CAD, but that's always the ideal situation in CAD. And in practice, you simply have environmental influences, you have manufacturing tolerances, you also have human influences, because what I also noticed was that the assembly sequence was a bit unclear for some parts, which is why the assembly in-volved more work than we planned. What finally could be avoided by my explanation again." P5*

Those designers who could participate in the working practices of service technicians on site make it clear that knowledge is a localizable activity. Practical knowledge is geared to doing, making decisions in situations and solving problems. Practice is a place where practice elements such as bodies, objects and technologies are contained and interrelated, entangled and defined. What the manufacturer and service organization need is an IT concept that places the process of interaction in the foreground, that applies to action as well as to interaction products, and that understands the respective interaction situation as the result of previous situations, and which are at the same time aligned with expected or planned situations. What should emerge is a continuous, perspective-bound reorganization of past, present and future action. In the adoption of perspective, one's own routines are put to the test by experiencing the practices and interactions of others with technology.

18.4.4 Process-oriented Alignment Supported by Virtual Reality

"The multitude of sequential actions involved in any interactional course requires a constant aligning (lining up) or articulation of these actions" (Corbin and Strauss, 1993). In order to make individual work processes visible in their mutual interrelationship, it is helpful to reconstruct the factually effective diversity of perspectives by experiencing completed actions from the perspective of different actors in the simulation. This form of perspective taking is not about a narrative representation of "layers" or "events," in which the awareness of the border between recipient and representation may be lost. If the interactive aspect is increased in the simulation, the recipient not only gets an impression of the perspective of the colleague and develops empathy for him but is also confronted with his work situation and develops strategies to deal with it. In this scenario, the working conditions have a stronger effect on the recipient's body and he not only mentally puts himself in the shoes of the other, but the situation becomes his own reality (Braun and Friess, 2019). This excerpt from the interviews perfectly describes how much it would help if the assembly conditions were simulated in VR.

"At some point the previous product was also designed. If you could have tested the product in a virtual environment that didn't exist 20 years ago. Then your colleagues would have noticed that you have to go up first, mark where the separation points have to be made, then you have to go down again with the heavy part. Maybe they would have noticed this earlier with a VR, and then the person who designed it would have thought about the assembly." S1

This description also coincides with the experience of the designers, who find it difficult to visualize the weights and dimensions of their constructed parts.

"For me as a designer, it is sometimes difficult to assess things, whether you can really assemble them the way you imagine. Of course, you have an idea somewhere of what works, what doesn't, also from experience, because as a rule every designer has done something practically to know what he's doing. But I personally lack the feeling of know-ing that if I do it this way and that way, I can do it at all." P5

It is just as important for the designers to simulate not only the assembly of a product, but also the working conditions on the construction site. In the descriptions of the problems in assembly and maintenance, most of the problems had to do with the fact that the work situation on site was not considered in the design. An isolated model in a hall is not enough for this designer.

"It helps if we install the product ourselves, but we can't always install a complete product, but most of the time we have a prototype where we can maybe predict 80% of the things, but then the assembly situation on the construction site is something completely different." P3

The virtual simulation of an assembly situation is not only suitable for the design engineers, but also for the fitters themselves, especially if the assembly of new products or new components is to be tested or trained. This test would make this technician feel better prepared.

"If you are lucky, you have been familiarized with the new product in a training course […] If you're unlucky, you get a package with a new product you've never seen before, and you must build it. […] The assembly works then somehow, but if you had already assembled something like this once or had perhaps also virtually already assembled it would perhaps be easier." S5

Probably one of the most important statements comes from a constructor and describes an ex-tended possibility space made possible by VR. He describes that if he would be able to assemble a product, he could make assembly improvements that the actual assemblers could not even imagine. This enrichment goes far beyond complaint systems.

> *"You will receive feedback if the problem is so big that it cannot be solved immediately. You will not receive feedback on how easy the assembly really is. It may be that I can greatly improve the product with simple changes and save my colleagues time, the mechanic may not even know these possibilities. [...] But of course one could try out such an assembly virtually, as it is best, because I don't think that every colleague always thinks about maintenance." S2*

In this moment, the constructor understands this interaction situation as the result of a preceding situation for which he himself may be responsible. Without this action in VR, he would not interrupt his drafts of action and not realign them in the future. By adopting the perspective, he is in an exchange process with the (virtual) environment of his colleagues, in which he can adapt actions in a reflective way and thus help to change the environment. The tension here exists be-tween the routines and standard procedures to which the designer is exposed in his everyday work and the uncertain individual cases from another professional practice with which he inter-acts in VR. This "alignment in the making" dispenses with an overemphasis on order and control creativity and innovation (Weick, 1998).

In the past, most technical solutions were text-based, so they were based on the mental perspective. What the actors imagine can be freely changed here and controlled by their will. There are no insurmountable obstacles, not the complicated harshness of the reality of the person you imagine. Fantasies can be changed at will, but no change can surprise the fantasizing person and make him or her learn something from it; this only exists in the perceived world. In VR simulation, the user cannot have arbitrary access to the objects, but interacts with them. The self-limitation of VR means that in simulations things do not move the way you want them to. The problem of the thought experiment is solved in an artificial world with perceptible physics. What remains is a virtual thought experiment, in which one tries things out; however, a deliberate amplification of the imagination that recognizes and presents the complexity and challenges of the different worlds of actors is required. VR is "when the image no longer serves as a medium to refer to something absent, but when the image becomes a medium with which a special kind of object is produced and presented – namely an object that is only visible and yet behaves ghostly, as if it had a substance and its properties" (Wiesing, 2005, p. 122).

18.5 Discussion

With regards to RQ1, this study shows that the misalignment of organizations in the value chain plays an important role in today's business enterprises. Whereas in the past the employee of an organization was able to monitor the entire value creation process, the division of work means that only partial aspects of the value creation process can be considered. In the past, the exchange of these partial aspects to each other were often included in the considerations of business and research. The effects of the individual sub-aspects on each other, which, however, are not directly related to the exchange, were dealt with in this study. This study extends the current state of knowledge in the field of social and cultural IT-Business Alignment. Current literature already provides knowledge on this topic, but the literature on alignment is still limited in terms of social and cultural IT-Business Alignment between organizations. By researching this field, this research can enrich related literature by contributing new insights based on our case study. Subsequently, the links between alignment and technological support were derived and possible positive or negative effects discussed. In terms of RQ2, our findings indicate that perspective taking is already being practiced. However, this perspective comes up against certain limits, namely when the knowledge about the followed processes is not available. This became clear with the example of the designer for the service processes. Although the designer has a general understanding of the service processes, special designs pose a challenge. As soon as environ-mental conditions or special designs are involved, there is a lack of understanding of these special conditions. As a result, it is difficult, or even impossible, to take on perspectives. It can also happen that the perspective view is only used in special cases within the framework of the standard evaluation, which does not meet the requirements.

The perspective taking has the possibility to consider the design of the special constructions or also the peculiarities of the environment in relation to the assembly and maintenance processes. The "simple" representation of the processes and conditions comes to a point where the interpersonal exchange of participants does not provide the necessary level of detail. Therefore, there is no possibility to experience this exchange in detail and based on the perspective finding. Here the paper came into play and confronted the employees with the latest IT technology. Both de-signers and service staff identified virtual reality technology as particularly important in its context.

The various actors with whom we had contact in the surveys act as representatives of the various working worlds, which, although they have a limited stock of similarities due to the joint development of a product, at the same time develop very different perspectives for action. As already discussed in the findings, each actor considers a different product, so it is a product of different practices. Admittedly, there are already measures such as the assembly cards, which are intend-ed to improve the processes between the actors. However, these are only applied in writing and relatively taciturnly in the case of acute problems. In fact, this does not give the actors the in-formation they need to identify opportunities for improvement. The aim is to translate the knowledge from the local practices of one actor into the context of the other and to stabilize the result of the interplay of these perspectives in product development or adjustment. To this end, we have reconstructed the diverging perspectives and examined their mutual references. The VR application serves as a medium that tries to productively turn around the tension between the perspectives.

It has been shown that misalignment occurs when a task positioned early in the process influences a task positioned late. In our case this was shown depending on design and maintenance. This study examines the social and cultural IT-Business Alignment of organizations and pro-vides an overview of the current state of research. The basic research of the 1990s is considered, as is current research (Pyburn, 1983; Reich and Benbasat, 1996; Schult and Wolff, 2012). The dimensions of IT-Business Alignment identified and delimited by science are clearly com-pared with their definitions. The current state of research is then examined and disseminated about the dimensions and the alignment consideration (internal/external) (Chan and Reich, 2007). The existing literature was qualitatively examined and thus put into context. It could be stated in the literature review that previous research on IT-Business Alignment has not concentrated on the structural and social/cultural dimension between several organizations.

Organizations need strategies for IT-Business Alignment (Chan and Reich, 2007). These strategies should consider previous and subsequent value creation processes. The improvement of alignment across organization boundaries can be countered, among other things, with perspective taking. VR-supported perspective taking is a promising possibility in this context. There were different approaches in the study to be considered on how perspective taking was viewed in the past with and through IT. Research has already shown that workloads can be realistically mapped and experienced in a virtual environment (Hagenmeyer et al., 2003;

Jestice, 2016). The excerpts from the interviews describes how much it would help if the assembly conditions were simulated in VR.

This practical approach is not only a new approach regarding alignment processes, but also for the approach of perspective taking. The decisive difference is the dialectic of maintaining and crossing borders. Where otherwise boundaries of one's own perspective are discursively or men-tally crossed, these are crossed in the approach presented here in the interaction in situation with environmental conditions and objects. The reason for this is that in the mental and discursive transgression, the actors tend to adopt the perspective of the other and to ignore their own perspective. If everyone ascribes the same meaning to the product, it is neither possible nor necessary to adopt perspective, because the perspectives for action are identical and do not require mutual representation. If, the actor's perspective persists and he thus recognizes that the perspectives vary, but at the same time show practically significant overlaps, then the actors can refer to it in their actions. Only in this way can new developments and improvements be made. As the actor needs his own perspective in order to act, this insight leads to the things that should be considered when designing such a VR.

The results of this study allow several implications for practice. First, organizations need to understand the relevance of this issue, and this study provides a clear approach. The IT-Business Alignment of organizations in the value chain should not be underestimated. It is therefore important to focus on the processes of manufacturing and maintaining technology, because it is a matter of considering the perspectives of different actors, from the point of view of practical working actions and the organizations created by them. When an employee talks about the relation to one product, it must first be noted that the product is the product of different practices. What is a product if it is treated as an effect of relational practices? The structures determine what a product is because they define its characteristics.

Second, lack of alignment supports negative aspects, but there are already digital technologies in place to reduce these negative aspects. One of these technologies can be virtual realities, which have been investigated in this study. In the interviews, the various designers drew up the prod-ucts in conversation as well as in their professional practice. For them, what they construct on paper is a product. The production line manufactures the parts of the product with the help of drawings and parts lists, identifying exactly what the product is. Another product is assembled by an assembler, while another is repaired by a service technician. A product with which the assembler interacts with the practices and tools specific to him is different from a product that is put on paper in the design office. The history of the "product multiplex" is a history of fluidity and diversity of practices and perspectives in which the question, "What is a product?" is carried out through overlapping practices from the time of construction to repair.

In VR, the knowledge stocks of different working worlds are bound and mutually addressable. It is important that the thoughts, feelings and actions of other actors are not presented here, but only the situations with the environmental conditions and the dimensions. The user himself should interact in these simulations and experience the consequences of his actions. For this to succeed, it is important not to incorporate scenic representations, since this type of immersion does not activate the user, and the user's own physical experiences are absent. The user should experience the situation from his perspective in order to link it with his past experiences and actions in order to adjust the product to his abilities.

18.6 Limitations and Outlook

This study provides interesting qualitative findings in the field of social and cultural IT-Business Alignment research, but it does have its limitations. For example, aspects other than perspective taking could have been considered. However, one goal of this study was to develop an approach that could be easily applied by practitioners, thus avoiding some of these more complex contexts. In this context, researchers can also examine other more general questions that have not been addressed in this study.

Despite the questions that remain unanswered, this study has strengths that should be considered. Interrelations between different organizations were identified, which are reflected in the business strategy, the IS strategy and the strategic alignment of the organizations towards each other. These results are of interest to both practitioners and researchers. Like any qualitative evaluation, the interviews give a feeling for the facts and enable us to build theory. The connection between social and cultural IT-Business Alignment, perspective taking and VR support could be demonstrated. However, although the design of the virtual technical support, in this case VR, was not the main part of this research, our findings can be used to further develop re-search that focuses on the development of an IT artefact. Methodologies from the domain of design science are promising to design and evaluate VR that incorporates perspective taking and enhances the social and cultural IT-Business Alignment between organizations.

However, it is an explorative quantitative study, and so a generalization and transfer of the results to completely different areas are therefore not possible. Virtual realities offer in theory the possibility not only of perspective taking, but also of executing these processes virtually. This can thus be described as a technically supported form of perspective taking and has already been applied alongside other digital technologies. However, the adaptation in this context of value creation across organization boundaries has not yet been considered. The data, however, allows the conclusion that here VR-supported perspective taking can bring a possible improvement.

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19 More Than You Know (P9)

Paper Number	**P9**
Title	**More than you know - An Investigation of VR to Support Tacit Knowledge Transfer within Organisations**
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Table 19.1 Fact Sheet Publication

More than you know - An Investigation of VR to Support Tacit Knowledge Transfer within Organisations

Abstract. The transfer of tacit knowledge continues to pose challenges to organisations. This paper investigates whether virtual reality (VR) can fill a gap in existing research on the transfer of tacit knowledge through the help of IT. For this purpose, the existing literature is analysed for potentials of VR that may support the transfer of tacit knowledge in a special way. Perspective taking, social interaction, and cognitive absorption are the potentials, which have been identified in 12 interviews. Based on these potentials, a research model is developed, which maps the interrelationships between the individual constructs. In the context of tacit knowledge transfer in organisations, this work offers a new perspective on the application areas of VR.

Keywords: VR, tacit knowledge transfer, perspective taking, social interaction

19.1 Introduction

The transfer of tacit knowledge constantly opens new challenges for organisations. Whereas the use of Information Technology (IT) for explicit knowledge transfer is comparatively easy to handle, completely different approaches and solutions are necessary for the transfer of tacit knowledge. Tacit knowledge helps to maintain competitive advantages and, if a transfer can be successfully completed, makes a decisive contribution to the sustainable development of the organisation (Afolayan 2020). Using IT for tacit knowledge transfer in organisations can become inefficient and costly because tacit knowledge is not tangible or can be written down (Bloodgood and Salisbury 1998). Today, the majority of approaches and frameworks in the literature concern organisational structures and the organisational environment requirements. Therefore, methods are proposed to promote, support, and stimulate the transfer of tacit knowledge (Afolayan 2020).

Nevertheless, there are less approaches for the direct use of IT for tacit knowledge transfer in organisations. An older approach proposes collaborative IT for tacit knowledge building in organisations (McQueen 1999). The focus is on making information widely available to a large number of employees within the organisation. Examples include forums, discussion groups, and email lists to stimulate discussion, communication, and exchange. These are intended to stimulate the development of tacit knowledge and provide basic resources in their function

(McQueen 1999). Tacit knowledge transfer requires approaches and technologies that enable more than a simple exchange of information. Tacit knowledge is primarily about experiences that enable new perspectives. From this point of view, technologies were sought that could enable such experiences. Looking on current technologies, we decided to focus on virtual reality (VR) in this study, because we expect an influence of VR on tacit knowledge transfer. Since tacit knowledge transfer often involves experiencing situations, VR provides a way to simulate realistic situations. VR is increasingly moving out of the context of consumer technology and is used more and more in various sectors and areas such as medicine, education, and industry. For the transfer of tacit knowledge within organisations, the use of VR could offer special potentials and create new opportunities (Li et al. 2019). This paper aims to build on this point by proposing and exploring an initial approach to the use of VR in this context.

Based on factors previously proposed in the literature to promote tacit knowledge transfer, for example direct face-to-face communication between employees is considered to be especially conducive to the transfer of tacit knowledge (Vonkrogh and Köhne 1998). This reaches its limits and is particularly difficult when employees and work processes are globally separated or have different knowledge bases. For the transfer of tacit knowledge, and the associated understanding of the work processes of other employees, it is necessary to carry out the processes independently and to get confronted with this problem. This experience is almost impossible in the normal everyday work, both in terms of space and time, as well as in terms of safety. At this point, VR could be used to break through the boundaries of personal communication (Weigel et al. 2020). For a targeted use, the special potentials of VR should be pointed out in advance, which can ultimately lead to added value and improve the process of tacit knowledge transfer. For this purpose, a total of 12 participants are interviewed in 6 experimental setups. To this end, this paper aims to develop a research model for the use of VR in the context of tacit knowledge transfer. To achieve this goal, this work is driven by the following research question:

RQ: Does VR offer opportunities to support tacit knowledge transfer within organisations?

The paper is structured as follows: In the next section, we present the theoretical background on tacit knowledge in organisations and VR. Then, we describe our methodological approach. Afterwards, we present the results of our semi-structured interviews and discuss our findings with the help of previous research. Finally, we reflect on our findings, point out the limitations of our research, and indicate avenues for further research.

19.2 Related Work

19.2.1 Tacit Knowledge in Organisations

The transfer of tacit knowledge is still a particularly relevant topic. In a recent paper, Afolayan (2020) comprehensively and chronologically works up und summarizes the previous literature and existing models on tacit knowledge and its transfer. He focuses on the characteristics of tacit knowledge, the prerequisites for successful tacit knowledge transfer, and approaches that can support and promote tacit knowledge transfer (Afolayan 2020). The transfer of tacit knowledge is also of particular importance in the context of organisational education (Seidler-de Alwis and Hartmann 2008). Thereby, it constantly opens new challenges for organisations. Employees are confronted with all forms of knowledge in their daily work. The difficulty associated with tacit knowledge is that employees are not able to fully pass it on to their colleagues. Polanyi (1966) describes the fundamental nature of tacit knowledge with the phrase "We know more than we can say". To illustrate his explanations, he uses the ubiquitous examples of riding a bicycle or swimming. In both examples, it is possible for the individual to successfully complete the tasks without being able to describe exactly how they do it. Ambrosini and Bowman (2001) investigate why it seems so difficult to transfer and reproduce tacit knowledge. They see the reasons in the fact that tacit knowledge is context-specific, personal, practical, and procedural, and, thus, is particularly deeply anchored in individuals (Ambrosini and Bowman 2001).

Tacit knowledge is especially needed when a solution to a new problem or situation is required (Afolayan 2020). In addition, in some cases, organisations are not aware of the value of their employees' tacit knowledge base. They are unaware of the extent it contributes to the development and progress of the organisation (Odiri 2016). Chennamaneni and Teng (2011) give different definitions of tacit knowledge and show that the degree of tacitness can vary. Thereby, the degree of tacitness determines how accessible the knowledge is. The more tacit the knowledge, the more difficult its reproduction and transfer is (Chennamaneni and Teng 2011). Tacit knowledge cannot be used by others until it has been shared with them (Afolayan 2020). Therefore, Chennamaneni and Teng (2011) propose several transfer mechanisms that support the sharing of tacit knowledge including for example video conferencing, mentoring, storytelling, and learning by doing.

Weigel et al. (2020) describe an example that shows the effects of a lack of tacit knowledge transfer across organisational boundaries. Due to the division of work processes, employees of an organisation usually only have insights in parts of the work and production processes today. This results in knowledge divergence in many places. In most cases, employees are not aware that they have a different knowledge base. In this context, the example of a group of two organisations consisting of a manufacturing and a service organisation was mentioned. The two organisations are linked via a value chain but are organisationally separated. The problem is that the employees of the manufacturing organisation construct a product which they themselves never had to maintain or repair. On top of that, you get little to no feedback on the problems that occur during maintenance and repair work. Since it is not possible for the product designers to experience the maintenance and assembly scenarios in terms of time and safety, they lack the experiential (tacit) knowledge that they could generate when problematic maintenance and assembly situations arise. A simple interpersonal exchange reaches its limits at this point (Weigel et al. 2020).

19.2.2 Current Development and Use of VR

The range of applications for VR has expanded greatly in recent years. VR technologies have constantly evolved over the past few years and their costs have decreased significantly. Application is no longer limited to specialized fields, such as the aerospace industry, but can be found in medicine, education, industry, and entertainment. The concept of VR describes a holistic simulated reality created with computer systems using digital formats (Martín-Gutiérrez et al. 2017). A distinction has been made so far between two manifestations of VR: immersive VR and non-immersive VR (Mills and Noyes 1999). Non-immersive VR includes 3D desktop displays where the user's experience is limited to what they see on the screen and hear through the speakers. As a result, the user does not feel immersed in the VR environment (Hofma and Constantiou 2018). In immersive VR, the user wears a head-mounted display (HMD) and is completely surrounded by the closed virtual world (Shu-Chen and Farn 2010). Sensors allow the user's movements to be tracked. Therefore, immersive VR technologies are suitable for the intended tacit knowledge transfer as they allow experiencing a simulation of a specific situation. The user's field of view is completely covered as they move their body in the virtual environment. For the user, the VR experience feels natural as real life is highly replicated (Hofma and Constantiou 2018). As far as the representation of environments and objects is concerned, there are hardly any limits in VR. Particularly engaging environments can be created, and places can be recreated or reinvented in a way that is true to reality (Jahn et al. 2018).

Virtual worlds support reinventing many business processes, services, and industries because strategies can be tested first in the virtual world (Mueller et al. 2011). In many organisations, there is a high motivation to use VR in the future to support their work processes (Berg and Vance 2017). Steffen et al. (2019) examine motives for VR use in a qualitative study. When interviewing industry professionals, it was found that every single participant surveyed could give specific examples of the practical use of VR technologies in their industry. None referred to VR as a gimmick or pure entertainment opportunity, and none suggested that there were no meaningful application areas for their field. This suggests that the industry is eager to adopt VR when it can address motives that cannot be met with current technologies and processes. It is important to focus on those activities that can be significantly improved through the use of VR technologies (Steffen et al. 2019). In this work, we investigate the relationship between immersive VR and the impact it has on enabling the transfer of tacit knowledge. Previous research has not yet established this connection between immersive VR and the transfer of tacit knowledge.

19.3 Method

Research methodology corresponds to an embedded single case design of a case study (Yin 2017). The two organisations studied are linked by a value chain, but organisationally separated from each other. They are a manufacturer and a service organisation. The flowing case consists of the real and holistic representation of the assembly process of the manufacturer's product by the service provider (single case). The analysis of the process contains systematic data from interviews with individual employees, assuming that the assembly process under consideration consists of a collection of individual activities. The theoretical implications of tacit knowledge transfer are used for the interviews with both production and service workers. The boundaries between our phenomenon of the common business process as a unifying element and the contextual conditions given by the production and the service organisation are fluid.

The study presented in this article is part of a research project to investigate how VR can be used for competence transfer between organisations. In this case study, one organisation produces machinery and technical equipment (name: "production") that is installed and maintained by another organisation (name: "service"). The spatial separation and the lack of time prevent an active exchange of employees across organisational boundaries. The transfer of tacit knowledge across organisational boundaries is therefore of particular interest. After all, the designer of one organisation has a decisive influence on the working conditions of the assemblers of the other organisation with his work results. Due to the limited exchange opportunities, an evaluation of the design and the service processes is only possible to a limited extent. Therefore, both organisations were considered in this case.

19.3.1 Case Design

In each experiment, two employees were confronted with the identical task of the assembly process in VR. Both employees were mutually represented in VR by avatars and audio communication between the participants was ensured via the HMD. The interaction in VR was designed in such a way that the participants could work through the given assembly tasks both together and alone. A total of twelve participants were thus interviewed in six runs of the experiment. At the beginning of the experiment, each participant was first asked individually about their previous knowledge and experience. Exemplary questions here were: “How often have you already used VR?” and “Do you expect to learn anything in today's VR experience?”. Then the experiment was conducted with both users in the shared VR space while they were located in different rooms in reality. In our experiment, we had participants test VR in multi-user mode. This allows users to have a realistic social experience by interacting with each other and their environment in a natural way (Wienrich et al. 2018). After the test run, each participant was again interviewed individually. Exemplary questions were asked like "How well did you cope with the VR scenario ‘crane assembly’?” and "Did you learn anything new from your colleague during the VR?”. Afterwards followed a focus group interview with both participants. In this focus group interview, open questions were asked again such as: “In which situations did the VR enable you to solve problems together with the second user?” and “Describe the interaction with each other in the VR. Did you feel like you interacted with each other as you would in real life?”.

No.	Organisation	Age	Gender	Position	Duration (Single Interview)	Duration (Group Interview)
1-1	Production	31	female	Marketing	5:01	33:02
1-2	Production	25	female	Technical draughtswoman	3:37	
2-1	Service	29	male	IT	3:45	31:02
2-2	Production	25	male	Technical draughtsman	4:54	
3-1	Production	27	male	Technical draughtsman	3:38	41:57
3-2	Service	37	male	Electrician	5:44	

No.	Organisation	Age	Gender	Position	Duration (Single Interview)	Duration (Group Interview)
4-1	Service	29	male	IT	4:01	23:10
4-2	Production	26	male	Controlling	5:23	
5-1	Service	32	male	IT	6:21	22:14
5-2	Production	32	male	Technical draughtsman	5:07	
6-1	Production	29	female	Sales manager	4:52	23:41
6-2	Service	21	male	Trainee	5:05	

Table 19.2 Overview of the Interviews

In order to get the widest possible range of responses and to allow participants to speak freely, we used a semi-structured guide with open-ended questions for the interviews (Pumplun et al. 2019). We followed Sarker's guide for qualitative research to avoid the pitfalls of qualitative semi-structured interviews (Pumplun et al. 2019; Sarker et al. 2013). We evaluated the first version of the questionnaire with an experiment, i.e. two pre-interviews. This meant that we only had to make small adaptions to the questionnaire during the interviews. After the total of twelve interviews, we assessed that there was little chance for further novel findings.

19.3.2 Data Analysis

The recorded interviews were transcribed and then analysed using MAXQDA software. Grounded theory methods were used to analyse the interviews. The applied coding methods include open coding, axial coding, and selective coding. Initially, open coding was used, i.e. factors and situations of tacit knowledge transfer were sought (Corbin and Strauss 2014; Glaser and Strauss 2017). This process was carried out independently by the researchers in order to collect as many results as possible. Afterwards, the results were compared and grouped (axial coding) to identify the relevant aspects of the study (Corbin and Strauss 2014). Different views of the researchers were discussed, and a common solution was sought in the interest of all researchers. The analysis was stopped at the saturation point, i.e. when no new higher-level measures were found. The following example explains the process: “Communication is enormously important, because it really gives you the feeling that you are interacting with the other person.” (Interview 5-1). This sentence was independently assigned code phrases by three researchers that best represent the content. One of the codes was "Social Interaction", and the other code was "Communication with the second user". From this, the code "Social Interaction with the second user" was then used as the axial code. Then, the axial codes were grouped according to themes. If there were disagreements between the two researchers on any point, a third researcher was consulted, and an axial code was discussed and determined with them.

19.4 Findings

Immersion and cognitive absorption are already well-known and extensively researched constructs in the context of VR design and use. The development and occurrence of both constructs depend, among other things, on the design of the VR environment. If the VR environment is particularly realistic and detailed, it is easier for the user to immerse completely in it and to fade out the surrounding real world. The users indicated that this depends on the VR visualisation's level of detail. Collision anxiety, which would negatively affect cognitive absorption, was counteracted by visualizing a grid in VR (Mütterlein et al. 2018). The VR users thus knew in which space they could move and could classify their respective position without having to fear colliding with surrounding objects in the real world.

> *4-1 "I only paid attention to the border markings and moved accordingly, but otherwise I saw myself completely in the virtual world."*

> *1-1 "We were definitely in a VR room. But even though I knew that for sure, I had the feeling of height during the task (...) as if I was standing on a 5-metre board in the swimming pool."*

The users described the VR experience as particularly real. This was especially evident in a task that had to be completed at a simulated height. The participant stated that he had a realistic feeling of height. It can therefore be assumed that the VR environment was perceived as immersive by the participant.

> *4-2 "I felt like I was really the virtual character and was in that scenario. I also felt somehow close to the second user, although it wasn't like that at all. I think it depends on the level of detail."*

Although the participants were in different locations in reality during the VR simulation, could only communicate with each other via the HMD headset, and perceive each other as abstract human avatars, they described their interaction and the feeling as particularly close and realistic.

> *6-1 "I already said that it felt as if he were here in the room with me. So, these real rooms here have really been completely blanked out for me, I really thought we were standing there together."*

4-1 "You were so immersed that you actually thought you were standing next to each other. The second user then explained the context to me as I would expect from a teacher. We also had two or three jokes and it felt like you were actually in a room."

The spatial separation in reality was completely faded out by the participants. They stated that they had the feeling of actually standing next to each other. Interaction and communication were also relaxed and as one would expect in reality. Some participants sprinkled in jokes, exchanged information about the functions and the VR environment or started to support each other. The fact that the participants had different levels of knowledge about VR use and the assembly process depicted made an exchange particularly relevant. One participant had the second user explain the steps and described the experience as learning from a teacher.

5-1 "Communication is enormously important, because it really gives you the feeling that you are interacting with the other person (...). Exactly, we then also tried to interact, along the lines of: If you do this now, then I'll do the next one and get the next items you need. And that actually worked out quite well."

Especially the communication among the participants strengthened the will to interact. The participants described the opportunity for verbal exchange as particularly important. They consulted with each other, coordinated tasks, informed themselves together about tasks that had already been completed and what work steps were next, and asked each other questions about the work steps. It additionally helped them to orient themselves and to perceive the other participant. Work steps of the teammate could be understood, and coordination was facilitated.

4-1 "Yes, the second user helped me and answered my questions, both technical questions and just how to use the tools. He brought me the ladder and set it up accordingly."

4-1 "We exchanged ideas about different things. For example, when my colleague explained to me which tools I have to use and why. He also explained to me the reasons why I have to deactivate the fire alarm when I work with the cut-off wheel. Also, the terminology about certain nuts, bolts (...). I was able to remember quite a lot."

The VR users were able to recognize and communicate the respective knowledge level of the other user. They perceived the limits of their teammate's knowledge and tried to support each other. They found out how they could support in order to work particularly efficiently and to be able to speed up the assembly process. They perceived the second user's way of working and tried to support him. In the process, they showed mutual consideration for their partner and explained individual work steps to him.

> *5-1 "We have coordinated with each other. We then looked at what I can do now, what is the next task, you do that already. We interacted and communicated together to solve the tasks. At first, you had to find your way around. But I think that's the same when you meet on a construction site. And here I had the same feeling that you first have to see how I can best do it together."*

> *3-1 "Actually quite good. Since you've never had to deal with VR before, it takes a bit of getting used to, but you'll get used to it pretty quickly once you've had a bit of practice."*

Participants who were not yet familiar with VR use described an initial moment of familiarisation. They first had to orient themselves and were more concerned with themselves and the possibilities of interacting with the VR environment. They stated that after a short familiarisation phase, it was then possible for them to focus on the interaction with the second player. It became apparent that the interaction initially depends on the extent to which the user is familiar with themself and their body in VR. When their own perception of and interaction with the VR environment becomes natural, users are better able to focus on and interact with the second user.

> *4-1 "At the beginning I had no expertise, and now I have gained knowledge through the VR. I learned how the process works and I definitely felt like a service mechanic in the role because I went through the exact steps."*

> *3-1 "If you look back at it, I think it's definitely helpful to see which assembly sequences exist and how they are built up. I think it's also interesting for outsiders that you can simply change this perspective."*

In addition, the interaction with each other led to an exchange of knowledge. After the VR experience, the users were able to remember the names of individual parts and indicated that they now knew and understood the assembly process with the individual work steps. Some participants indicated that they felt like they were in a different role. The fact that the work steps of the assembly process corresponded to reality gave them a realistic feeling of actually carrying out the assembly themselves. Employees from other areas described it as particularly interesting and helpful to get the information from another area of the organisation. They had experiences they would have never had without the VR simulation and at the same time gained a new awareness of the assembly process.

> *2-1 "But of course I've always thought about how, for example, if you lift the things in there now, the boom or something, how would that work in reality, how would others do it."*

> *1-1 "In VR I thought about how, for example, some tasks would be in reality. For example, when you work with heavy things, it's very easy in VR, but how would that work in reality and how would the real service mechanics do it?"*

For other participants, questions about the assembly process came up while they were in the VR simulation. Afterwards, they thought about difficult and problematic situations that could occur during assembly. They realized that some assembly steps cannot be done alone and what difficulties can occur.

> *3-1 "I say that I understand the rationale for often doing an assembly in pairs, namely because of the activities that can only be done in pairs. I also understand the problem with our assembly time calculation. We would have to set up the calculation differently, because I would say that these idle times, when only one colleague can assemble something, are not considered in a meaningful way. And yes, that makes you think."*

In focus group interview 3, a discussion about assembly time calculation arose after the VR simulation between a design engineer and a service technician who had experienced the VR simulation together. They discussed a problem that can occur during the assembly time calculation when there are not enough service technicians available. The designer realized that an adjustment of the assembly costing would be necessary at this point.

Based on the interview data, a research model is developed to open the research area of VR in the context of tacit knowledge transfer. It is an initial investigation of the relationships between the identified constructs. Existing theories and constructs are used for this purpose. The investigations of the state of development and the areas of application of VR so far show that immersive VR in combination with suitable hardware creates special possibilities that a 3D desktop visualisation does not cover. The three potentials highlighted are "cognitive absorption" (Agarwal and Karahanna 2000; Kampling 2018) (focus group interview 1, 4, 6), "perspective taking" (Weigel et al. 2020) (focus group interview 1, 2, 3, 6) and "social interaction" (Mueller et al. 2011) (focus group interview 3, 4, 5).

19.5 Discussion

In the following, these potentials (cognitive absorption, perspective taking, and social interaction) will be explained, placed in the context of tacit knowledge transfer and hypotheses will be generated. The configuration of the individual potentials allows consideration of several factors, forecasting a tangible result.

19.5.1 Perspective Taking

Perspective taking describes the ability to put oneself in another person's thoughts, feelings and spatial perspective (Erle and Topolinski 2015). VR enables the user to experience many situations from every perspective (Herrera et al. 2018). One study examined the empathy developed when taking perspective with immersive VR compared to traditional perspective (the attempt to put oneself in someone's position). The empathy lasted longer and was more pronounced when taking perspective in VR than in traditional perspective taking. In a second part of the study it was found that the VR experience of the situation of the persons to put oneself in led to a more pronounced empathy than if the test persons only received information about the other group (Herrera et al. 2018). Participants from the focus group interviews 3 and 6 described that the VR 317isualization allowed them to take the perspective of a service technician. While experiencing the assembly process in VR, they became aware of processes that are particularly difficult in a real assembly process and could confront the service technician with problems. In turn, taking the perspective was enabled by the immersive VR experience, through which they had a real sense of being in the role of the service technician. These observations allow us to formulate the following hypothesis:

H1: If the design of the Visualization offers a particularly immersive user experience, the potential for perspective taking is all the greater.

Experiences that individuals make by taking another person's perspective are frequently tacit. Such experiences can influence the individual's decisions significantly. Lee et al. (2018) put a product manager in an experiment in the position of the end user who would be affected by the introduction of his product with faulty functions. After the negative experience of the end user with his product that had entered the market too early, he was prepared to postpone the market launch and fix the bugs until then (Lee et al. 2018). In the present experiment, focus group interview 3 showed that the immersive VR experience served as a downstream basis for discussion. The participant from focus group interview 3 began to discuss problems encountered during assembly after the VR experience. The technical drafter became aware that the assembly calculation needed to be adjusted to address current problems during assembly.

In Interview 6-1, the employee from the sales department described after the VR experience that she had only now become aware of the effort involved in some assembly processes and questioned processes. She described it as particularly useful to experience the assembly process from the service technician's perspective. Participants had an experience they would not have had without the VR experience. They said they gained knowledge about difficult situations and gained an awareness of the process itself. The following hypothesis can be derived from this:

H2: If the perspective taking is more pronounced when using VR, then the transfer of tacit knowledge through the feeling of really experiencing the situation of another person is all the greater.

Weigel et al. (2020) present the potential of immersive VR for perspective taking. They concluded that traditional perspective taking reaches its limits when the knowledge about the processes being followed is lacking. A perspective view in immersive VR creates the possibility to present the design of special environmental conditions and constructions and to make them tangible for the designer without having to go to the assembly site. This can lead to a successful perspective taking, which enables the designer to rethink his designs at an early stage (Weigel et al. 2020). A special advantage of perspective taking with immersive VR is that the user can concentrate completely on acting and reacting in the VR experience. They do not have to invest mental resources to create specific environments or situations, as these are already defined and presented in advance. This means that there is no danger of the users falling back into their own patterns and prejudices and thus subjectively influence the way they take in the perspective (Herrera et al. 2018).

19.5.2 Social Interaction

Qureshi et al. (2018) investigated IT-based social interaction in comparison to face-to-face interaction. They conclude that IT-based social interaction is more beneficial for interpersonal knowledge exchange because it has a stronger competence-based trust and a better heterogeneity of the employees' environment, which is more difficult to achieve with face-to-face interaction. VR enables users to interact in real time and to represent users as avatars. Through voice, text and body language as well as 3D visualisations, they also offer a variety of communication channels, which can enhance user interaction (Qureshi et al. 2018). In our experiment, we had participants test VR in multi-user mode. This allows users to have a realistic social experience by interacting and their environment in a natural way (Wienrich et al. 2018). Our participants mentioned that they were motivated to share and interact by the possibility of perceiving the second user and communicating via the HMD. They were able to exactly follow the movements of the second user and had a realistic feeling of being in a shared space and experiencing the assembly process together due to the detailed representation. Some tasks could be worked on simultaneously by two people. The participants took advantage of these opportunities to ask each other to collaborate. The following hypothesis can be generated from the findings:

H3: If the VR environment is more immersive and realistic, the potential for social interaction will be higher.

Additionally, Quereshi et al. (2018) found out that frequent IT-based social interaction is the most beneficial for interpersonal knowledge transfer (Qureshi et al. 2018). Ryan and O'Connor (2013) argue that social interaction is a critical success factor for tacit knowledge transfer and knowledge sharing (Ryan and O'Connor 2013). Shu-Cheng and Farn (2010) also cite social interaction as a particularly helpful variable that promotes tacit knowledge transfer and acquisition (Shu-Chen and Farn 2010). In the context of knowledge transfer, virtual environments provide the opportunities for social interactions that are necessary for the knowledge creation and knowledge transfer process. In virtual worlds real collaboration can be mapped. They create new tools for communication, facilitate global and temporal collaboration, create a common context for collaboration, and improve knowledge and knowledge processes (Mueller et al. 2011). In the literature listed, knowledge is often considered in an undifferentiated way. A precise division into tacit and explicit knowledge is less communicated. In this study, the transfer of tacit knowledge through VR will be investigated. Some participants described that through the exchange with the second user in VR and after the VR experience (focus group interview 3), they gained information about the assembly process that they would not have gained without the VR experience. The VR experience served as a basis for them to discuss problems, and even during the VR experience, participants who were already familiar with the real assembly process provided information from older assembly experiences. They pointed out where problems can arise during maintenance, which parts are difficult to assemble under which circumstances, and why the assembly instructions for the real assembly process do not always reflect the ideal assembly sequence. At this point the following hypothesis can be made:

H4: If social interaction is more pronounced in the VR environment, the potential for successful tacit knowledge transfer between employees will also be higher.

19.5.3 Cognitive Absorption

Immersion is regarded as a crucial feature of immersive VR and is a key factor in the literature for flow theory and its further development towards cognitive absorption (Agarwal and Karahanna 2000; Csikszentmihalyi 1990). Both, flow theory and the concept of cognitive absorption, explain a strong mental absorption state of a person, which is associated with high attention and concentration, a changed sense of time, a feeling of strong control over one's own actions and a high level of immersion (Kampling 2018). Burton-Jones and Straub (2006) describe immersion as a substructure of cognitive absorption and explain that immersion is the only element, that can be measured.

When designing a VR environment, several factors determine the degree of the user’s cognitive absorption. The more immersive the VR, the higher the cognitive absorption. This means that the use of an HMD leads to a particularly strong cognitive absorption compared to a 3D desktop visualisation (Huttner and Robra-Bissantz 2017). The participants described the VR visualisation as particularly detailed and immersive. They each wore an HMD and were able to completely fade out the real world. They described that they had the feeling of being in the same room with the second user, even though they were locally separated (focus group interview 1,4,6).

VR enables the user to interact with the virtual environment by physical body movements (e.g., walking, turning, stretching arms, turning the head) and the operation of the controller as if the user was actually present. The possibilities of physical movement lead to an improvement in the user's performance in solving cognitive tasks and the experience gained in the VR has an impact on both, behaviour and perception. These capabilities allow users to gather information about the virtual environment with the same perceptual systems they use in the real world (Herrera et al. 2018). Furthermore, a realistic and high-quality representation leads to a stronger cognitive absorption. Overall, 56.1% of cognitive absorption is described by design features such as interactivity, liveliness, and realism (Chang et al. 2018; Mütterlein et al. 2018). The VR visualisation allowed participants to perceive the controllers as realistic hands. They could manipulate the VR environment with these hands and grab tools or small parts by grasping them with their hand. Additionally, a tablet could be operated by touching the surface with the finger as in real life.

Adapted acoustic and haptic feedback are further factors that enhance cognitive absorption through a more immersive VR experience (Huttner and Robra-Bissantz 2017). While users were operating different tools, they simultaneously received the appropriate sound and haptic feedback via the HMD and the controllers. This made the work particularly realistic.

Furthermore, the virtual presence is positively influenced by cognitive absorption. A stronger sense of presence in VR increases user satisfaction, which in turn increases user intention (Kim and Mousavizadeh 2015). The participants described the second user as particularly present to them. They were able to locate each other using the abstract human representation as an avatar and understand each other's work. By perceiving and communicating via the HMD, they were able to coordinate and act with each other.

Overall, the results allow us to establish cognitive absorption as a positive moderator of social interaction. Moreover, a positive influence of cognitive absorption on perspective taking was observed in the experiment. The participants described being in the role of the service technician due to the realistic feeling in the VR visualisation.

The influence of cognitive absorption as a positive moderator on perspective taking and social interaction allows the constellation of the following hypothesis.

H5: If cognitive absorption is more pronounced when using immersive VR, there is greater potential for perspective taking and social interaction.

In connection with VR, Mütterlein et al. (2018) name further factors that influence the level of cognitive absorption. One of the factors is the user's previous experience with VR. If users have no experience with VR, they will have difficulty orientating themself and adjusting or operating the hardware. By wearing an HMD, the users are excluded from the real environment. In the presence of other external people, the VR user may feel distracted or isolated, which has a negative effect on cognitive absorption. If only a relatively small space is available for VR use, this can trigger fear of collision with surrounding objects during VR use (Mütterlein et al. 2018).

19.6 Research Model

Figure 1 summarizes the 5 hypotheses in a coherent research model. Immersive VR technology was used in the experiment, so this defines the starting point of the research model. Cognitive absorption represents a positive moderator for perspective taking and social interaction. Immersive VR technology consequently has a positive effect on perspective taking and social interaction. The opportunities of perspective taking, and social interaction stimulate and enable tacit knowledge transfer.

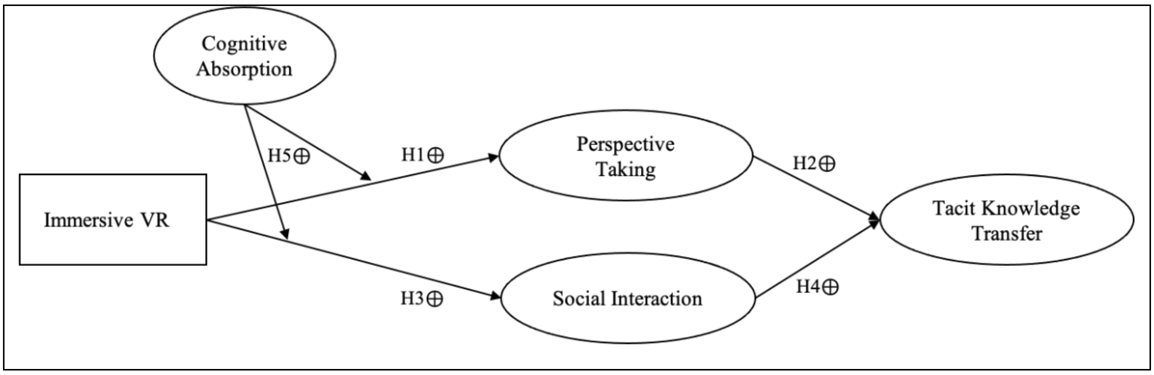

Figure 19.1 Research Model

In relation to the RQ, this study and the developed research model show that VR offers potentials to support the transfer of tacit knowledge in organisations. Whereas in the past the transfer of tacit knowledge has often been considered at the level of individual employees in an organisation, these research findings now enable the consideration of interrelated value creation processes across organisational boundaries. This study contributes to the current state of knowledge on tacit knowledge transfer. The results show that cognitive absorption, perspective taking, and social interaction are potentials of VR to support tacit knowledge transfer in organisations.

19.7 Limitations and Outlook

The research findings have to be viewed in the light of limitations that are inherent to this kind of study design. Our approach uses a qualitative method to connect the identified potentials of VR with the existing literature. It is difficult to identify which phenomena caused other phenomena, here we derived five hypotheses using existing literature. For example, it has a significant impact on social interaction if participants already know each other. It should be noted that some of our participants already knew each other even though they do not work in the same area of the organisation. Although they could only see each other as avatars during the VR simulation, the users said that they still had a real image of the second user in their minds because they had seen each other at least once in real life before the experiment. Another decisive influencing factor is the personality of the participants. The majority of our participants are characterized by an open and communicative personality. Communication seems to be particularly important for cooperation. An open and communicative personality can therefore be particularly conducive to social interaction. During the execution of the VR experiment, we sporadically detected an influence of participants' previous VR experience on cognitive absorption. In order to consider the previous VR experience as a moderator for cognitive absorption, the VR experiments would have had to be conducted with several participants who did not yet have VR experience.

During the research work for this paper, topics and questions that seem to be useful in the use of VR were scientifically examined, since they can have an influence on the actual use. When using immersive VR, many users face the problem of so-called 'motion sickness'. This feeling is accompanied by dizziness and has a negative impact on the intention to use the technology (Munafo et al. 2017). Even for people who wear glasses the use of HMD is not always unproblematic. The user’s age also seems to be an influencing factor. Not only in terms of motivation to use new technologies, but also in the context of the occurrence of motion sickness (Arns and Cerney 2005). In the context of organisational VR usage, the factors mentioned could have a significant influence. Their inclusion in the research model would have exceeded the scope of this paper but seems interesting for future work and research.

This work does not provide significant theoretical results. Nevertheless, the researchers believe that based on their extensive literature review and the interviews conducted, they were able to identify interesting correlations that may provide a promising basis for future research. In these cases, it can be helpful to explore interdependence through quantitative analysis. Quantitative studies are also able to address a broader population and provide generalisable findings. These factors were neglected because the focus was on the relationship between immersive VR and tacit knowledge transfer. Consideration of other factors could broaden perspectives. Therefore, this study offers potential for further research. It can be expected to contribute to a more general theory on appropriate tacit knowledge transfer measures. This would open the possibility of including external or personal factors in the analysis to avoid blind spots in further research. Such a theory could then be tested with a quantitative approach.

19.8 Acknowledgements

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20 Bittersweet VR Collaboration: Conditions for Collaboration (P10)

Paper Number	**P10**
Title	**Bittersweet VR Collaboration: Necessary and Sufficient Conditions for Collaboration in VR**
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Table 20.1 Fact Sheet Publication

Bittersweet Virtual Reality Collaboration: Necessary and Sufficient Conditions

Abstract. The spread of COVID-19 has led to new challenges on organizations of every size. This also affects collaboration, which since then has had to be more digital than ever. While traditional collaboration tools, such as video- and audioconferences have reached their limits in terms of interactive and flexible collaboration, the development of multi-user virtual reality (VR) technology is introducing new possibilities. We investigate which conditions have an impact on the intention to collaborate in VR environments. To this end, we conducted a multi-user VR experiment and then interviewed participants individually and in focus groups on their collaboration behaviors. We were able to identify technological-, task-, and user-related conditions, which could be distinguished in necessary and sufficient conditions. Our research has helped to create evaluation opportunities to determine what conditions should be met to foster collaboration in VR.

Keywords: Digital collaboration, virtual reality, multi-user, exploratory research

20.1 Introduction

On March 11, 2020, the World Health Organization declared the coronavirus disease 2019 (COVID-19) as pandemic (WHO, 2020). COVID-19 and interrelated home office policies as well as contact restrictions pose new challenges for organizations, teams, leaders, and employees (Kohn, 2020; Zeuge et al., 2021). At the same time, the requisite flexibilization and digitalization of daily work act as a driver for digital transformation (Soto-Acosta, 2020). Before COVID-19, there was a significant upswing in digital collaboration technology that enabled location-independent collaboration (Hossain & Wigand, 2006). However, the pandemic has caused a more rapid increase in the use of collaboration technology due to the changing nature of day-to-day work (Soto-Acosta, 2020).

Collaboration is generally defined as the joint effort of two or more people to achieve a team goal (Briggs et al., 2003; Fan et al., 2012). Individuals in a team collaborate to create value that the members cannot create through individual effort (Briggs et al., 2009; Bruns, 2013). Collaboration is characterized by task-related and social interaction as well as communication to share resources and knowledge (Fleischmann et al., 2020). Thus, collaboration is a complex construct composed of different dimensions, e.g., communication, trust, and coordination (Brown et al., 2004; Deshpande et al., 2016; Russell et al., 2017).

Digital collaboration is a collaboration process in which team members primally interact and communicate digitally (Fan et al., 2012; Hossain & Wigand, 2006). Thereby, information and communication technology (ICT) represents a key component for the success of digital collaboration (Majchrzak et al., 2005; Smith & McKeen, 2011). Traditional digital collaboration tools (e.g., audio- or videoconferencing), however, reach their limits when it comes to interactive and flexible collaboration (Nor'a & Ismail, 2019). While for example, digital whiteboards or mind maps can support collaboration in two-dimensional space in an efficient way, the functions are not sufficient for three-dimensional space (e.g., prototyping). In addition, facial expressions and body language are lost to a great extent (Isaacs & Tang, 1994).

The development of virtual reality (VR) technology and content have attracted its use for everyday work (Muñoz-Saavedra et al., 2020) and introduced new opportunities for supporting digital collaboration (e.g., Hatzipanayioti et al., 2019; Mütterlein et al., 2018). Especially the development of multi-user VR solutions extends traditional tools by inviting multiple users to meet and interact in virtual spaces (Alghamdi et al., 2016; Heldal, 2007). With the use of VR for collaboration, participants collaborating can meet in a virtual space and interact with each other as well as objects regardless of their physical location. In addition, communication is enriched since, for example, gestures can be transmitted and thus perceived by the other participants. Currently, the benefits of a purpose-built VR environment likely do not exceed the resources required for development. The intention to use VR for collaboration may create areas for actual collaboration that otherwise would not be achieved.

While the benefits of using VR for collaboration have been widely studied, research encourages a more thorough examination of the conditions that drive users' intentions to collaborate in VR (Mütterlein et al., 2018). User intention to collaborate thereby means the willingness to commit to a collaborative process, since collaboration is, by its very nature, voluntary (Roberts & Bradley, 1991; San Martín-Rodríguez et al., 2005). First valuable efforts have been made to explore how certain conditions (e.g., immersion) influence the intention to collaborate with other users in VR (e.g., Hatzipanayioti et al., 2019; Mütterlein et al., 2018). However, to the best of our knowledge, no research has been conducted so far to determine overall which conditions influence user intention to collaborate in VR. Therefore, this research aims to investigate if there are other conditions and how these conditions influence the intention to collaborate. To this end, we conducted an exploratory research in a multi-user VR environment. Here, participants of two organizations connected by a value chain were interviewed. It is important that participants are exposed to a process that is designed for real-world collaboration. However, collaboration across organizational boundaries does not currently occur in the simulated process, even though both organizations would benefit from collaboration. Consequently, conditions that influence the intention to collaborate in VR could be identified. These conditions could be differentiated into necessary and sufficient conditions in this research. For research purposes, our findings were linked to existing literature, and for practice purposes, recommendations could be derived on how collaboration occurs in VR. Thus, it has become clear which conditions that influence collaboration intention can support the creation of collaborative VR experiences.

The paper is structured as follows: In the following section we review the literature on collaboration and collaboration in VR. Subsequently, we present our methodological approach. We then present the findings of our exploratory research and discuss them. Finally, we conclude by reflecting on our findings, highlight some important limitations of our research, and provide fruitful avenues for future research.

20.2 Related Work

20.2.1 Collaboration

Teamwork is defined as "(a) two or more individuals who (b) socially interact (face-to-face or, increasingly, digitally); (c) possess one or more common goal(s); (d) are brought together to perform organizationally relevant tasks; (e) exhibit interdependencies with respect to workflow, goals, and outcomes; (f) have different roles and responsibilities; and (g) are embedded in an encompassing organizational system, with boundaries and linkages to the broader system context and task environment." (Kozlowski & Ilgen, 2006, p. 79). The effectiveness of a team is defined as the degree to which a team attains a goal while the efficiency of a team is defined as the degree to which a team preserves its resources during the accomplishment of this group goal (Cohen & Bailey, 1997).

Briggs (1994) observed three levels of teamwork: the individual, the coordination, and the collaboration level. Teamwork on an individual level describes uncoordinated effort from individuals toward a shared goal. It is characterized by individual processes from the beginning to the end (Nunamaker et al., 2001). The success of the team is the sum of the individuals' outputs (Briggs, 1994). On the coordination level, the individuals' efforts are coordinated to accomplish a shared goal (Nunamaker et al., 2001). Coordination is necessary to manage interdependencies within the task (Malone & Crowston, 1994). The team's success is the sum of all the members' individual, ad hoc, and coordinated team performances (Briggs, 1994). On the collaboration level the individuals of a team collaborate to create value that their members cannot create through individual effort (Briggs et al., 2009; Bruns, 2013; Nunamaker et al., 2001). The team's success is the sum of all the members' individual and concerted group performances (Nunamaker et al., 2001).

We refer to Briggs et al. (2003) and define collaboration as a joint effort towards a team goal. Collaboration is a multi-dimensional construct composed of different dimensions (Kotlarsky & Oshri, 2005; Thomson et al., 2007). One central dimension of collaboration is trust (Brown et al., 2004; Jarvenpaa et al., 1998). Brown et al. (2004) describe trust as the "glue" that sticks people who collaborate by fostering confidence that all participants will contribute as agreed and not behave opportunistically. Trust reduces complexity and transaction costs (Jarvenpaa et al., 1998; Thomson et al., 2007) and includes the freedom to test assumptions, to experiment, and to make and talk about mistakes (Dixon, 2017). Since communication facilitates all forms of teamwork, it provides the basis for effective collaboration (Deshpande et al., 2016; Fleischmann et al., 2020). Jarvenpaa and Leidner (2006) indicate that certain communication behaviors can foster trust in early stages (e.g., social communication) as well as in later stages (e.g., substantial and timely responses). Another essential dimension of collaboration is coordination (Bruns, 2013; Jassawalla & Sashittal, 1998; Russell et al., 2017). Coordination, in the context of collaboration, is defined as "the act of managing interdependencies between activities performed to achieve a goal" (Malone & Crowston, 1994, p. 361). Coordination guarantees the efficiency of the collaboration (Raposo et al., 2001). Further dimensions of collaboration mentioned in literature are governance, administration, autonomy, and mutuality (Kotlarsky & Oshri, 2005; Thomson et al., 2007).

While physical collaboration is a collaborative process where team members work face-to-face, digital collaboration is a collaboration process in which team members primally interact and communicate digitally (Fan et al., 2012; Hossain & Wigand, 2006). Digital collaboration largely transcends time and space, connects people across disciplines, functions, and organizations, and combines the skills of all team members (Peters & Manz, 2007). Fan et al. (2012) suggest that collaboration efficiency and performance are significantly affected by the collaboration technology selected for collaboration.

Collaboration technology provides all team members who are dispersed across place and/or time with the same opportunity to participate (Majchrzak et al., 2005; Smith & McKeen, 2011). Collaboration technology is the umbrella term for ICT supporting collaboration (Brown et al., 2010) and includes a wide range of asynchronous (e.g., e-mail, calendaring systems, or group discussion boards) and synchronous tools (e.g., chats, audio, or videoconferencing). Therefore, collaboration technology can be understood as the package of hardware and software supporting for communication, information-processing, knowledge sharing and the adoption and use of such technologies (Brown et al., 2010; Venkatesh & Windeler, 2012). They are designed to enable teams to work together regardless of time or physical location (DeSanctis & Gallupe, 1987; Venkatesh & Windeler, 2012).

20.2.2 Collaboration in Virtual Reality

With technological progress, the development of VR technology has opened new ways to experience virtual spaces, i.e., virtual environments or virtual worlds (Gleasure & Feller, 2016; Weigel et al., 2020; Wohlgenannt et al., 2020). A virtual environment consists of ‘‘software representations of real (or imagined) agents, objects, and processes; and a human–computer interface for displaying and interacting with these models” (Barfield et al., 1995, p. 476), while virtual worlds are ‘‘shared, simulated spaces which are inhabited and shaped by their inhabitants who are represented as avatars” (Girvan, 2018, p. 1099).

VR technology can be characterized by three properties: Telepresence, interactivity, and immersion (Walsh & Pawlowski, 2002; Wohlgenannt et al., 2020). Telepresence describes the extent to which VR can create a subjective feeling that one is in a virtual environment or world (Sanchez-Vives & Slater, 2005). Interactivity refers to “the degree to which users of a medium can influence the form or content of the mediated environment” (Steuer, 1992, p. 80). Immersion is the subjective experience of feeling completely absorbed or engaged with the activities conducted in the virtual environment or world (Dede et al., 2017, p. 3).

Suh and Lee (2005) distinguished two broader VR categories: non-immersive and immersive VR systems. According to Suh and Lee (2005), non-immersive VR refers to a virtual experience on a desktop or laptop computer that allows one to control characters or activities within a software. However, there is no direct interaction with the virtual environment. Immersive VR in contrast allows interaction with the virtual space (Schultze, 2014). Complex interface technologies, such as Head Mounted Displays (HMD) or cave automatic virtual environments (CAVEs), enable the user to be surrounded in an enclosed virtual space (Mills & Noyes, 1999). Controllers enable the user to interact with objectives in the virtual space.

Besides the technical improvements in VR hardware and software, multi-user VR solutions have developed significantly (Alghamdi et al., 2016; Jalo et al., 2020; Li et al., 2020) and invite multiple users to meet and interact in virtual spaces (Alghamdi et al., 2016). Here, users can simultaneously look, move around, and interact with virtual objects as well as with each other (Jalo et al., 2020).

Traditional collaboration tools (e.g., audio- or videoconferences) meet their limits especially when it comes to an interactive and flexible collaboration (e.g., prototyping). Multi-user VR technology extends these traditional tools and creates new opportunities for digital collaboration (Heldal, 2007; Li et al., 2020; Mütterlein et al., 2018). Therefore, it enables digital and interactive collaboration across departments and fields, independent of physical boundaries (Hatzipanayioti et al., 2019). Li et al. (2020) posit that multi-user VR is a promising new medium for digital collaboration, which better supports social presence (e.g., intimacy), rich non-verbal communications (e.g., mimic), and immersive realistic interactions.

Previous research has shown that collaboration in VR requires a different kind of investigation than the physical one. For example, Hatzipanayioti et al. (2019) investigate if collaborators who were physically in the same room and interacted with each other before the start of the task, collaborate more efficiently compared to collaborators who meet and interact only within the virtual space. Results show that sharing the same physical space and/or meeting each other before collaboration starts, creates a mental representation of the collaborating ones, builds trust, and therefore increases the collaboration efficiency. Mütterlein et al. (2018) study how immersion affects the users' intention to collaborate. To examine this effect the authors identified potential drivers of immersion in the individual domain (i.e., telepresence and interactivity) and the collaboration domain (i.e., social presence, media naturalness, and trust). They confirm that immersion is an important driver of the users' intention to collaborate and outline the importance of interactivity and immersion. However, telepresence, social presence, and media naturalness seem to be negligible.

Despite these valuable efforts to investigate how to foster collaboration, the conditions that drive intention to collaborate in VR are rarely investigated (Mütterlein et al., 2018). The new opportunities to collaborate digitally raise new questions about how people collaborate and how the intention to collaborate can be encouraged (Pouliquen-Lardy et al., 2016). Due to

COVID-19, it has become increasingly clear that collaboration does not have to be limited to the same location (Waizenegger et al., 2020). This coincides with the ongoing digitalization and the increasing requirements of organizations on how their employees collaborate (Orellana, 2017). VR technologies offer a promising tool for this purpose, especially to support previously unknown potentials (Weigel et al., 2021). It has not been comprehensively clarified if there are conditions that influence the intention to collaborate in VR. With their research, Hatzipanayioti et al. (2019) indicate that social interaction plays an important role in collaboration. But they also show that the investigation of conditions of collaboration has not been exhausted and future research may start here to identify additional ones. Mütterlein et al. (2018) also state that conditions need to be further investigated, since conditions of individual use cannot be straightforwardly adapted to a collaborative setting. They refer that future research should focus on a deeper comprehension and the diverse conditions by using quantitative research approaches to gain a better understanding of the intentions of collaborating in VR. This is where our research intervenes and examines the conditions for the VR context in light of the unexplored influences on collaboration. As an area that has not been extensively studied so far, our research contributes to a more comprehensive understanding on the intention to collaborate in a VR environment, providing an initial overview of the diversity of condition, and indicates implications for theory and practice. Therefore, we raise the following research question (RQ):

RQ: Which conditions do influence the intention to collaborate in VR?

20.3 Method

20.3.1 Method Selection

We follow an exploratory research design. For this purpose, we consider a group of organizations consisting of manufacturing and a service. These two organizations are organizationally separated, but together, they represent a value chain. We perform a real and holistic analysis of business processes by looking at a common process. The analysis of the process contains systematic data from the interview with individual employees. This research is part of a project that explores how VR can be used for collaboration between organizations. To this end, we interviewed the two organizations (one manufactures technical equipment, which is installed and maintained by the other). Barriers to collaboration were cited as physical separation, lack of time, and risks associated with the installation. The results of the manufacturer's construction processes have a significant impact on the service processes of the service provider. Therefore, both organizations were considered.

20.3.2 Case Design

In each experimental setup, two participants were confronted with the same scenario, namely that of the assembly process in VR. Physically, the participants were in two different locations. Participants were matched regardless of age and gender, but all participants were from a limited group of employees from the two organizations under research. During matching, care was taken to ensure that some participants knew each other prior to the experiment and other participants did not have such a familiar relationship because they each came from different organizations. In VR, each participant was represented as an avatar so that the participants could follow each other's movements and actions. In addition, Voice over IP communication was enabled between participants via the HMD.

The overall assembly process in VR can be performed by one person or by two people working collaboratively. However, some of the assembly tasks have been designed in such a way that the individual steps to complete this task can only be performed by one person (e.g., inserting the mortar) and some tasks can be performed both together and alone (e.g., carrying a ladder). This ensured that the collaboration between users could take place on a voluntary basis (Roberts & Bradley, 1991). Ten runs of the experiment were conducted resulting in twenty participants. Before the experiment, each participant was asked individually about their prior knowledge and experience. Exemplary questions here were: "How often have you used VR?" and "What do you expect from today's VR experience?". This was followed by the experiment, where the participants had to perform an assembly in multi-user VR mode. This was divided into eight process steps (site inspection and securing, assembly preparation, fastening plate assembly, column assembly, jib arm assembly, chain hoist assembly, functional test, and acceptance), with each step consisting of subtasks. As an example, process step 1 "Checking and securing the construction site" is described here, which consisted of the subtasks of measuring the construction site, comparing with construction plans, checking the floor thickness, and securing the assembly site. In the VR application, these tasks can be performed jointly by two participants, such as drilling holes (Figure 1 left). All tasks were processed in a VR industrial environment (Figure 1 right).

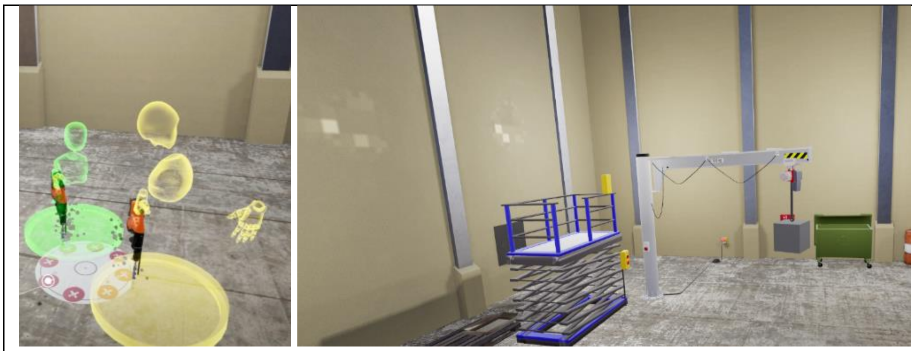

Figure 20.1 Screenshots of the Experiment

During the VR experiment, the two participants were supervised by two experimental supervisors. Here, for example, care was taken to ensure that the individuals did not collide with the physical walls of the room. They also subjectively observed if the participants collaborated with each other. Because each experimental supervisor has one participant at a time, they then compared their assessments and the situations in which they recognized collaboration among the participants.

After the VR experience, which took an average of 45 minutes, each participant was interviewed again individually. Questions were asked, such as “How well did you cope with the VR scenario ‘crane assembly’?” and “Did you feel supported by your colleague?”. These additional individual interviews were followed by a focus group interview with both participants together. Here, open-ended questions were asked, such as: “In what situations did the VR allow you to solve problems together with the second user?” and “Describe your interaction with each other in the VR. Why did you or did you not feel that you were interacting with each other as you would in real life?”. A total of twenty participants were interviewed; the exact composition of the data can be found in Table 1.

No.	Organization	Age	Gender	Position
1-1	Manufacturer	31	female	Marketing
1-2	Manufacturer	25	female	Technical draftswoman
2-1	Service provider	29	male	IT
2-2	Manufacturer	25	male	Technical draftsman
3-1	Manufacturer	27	male	Technical draftsman
3-2	Service provider	37	male	Electrician
4-1	Service provider	29	male	IT
4-2	Manufacturer	26	male	Controlling
5-1	Service provider	32	male	IT
5-2	Manufacturer	32	male	Technical draftsman

No.	Organization	Age	Gender	Position
6-1	Manufacturer	29	female	Sales manager
6-2	Service provider	21	male	Trainee IT
7-1	Manufacturer	19	male	Trainee technical draftsman
7-2	Service provider	37	male	Service fitter
8-1	Service provider	25	male	Trainee IT
8-2	Service provider	27	male	Trainee IT
9-1	Service provider	27	male	IT
9-2	Service provider	27	female	IT
10-1	Manufacturer	44	male	Factory manager
10-2	Service provider	51	male	CEO

Table 20.2 Overview of the Participants

We used a semi-structured guide with open-ended questions (Pumplun et al., 2019) during the interviews to obtain the broadest possible range of responses and to allow participants to speak freely. In addition, we followed Sarker's guide for qualitative research to avoid the pitfalls of qualitative semi-structured interviews (Pumplun et al., 2019; Sarker et al., 2013). Thus, we evaluated the first version of the questionnaire with one experiment, i.e., two interviews. This meant that we subsequently made only minor adjustments to the questionnaire based on the findings from the interviews. After a total of twenty interviews, we assessed that there was little chance for further new findings.

20.3.3 Data Analysis

The interviews were recorded and subsequently transcribed. The transcribed files were then analyzed using MAXQDA software. Grounded theory methods were used to analyze the qualitative data. Coding methods included open coding, axial coding, and selective coding. In the beginning, open coding was used. For this, conditions and situations of collaboration in VR were searched for (Glaser & Strauss, 2017). This step was performed independently by each of the authors to collect as many findings as possible. Axial coding followed, in which individual findings were compared and grouped to identify relevant aspects of the research (Corbin & Strauss, 2014). When it was expected that no more new insights would be found, the analysis was stopped at the so-called saturation point. The following example illustrates the process of data analysis: "Communication is hugely important because it makes you feel like you are interacting and collaborating with the other user." (Interview 3-1). Two researchers independently of each other assigned the codes to this passage, which in their opinion represented best the contents. One of the codes was "communication" and the other code was "interacting and collaborating". They were combined to the code "communication enables collaboration" to be then used as the axial code. The axial codes were then grouped by topic. In the case of the present example, the text passage was assigned to the superordinate item "Communication". These parent items were later further grouped into technology, task, or user, and into necessary, or sufficient conditions. If there was disagreement between researchers on any issue, a researcher not involved in coding was brought in to discuss and determined an axial code.

In addition to this analysis, the observations were also evaluated. Here, the experimental supervisors assessed if and in which situation collaboration took place. These two assessments of a situation were evaluated for commonalities and then discussed.

20.4 Findings

We were able to classify our findings into technology, task, and user conditions. This corresponds to a widely used classification of factors influencing information technology in Information Systems (Goodhue, 1998; Serrano & Karahanna, 2016). Further, we were able to distinguish between sufficient and necessary conditions that influence the intention to collaborate in VR. Necessary conditions represent the basic conditions for collaboration in VR. However, if these conditions are fulfilled, this does not mean that collaboration will occur; for this, sufficient conditions are needed that foster collaboration in the multi-user setting. In the following, we show the conditions of technology, task, and user and how these are divided into necessary and sufficient conditions.

20.4.1 Technology

Technology plays a crucial role in the context of VR. As a basic prerequisite for the use of VR, technology is what makes the experience and the implementation of VR possible. It describes the intersection between the user and the virtually designed reality and offers the possibility of interaction. This includes both, the software for development and the hardware that enables users to enter the virtual world. Therefore, technology is a necessary condition for collaboration in VR that emerges with several underlying influences.

One technology-related condition of collaboration in VR is its **handling**. Since VR handling is necessarily dependent on hardware usage (i.e., HMD, controllers, sensors), collaboration is also affected. If the way of handling the VR is not known or not yet internalized or if the technical restrictions (e.g., a certain defined area for VR use) are not observed, this has an influence on the collaboration, since the interaction with the partner and the VR itself is interrupted. For instance, exceeding the interaction radius of the VR has the consequence that the user can no longer be detected and thus no collaboration can take place. With regard to VR handling, the interviews revealed two different conditions that have an influence: first, the handling outside the VR environment, which includes technical, external conditions. These were caused, for example, by the handling of the controllers or positioning of the sensors, which resulted in problems for the users.

> *"Sometimes I had problems with the handling of the controllers. So that I got the buttons mixed up. Or that I was outside the detection space of the sensors." Interview 8-2*

> *"What was difficult? Well, the controls in general at the beginning. I would say that if it's completely unfamiliar, then it's not easy from the beginning. But I'd say the variety of keys is limited, so if you're a bit practiced, you'll be able to handle it." Interview 5-1*

Second, the handling within the VR environment. Elements of handling implemented within VR that allow a collaborative interaction were perceived to be necessary for collaboration. Interviewee 6-2 mentioned a specific task of the scenario, which was performed together with the collaboration partner.

> *"Yes, the [working] platform was good. I first got it in front of the crane and she stood on it and I raised it from below while she attached it to the top and then I lowered it again." Interview 6-2*

Another condition that influences the intention to collaborate is the **level of detail of the VR environment**. How a VR environment is perceived often depends on its details. This emerged as a result of collaboration and was stated in the interviews. The case depicted from the reality of crane assembly is a process characterized by collaboration. The difference to VR is the representation of details, which is clearly given in reality. The interviews showed that the level of detail is also a condition for the intention to collaborate in VR. On the one hand, due to the level of detail required by the case.

> *"I think it depends on the level of detail. I mean, in construction, of course, there are very detailed constructive things that you might not be able to represent in VR because that would be very time-consuming." Interview 2-2*

"I think that a proper cooperation, such as hooking the jib arm, was not necessary at all. [...] Normally the forklift driver lifts the jib arm in there, then the fitter has to look above to see how the bolt fits above [...]. Of course, this kind of cooperation does not occur here. However, this is probably also difficult to represent in VR, because the details are just so difficult." Interview 5-2

On the other hand, the interviews showed that the level of detail of the environment contributed to an increase in collaboration, as it particularly created a sense of real proximity and presence of the collaboration partner.

"Well, if it is depicted very detailed, I would say so. [...] I felt very much in the role and was somehow close to the second user, although it wasn't like that at all. I think that depends on the level of detail." Interview 4-1

Besides the VR environment and its level of detail **the avatars of the participants** collaborating with each other are necessary. The interviews indicate that the way the avatars are presented influences the intention to collaborate. The fact that the avatars were only represented in shadowy visualization (i.e., Figure 1 left) partially impaired collaboration. The participants had to search for each other because of the avatar's visualization and thus could not directly recognize where the other was located. Interviews showed that the representation would be better if the avatars would have been more adapted to the situation.

"The avatars could be a bit more present; they don't have to be like a real person, but sometimes I had to look for my teammate [to check] what she is doing." Interview 1-2

"I had to search for him sometimes. I liked it visually, but I think I would find a classic outfit more suitable in the scenario." Interview 4-1

When asking if the interviewees had the feeling of interacting with each other in VR as they would in the real world, for example, interviewee 2-2 replied: "Well, that would probably be something else because in VR you don't see each other, only schematically and only when you pay attention. In real life, you pay much more attention to each other." This supports the statement that the avatar design is a necessary condition of collaboration and the associated behavior of the participants.

However, that the level of detail does not have to be realistic on all levels was shown by the interviewees 7-1 and 7-2. While one lacked gestures and facial expressions and thus impaired the communication needed for collaboration, this aspect was seen by the other as support and a real reflection of collaboration.

“In real life, it would be different from my point of view because [...] you don’t have any facial expressions or gestures when you talk. That means you tend to hold back here and there to say something because it would or could come across completely wrong on the other side because you simply have no gestures or facial expressions.” Interview 7-2

“But I don’t think that’s as dramatic as it sounds because if you do that in real life with a stranger who you’ve never seen before, a guy you get from the customer, then it’s just the same. And that is the point. That is already mechanic-like.” Interview 7-1

Another technically necessary condition for collaboration in VR is related to design. **Immersion** is a common attribute of VR use (Mütterlein et al., 2018). It is not only necessary for the perception of the virtual environment and the fading out of the real world, but also influences collaboration. The feeling of collaboration arose primarily from the fact that the VR environment felt like real life to the participants, and they were able to completely fade out the real world. Whereby, for example, the possibility of communication reinforced the effect of immersion and thus supported the collaboration.

“You were sometimes so immersed that you actually thought you were standing next to each other [...]. We did two or three jokes and it felt like you were actually in the same room.” Interview 4-1

“It felt like he was in the room with me. So, the real rooms […] [were] completely blanked out for me, I really thought we were standing there together.” Interview 6-1

As mentioned, **communication** supports the intention to collaborate. It is a necessary, technology-related condition, since the technology acts as a prerequisite for communication between participants. Communication could be exchanged verbally and nonverbally by pointing or walking in the experiment. Unfortunately, recognition of facial expressions was not possible by the software. However, the verbal and rudimentary, nonverbal communication already led, among other things, to collaborating with each other.

“Communication is hugely important because it makes you feel like you are interacting and collaborating with the other person.” Interview 3-1

Furthermore, communication is significantly enriched by the fact that the participants could additionally perceive the mutual location through the representation by avatars. This resulted in occasions for communication, since participants put themselves in the role and position of the other and knew that the other was now closer to the tool or component. This initially led to the division of labor and cooperation. However, it also enabled collaboration among each other.

> *"Classic communication is also orientation work, so where do you and the other person stand? Am I taking this now or is the other person taking this now? We were able to reach these agreements very well." Interview 8-1*

> *"I found the collaboration particularly intense because of the communication, so we talked to each other and I also looked where the other person was and what the person was doing, at least what you could perceive." Interview 3-1*

20.4.2 Task

Another condition influencing the intention to collaborate in VR is the given task that participants are asked to perform. As collaboration requires a task to be performed together (Fleischmann et al., 2020), it seems to be a necessary condition of collaboration in VR. However, the interviews indicated that the task can be both necessary and sufficient, which could be distinguished taking on the identified conditions as a basis.

A necessary condition for collaboration is that the **formulation of the task** requires collaboration. Within the crane assembly process, participants were required to fulfill various tasks. The interviewees noted that some tasks (e.g., inserting the mortar) can only be performed by one user because, for example, only one tool was available. Few tasks in the VR environment did not explicitly ask for collaboration, so participants shared the tasks and worked on them individually, i.e., cooperated.

> *"We checked the tasks and then one of us did the first and the other prepared the next one. So, you knew you weren't alone, but you were doing something together. But when it comes to the task itself, you're working alone, because you can't do it together." Interview 2-2*

> *"We did not collaborate on these simple tasks because the tasks did not require collaboration. I found the tasks where it was desirable that we could do that." Interview 9-2*

Another necessary condition that influences the intention in VR collaboration is the exchange and intentional **transfer of information** between the participants. For crane assembly, this especially includes the exchange about the process. The interviews made clear that an understanding is nevertheless built up through the abstraction of the tasks. Another point is that the simplified but still recognizable progress in mastering the tasks initiates a learning process.

> *"The biggest information gain for me was the whole process. Before, I could only imagine how a crane is built, but now you really know how many steps are involved and how they interlock. I think it's because you've seen the different states as the crane "grows"." Interview 8-2*

> *"I think it's because it's just more descriptive than other learning environments. Because you can abstract well. I realize that I'm not using a screwdriver or really drilling a hole here in VR, but I can still link things well because I know from the real world how a drill works." Interview 8-1*

In this context, the interviewees emphasized that the intention to collaborate can be fostered by a more **realistic design of the tasks**. But different to the formulation of tasks and transfer of information the realistic design is a sufficient condition for collaboration in VR. Since even if the task is not mapped realistically, collaboration can be possible. Some tasks in the assembly process could be performed by one user in the VR environment but would require the collaboration of two service technicians in reality (e.g., carrying the ladder). Instead of working collaboratively as in reality, in the VR environment the participants split up these tasks. By designing the tasks more realistic (e.g., ladder has to be carried by two participants), the intention to collaborate can be promoted, as described by interviewee 2-2 and 5-2.

> *"But you could definitely collaborate more. For example, you could do a few tasks together. [...] You might carry a ladder together because it's heavy." Interview 2-2*

> *"Anyway, there was less collaboration necessary than in real life, starting with the plumb line, for example. In reality, I can't read the plumb line from the ground [...]. That means in real life I have to look at it from above and then have to tell the colleague who is on the ground which screw he should turn." Interview 5-2*

In addition, the interviews indicated that the intention to collaborate is increased if the tasks can be implemented more **efficiently through collaboration**. Interviewee 4-1 and 8-2 stated that even though they could have completed the tasks on their own, they collaborated to save time.

> *"It was also particularly useful to collaborate because it saved time. I don't think we had any tasks that we couldn't have done on our own, but it was a time saver." Interview 4-1*

> *"I think you could do the tasks alone but I think working together is more efficient because you work in a more coordinated way and you support each other in the tasks." Interview 8-2*

Another sufficient condition that influences the intention to collaborate is the **level of difficulty of the task**. Simple tasks were more likely to cause the interviewees to try to fulfill the task on their own, rather than collaborating with their partner. However, when the tasks became more difficult, they started to collaborate and helped each other. In addition, Interviewee 4-1 highlighted that at the beginning of the scenario he wanted to familiarize himself with the environment and started working independently. However, as he was confronted with more complex tasks later, he began to collaborate with his partner.

> *"At the beginning, I tried to familiarize myself with the scenario. First, I tried to solve everything on my own. But when it came to the more difficult tasks, I had to turn to my partner for support." Interview 4-1*

> *"For tasks that were a bit more complex, that were perhaps more challenging, we actually collaborated more closely in order to support each other, to ask each other questions, or to help each other." Interview 9-2*

20.4.3 User

Moreover, the interviews revealed that user attributes are sufficient conditions for collaboration in VR. As they are not necessary like technology as a kind of prerequisite for collaboration, they show an impact on the intention to collaborate that is important to consider, but in a more sufficient manner.

A condition related to the intention to collaborate depends on the **personal acquaintance** of the collaborating partners (Hatzipanayioti et al., 2019). The participants who collaborated in our setting already had known each other, which affected the way they work together. According to the interviewees, the familiar basis compensated for the lack of facial expressions and gestures of the avatars and made it possible to derive non-verbal signals and emotions from the partner's voice and the avatar's body language. The interviewees emphasized that in this way a more personal level of collaboration was achieved.

> *"Well, because you knew who the other person was, it actually supported it. But I would say that if you didn't have any relationship at all, i.e., if anyone would be there, then it would be impersonal because you could not recognize his face." Interview 5-2*

> *"If we hadn't known each other, I don't know if it would have been so personal. Because you can't see the face or emotions, only hear the voice. But this way I found it personal, we could communicate quite normally." Interview 2-2*

The possibility of **perspective taking** in the crane assembly process allowed to help each other with their tasks and thus influenced the intention to collaborate. By taking on each other's tasks (e.g., extending the lifting platform) and giving hints on how to accomplish the task, partners could better understand the process and challenges of each subtask. Taking on another's perspective can thus improve the collaboration process by creating a shared understanding of challenges and allowing partners to work collaboratively on a solution. Additionally, information and knowledge were transferred from reality to VR, for example in the use of tools or in explaining processes and which tool is needed for which task. As a result, the participants collaborated and exchanged knowledge and information.

> *"The most collaborative thing we did was with the lifting platform. I could see a certain angle where it turned green, and he could not. So, I would say that's kind of work where you have to take on the other perspectives to solve a problem." Interview 8-1*

> *"The second participant gave me a lot of advice, both technical and in dealing with it, and without him it would have taken longer, that's for sure." Interview 4-2*

> *"So, I asked the second participant: Where does the screw have to go in now and where I have to attach the flexes? The second participant then gave me the instructions and told me that I have to do this here and there." Interview 1-1*

Additionally, we can add the **transfer of knowledge** between participants as a sufficient condition. Based on the interviews, we have determined that this is a "teacher–pupil" exchange. That is, the knowledge transfer or learning effect between participants occurs when one participant has less knowledge or less experience than the second one. Both participants work on the same task and the experienced participant gives explanatory instructions, which are thus only presented abstractly in VR. Contexts are conveyed and special situations are discussed that have a particularly memorable effect on knowledge transfer. For example, it was explained which task follows the current task and for what reason and how this task can then be processed in collaboration.

> *"If someone tells you what to look for, then that's what you learn. Just like that, based on the information from a manual, I don't think it would have really had that success." Interview 2-1*

> *"I was able to learn a lot in different situations. For example, when the second participant explained to me which tools were used and why. Also, why certain tasks were done in between and where the connection is. The terminology for certain nuts, bolts... I was able to remember some of that." Interview 4-2*

Besides our findings and as described in the method section, the experimental supervisors rated collaboration. Whenever the two participants worked together on a task, this was rated as collaboration. If the collaboration consisted of parallel processing, for example, this was rated as no collaboration. For example, "You take the advice, I take the screw". However, when participants worked together on a task (e.g., both participants drilled the holes at the same time or content questions were discussed and answered among participants), this was scored as collaboration. Thus, it remains to be noted that situations of collaboration between participants occurred in all ten experiments.

20.5 Discussion

The findings allowed us to distinguish between technology, task, and user conditions that influence the intention to collaborate in VR, which were divided into necessary and sufficient condition. Using the example of the identified conditions – communication and perspective taking – we will distinguish them exemplarily into a necessary and a sufficient condition. Communication: In reality, the participants of the collaboration have all possibilities of communicative exchange. In the VR experiment, there is the peculiarity that no facial expressions can be transmitted. The participants in VR only have the possibility to communicate with each other via Voice over IP and with rough hand and head postures. However, this limited form of exchange is necessary to enable collaboration, as the interview excerpts show. Communication as a necessary condition for collaboration is probably also shared in general, but the peculiarity in this VR experiment is that already voice communication with a rough transmission of gestures in VR is enough. Perspective taking: When the perspective of a third party is taken, it becomes clear that the view of the process changes. In reality, as an observer of the process depicted in the experiment, one remains at best an outsider, as there are environmental and injury hazards in carrying out the process, for example. In VR, these hazards do not exist; the participant is in the position of the service worker, without environmental or injury hazards. As the interviews show, perspective-taking worked several times. However, the interviews also show that this is a sufficient condition. There were experiments where objective collaboration was found but perspective taking was not observed in the interview. Since this is a qualitative research, this necessary and sufficient condition cannot be applied to collaboration in general but refer to the intention to collaborate in VR. Regarding our RQ (Which conditions do influence the intention to collaborate in VR?), we identified collaboration-relevant conditions for VR, based on the interviews conducted, and indicated that the intention to collaborate within VR depends on a variety of influences. Besides conditions that arise from the use of VR, such as immersion, there are additional ones that should be considered in theory and practice for future ventures. Table 2 shows a summary of the conditions and an example of each from our research.

Condition			**Example in the VR experiment**
Necessary	Technology	Handling	Intuitive use of VR hardware and VR environment
		Details of environment	Perception of crane assembly
		Design of avatars	Perceiving each other as human
		Immersion	Realistic representation of the assembly scenario
		Communication	Exchange-related tasks
	Task	Formulation of tasks	Allow collaboration
		Transfer of information	Exchange about the assembly process
Sufficient		Realistic design of tasks	Require collaboration
		Efficiency through collaboration	Division of tasks
		Difficulty of the task	Need for collaboration
	User	Personal acquaintance	The participants know each other before
		Perspective taking	Taking on the role of the service technician
		Transfer of knowledge	Exchange of experiences and knowledge

Table 20.3 Conditions Influencing the Intention to Collaborate in VR

Our research contributes to the current state of literature by addressing the demand of further investigation on conditions for collaboration in VR. As a field that has not received much attention so far, our research provides an initial overview of several conditions that influence the intention to collaborate in VR by expanding previous results (Hatzipanayioti et al., 2019;

Mütterlein et al., 2018). Here, it should be noted that the technological conditions in their entirety are necessary conditions in VR. The person-related conditions can also be assigned to the sufficient conditions in their entirety. For the task-related conditions, the distinction is bipartite. While task formulation and transfer of information are considered as necessary conditions, realistic task design, efficient collaboration, and task difficulty are considered as sufficient ones.

This research is one of the first to examine what conditions influence collaboration in VR. The three properties (telepresence, interactivity, and immersion) of VR (Walsh & Pawlowski, 2002; Wohlgenannt et al., 2020) could be addressed in our research. For this, our guideline included questions about user experience with the scenario of a crane assembly. By doing this, we refer to Mütterlein and Hess (2017) and derived our questions from previous findings. For example, we used the question "To what extent could you hide the real environment in the VR scenario?" to ask about the occurrence of telepresence. Based on our findings, we decomposed telepresence (Sanchez-Vives & Slater, 2005) into two components. First, the perceived details of the environment and second, the design of the avatars, i.e., the extent to which the avatars are perceived as human and thus present. Interactivity (Steuer, 1992) can be found in the point handling. Here, it is listed as a necessary condition of the technology that the operation should be as close to reality as possible. So that the interaction is perceived as intuitive. Immersion (Dede et al., 2017; Suh & Lee, 2005) could be identified as such in the technology-related necessary conditions.

Based on the number of conditions, it can be said that VR collaboration is bittersweet. For the sufficient conditions, this is particularly appealing, since not all conditions need to be true at the same time. If one sufficient condition occurs it does not imply that another one must be true to the same degree. Therefore, sufficient conditions should be considered independently of each other. The necessary conditions, however, must be fulfilled for collaboration in a multi-user VR environment to take place at all.

20.5.1 Implications for Theory

Based on our findings, we were able to derive implications for both, theory and practice. For theory, our research extended existing research on multi-user VR solutions (Alghamdi et al., 2016). Our VR scenario allowed both participants to look around and move independently. It also allowed participants to interact with virtual objects and with each other (Jalo et al., 2020). Additionally, we were able to confirm the findings of previous research that multi-user VR is a promising new medium for digital collaboration (Li et al., 2020). All users collaborated objectively and subjectively.

First of all, based on previous research, we were able to further investigate the intention to collaborate in the VR. Hatzipanayioti et al. (2019) looked at interactive collaboration across departments and fields, regardless of physical boundaries. Mütterlein et al. (2018) investigated how immersion influences the users' collaboration intentions by stating additional conditions to enrich current research. Basically, we were able to continue and extend these researches and add an application example. In particular, we addressed the question of how to foster collaboration in multi-user VR and answered it with necessary and sufficient conditions based on our data. Our findings enrich existing literature with an overview of conditions for collaboration in VR and thus complement previous findings (e.g., Hatzipanayioti et al., 2019; Mütterlein et al., 2018). These will enable future research to identify new entry points and further advance research in this field so far only slightly studied. In addition to the reasons already identified in the literature, such as social presence (e.g., intimacy) and immersive realistic interactions, we were able to derive necessary and sufficient conditions.

Apart from the VR literature, findings can provide implications in the field of knowledge transfer. The separation of information and knowledge transfer is consistent with the theory of the knowledge staircase (North et al., 2016). Here it is defined, among other things, that information only becomes knowledge through the addition of experience. We were able to confirm this in our research; we identified the fundamental possibility of information transfer as a necessary condition for VR collaboration. This means that the task must enable information transfer in order for collaboration to occur. However, knowledge transfer is a sufficient condition because user experience is a key contributor here. Only when a subject enriches the information with personal experience, aggregated knowledge could be shared. Thus, it can be concluded that classical approaches, such as the knowledge staircase (North et al., 2016), can also be used in innovative solutions like VR and provide the possibility of further adaptations for theoretical purposes.

20.5.2 Implications for Practice

Virtual collaboration will continue to influence our working world in the future. Our research therefore enables not only a short-term, but also a long-term contribution for practitioners. First, we have shown where previous digital collaboration tools reach their limits (Heldal, 2007; Li et al., 2020; Mütterlein et al., 2018). To overcome these limitations, this and previous research propose the use of collaborative VR technology (e.g., Alghamdi et al., 2016; Heldal, 2007). VR enables more interactive and flexible collaboration than technologies, such as virtual flipcharts or virtual mind maps. Our research provides an overview of the conditions that must be considered when workers collaborate in VR and that the conditions are either necessary or sufficient to an intended collaboration. Technical requirements, such as the most realistic possible representation of the VR environment, enable abstraction from reality. Conditions, such as immersion, should therefore be considered from the outset when designing VR environments. For designers, the representation of the participants must be designed with care in such a way that participants are mutually perceived and verbal and non-verbal communication is enabled.

Task design also has a significant impact on the intention to collaborate in VR. There are simple tasks, such as cutting off screws, that do not invite collaboration, even though they are designed for collaboration. An exception is the situation when this task has to be performed simultaneously and multiple times (e.g., drilling holes). In contrast, more complicated tasks, such as correctly tightening the bolts on the crane, were directly tackled collaboratively by the subjects. For VR developers or VR designers, this means that task difficulty in complexity and temporal scope also plays an important role for VR collaboration.

However, necessary and sufficient conditions are required to foster the intention to collaborate in VR. For practitioners, such as VR developers, our research provides an indication of the minimum conditions that must be met to enable collaboration in VR. The sufficient conditions can then be additionally addressed to foster the intention to collaborate. However, the user conditions do not really depend on the developer, but on the participants. Depending on the goal of VR collaboration, the combination of participants can be influenced. For example, if the goal of VR collaboration is to achieve a formal learning outcome, then it makes sense to use a VR-experienced user as the instructor and an inexperienced user as the student. If problem solving is formulated as the goal, then users with similar levels of experience are advantageous, as they can discuss and try out different approaches together.

20.6 Limitations and Outlook

We conducted a qualitative research to investigate the conditions influencing the intention to collaborate in VR. Here, we were able to identify conditions regarding technology, task, and user level, which could be divided into necessary and sufficient conditions. However, as with every research, this research comes with limitations, which invite future research to build on. This research comes with typical limitations of qualitative studies (e.g., weak internal validation). Apart from those, it is important to acknowledge further limitations: First, it should be emphasized that the findings are based on one exploratory research in which two participants always collaborated. Consequently, there may be other conditions (necessary and sufficient) that influence intent to collaborate, which could not be identified by our data. For example, it would be conceivable to examine the intimacy between the collaborating participants in more detail and, additionally, their baseline trust toward VR technology, which could have affected their collaboration performance. In terms of personal acquaintance, our research was able to order initial approaches, which, however, only partially reveal conclusions about the intimacy of the collaborating participants. We therefore encourage future research to build upon our findings and to validate our findings in further VR scenarios as well as with different amounts of people who collaborate. In addition, future research should focus on randomizing participants based on socio-demographic characteristics, such as age, gender, and professional status, which was not possible in this research due to the case design of the two organizations. This randomization would reduce theoretical bias of socio-demographic characteristics due to the selection of participants. Second, it should be emphasized that both collaborating participants were supported by an experimental supervisor. This became necessary because participants had only been in VR a few times before and the supervisors were objectively observing if collaboration took place. Some of the interviewees mentioned in the interview that this distracted them to some extent: “It was a bit difficult that I was in one room and (name of participant B1) in another; we could talk to each other, but I always talked a lot with you [supervisor 1] and [name of participant B1] a lot with you [supervisor 2] and that was of course a bit difficult. So, because of that, (name of participant B1) and I talked less with each other and rather with you [supervisor 1 and 2].” (Interview 2-2). Therefore, it should be noted that this may have adversely impaired the collaboration process. Future research should therefore ensure that there are no supervisors in their research settings or instruct their supervisors to remain passive during the collaboration process. Third, the conditions identified are based on the respondents’ perceptions and experiment leaders’ observations. The findings do not provide any information if these conditions also objectively increase the intention to collaborate. Future research can build up on the identified conditions and can investigate if these can also objectively foster collaboration. Researchers can build upon our findings and explore how specific conditions influence the intention to collaboration in detail. Furthermore, one could examine if and how the different conditions influence each other. Finally, another interesting aspect could be a consideration of variously designed tasks. In our research, tasks in VR are predominantly physical tasks. The conditions for successful collaboration could be different when it comes to immaterial tasks. Future research could therefore investigate the extent to which the physicality of tasks is a decisive factor for the conditions for collaboration in VR.

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21 Keep an Eye on CAD in VR (P15)

Paper Number	**P15**
Title	**Keep an Eye on CAD in VR: Toward a Theory of Behavior Change**
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Table 21.1 Fact Sheet Publication

Keep an Eye on CAD in VR: Toward a Theory of Behavior Change

Abstract. Immersive virtual reality (VR) is being used by organizations as part of the digital transformation to innovate and optimize their work processes. To unlock the potential of VR technology in computer aided design (CAD) work processes an experimental case study was conducted. Based on dual process theory by Strack and Deutsch (2004), a research model was developed by adding environmental congruence and perspective taking to investigate whether various manifestations of VR influence the behavior of design decisions. For the experiment, data was collected from 97 participants of two German organizations. Participants processed two different VR environments with different characteristics of the environmental design. Here, a distinction was made between an abstract environment (i.e., white room) and an environment that mimics reality (i.e., harbor). In order to test the hypotheses of the research model, a self-assessment survey was conducted. While items rely on previous research, the measurement of environmental congruence was self-developed. In addition, eye-tracking was used for objective measurement for participants' perception of the VR environment. A multilinear regression was performed to examine hypotheses. Results showed significant effects on behavioral change regarding environmental congruence, perspective taking, and both systems of the dual process theory. Hence, this study makes a valuable contribution to the research field by testing the explanatory power of three theoretical approaches by proposing a unified theory of behavior change in a VR setting and provides fruitful points of references for further investigations.

Keywords: Dual process theory, environmental congruence, perspective taking, VR, eye-tracking, CAD

21.1 Introduction

The introduction of new technologies such as immersive virtual reality (VR) is being used by organizations to innovate and optimize their work processes in the context of digital transformation (Jalo et al., 2022). Virtual worlds are understood either as a medium, as a place, or as an extension of reality, while it influences the expectations of the functions of virtual worlds and thus the purpose of their use (Scavarelli et al., 2021). For processes, the use of VR training scenarios is a widespread application of digital transformation (Bhagat et al., 2016; Koutitas et al., 2021). For instance, work processes such as assembly and maintenance processes can be simulated through VR training scenarios (de Oliveira et al., 2020). Beyond that, the use for evaluation in computer-aided design (CAD) work processes is already being practiced and theoretically explored (Bellalouna, 2020; Feeman et al., 2018). The advantage of using VR in contrast to conventional three-dimensional (3D) desktop visualization is the ability to view the model and its environment, which can additionally be mapped to real-world conditions (e.g., realistic dimensions of the factory hall). Research has shown that errors during the evaluation of 3D models are detected more quickly when using VR technologies (Fernández & Alonso, 2015). If additional departments that are not directly involved in CAD design (e.g., maintenance service, sales) are also involved in the evaluation process, errors can be identified at an early stage and thus avoided (Wolfartsberger, 2019). Observation in a VR environment allows the user to take the simulated perspective and thus evaluate the simulated facts. In the best case, this leads to a reflection, which in turn results in adjustments of the model (Weigel et al., 2020).

For the design process of industrial machinery (e.g., cranes) it is important to evaluate it conscientiously to counter problems during the assembly process. The design, as a previous step of the assembly, has to consider all contingencies of the assembly site (e.g., inaccessibility, conflicts with other components) to allow a smooth assembly. For this reason, perspective taking, and reflection are crucial for the design process during the CAD modelling because design decisions regarding the machinery or single parts can be changed without incurring large costs. Due to the simulation in a virtual environment, this gets possible. While perspective taking enables people to examine issues from a different angle and thus generate a deeper understanding (Goldstein et al., 2014), reflection is based on distinct thought processes. The dual process theory by Strack and Deutsch distinguishes between decisions that require reflection of different information (i.e., reflective system) and decisions that arise spontaneously based on existing schemata (i.e., impulsive system) (Strack & Deutsch, 2004). For evaluating industrial machines, a reflective decision on the design and the inclusion of all required information (e.g., position within the industrial environment) (i.e., reflective system) is necessary, rather than a standardized design in which the type of construction is based on certain schemes (i.e., impulsive system). However, for the dual process theory, both systems influence the behavior independently and are processed in parallel. As VR supports the designer with additional information (e.g., the environment), it can be assumed that VR technologies encourage designers to think more reflectively about their constructions, and consequently their decision-making process about a design is influenced.

To be able to use the evaluation possibilities of VR technology in the CAD work process, it is necessary to first examine these in detail (Feeman et al., 2018). To elicit a change in design through VR, factors must be identified, that, in theory, may influence behavior change. One factor can be the construct of environmental congruence, which describes whether the expectations a person has of the VR environment are met by the VR environment and fit within the context of the design. Another factor can be perspective taking (Davis, 1980, 1983), comprising the effects when an individual in VR encounters the simulated perspective of a third party. To this end, the reflective system must also be examined as part of the dual process theory (Strack & Deutsch, 2004) when addressing behavior change, as reflection is how behavior change occurs. All of these theories can be explored subjectively in VR through a survey. In addition, combined with other technologies such as eye tracking, new objective insights can be gained. Eye-tracking can help to explore the factors influencing the user's objective perception of the VR environment, which can affect and guide design decisions within VR simulations.

In order to examine the potential impact of CAD evaluation in VR on designers' behavior change in relation to their design, a research model is developed to measure the impact based on dual process theory (Strack & Deutsch, 2004). In this regard, the following research question (RQ) is addressed:

RQ: How can objectively useful behavior change in CAD be promoted through the use of VR?

To answer the RQ, this research is organized as follows: First, we review the literature on VR, the dual process theory, perspective taking, and environmental congruence. Based on this, we establish a research model and formulate hypotheses. Third, we present our methodological approach to test the hypotheses experimentally. Fourth, we point out and discuss the results of our research. Finally, we reflect on our results, derive implications for theory and practice, point out limitations of our research, and suggest directions for future research.

21.2 Theoretical Background

21.2.1 VR

VR is characterized by its virtualization of space and its objects. Defined as “a computer-generated, interactive, 3D environment in which people become immersed” (Suh & Lee, 2005, p. 675), VR technologies enable users to isolate themselves from the physical world. The extent to which users are isolated depends on telepresence, interactivity, and immersion (Mütterlein, 2018) making VR usage tangible. Immersion describes the degree of isolation in which users of a VR perceive the world and its objects and regulates the isolation from the physical world, as an "experience of feeling a loss of time, high concentration and total involvement" (Winkler et al., 2020, p. 1511). Depending on the technology the level of immersive experience varies.

The tangibility of a VR experience can be defined by three attributes of VR technology: First, telepresence is a subjective feeling, acquired by VR usage, of being in a virtual environment or world, which is different from the physical one (Mütterlein et al., 2018; Sanchez-Vives & Slater, 2005). Second, interactivity relates to "the degree to which users of a medium can influence the form or content of the mediated environment" (Steuer, 1992, p. 80). And third, immersion as "the degree to which an individual accepts that a virtual world is real" (Scavarelli et al., 2021, p. 3). Immersive VR allows interaction with and within a virtual space. For this, cave automatic virtual environments (CAVE) or head-mounted displays (HMD) are used to surround a user with an enclosed virtual space (Mills & Noyes, 1999).

VR offers great potential for application in different industrial contexts resulting in time and cost savings and increased development quality (Lawson et al., 2016) or sustainable enrichment of the product development cycle (He, 2019). For instance, training simulations of assembly or maintenance processes (e.g., de Oliveira et al., 2020) are, in contrast to real process executions, an efficient way to support and train technical staff in their work. In addition, safety-relevant aspects (e.g., areas of occupational safety) in training can be avoided because workers are not exposed to real danger (e.g., working on operating machines or high-altitude work) by using the simulations and the experience in VR (Bellanca et al., 2019).

Due to the virtualization of products VR can be used as an extension of CAD modeling. The use of VR allows designers and design-related employees the virtual experience of product models in a digitally created world. In contrast with CAD modeling, when the model is merely displayed in a neutral environment in the visual form of a white room, the use of VR technology allows viewing the model in a virtual space that mimics a real environment (Dangelmaier et al., 2005). This kind of extension of CAD modeling is already applied in organizations and theoretically investigated in research (Corseuil et al., 2004; Whyte et al., 2000; Ye et al., 2006). Using VR enables employees to take a perspective (Weigel et al., 2020) that CAD cannot depict. By simulating an environment related to reality, properties (e.g., size ratios) and complications (e.g., interfering edges with the environment) of the product can be visualized.

This provides designers with an insight into, for example, downstream processes (e.g., maintenance of the product), which can then be considered during the design process.

Using eye-tracking in VR is comparatively new to conventional ways of tracking eye movements (Clay et al., 2019; Pastel et al., 2021). For virtual spaces, eye-tracking provides new insights into human behavior (Howie & Gilardi, 2021; e.g., Pfeiffer et al., 2020). Clay et al. (2019) argue that the combination of both, VR and eye-tracking allows “unprecedented monitoring and control of human behavior in semi-realistic conditions” (Clay et al., 2019), which indicates promising investigative potential. Although eye-tracking makes it possible to measure attention (Yoshimura et al., 2019), the perception of the environment and the consideration of objects (e.g., regions of interest) in virtual spaces, the recording of eye movements in 3D space remains underutilized with e-commerce as an exception. There, studies use the eye-tracking feature to investigate why and whether customers would adopt immersive shopping experiences (Peukert et al., 2019). However, initial approaches are also emerging for the industrial context, for example, by integrating eye-tracking into maintenance processes in virtual spaces (Schlechtinger, 2020; Walsh & Pawlowski, 2002).

21.2.2 Dual Process Theory

Dual process theories represent a foundation for explaining the emergence of thought processes. It is assumed that in decision-making processes or in solving problems, individual intuition plays a central role. Thus, it may occasionally happen that people spontaneously do things without being able to name a reason for it. An example of this might be the temptation to buy the latest iPhone, even though one has resolved to save one's money. Research has also shown that problem solving can occur when people are not directly concerned with it in their minds. Both indicate that when decisions are made (e.g., for behavior) or problems are solved, thought processes run in the background, which are unconscious to the person. Dual process theories distinguish two processes and explain how thoughts arise and how behavior is influenced by them.

The dual process theory formulated by Strack and Deutsch (2004) explains human behavior in terms of a reflective and impulsive system. Contrary to the view that human behavior is oriented toward doing what is good for oneself, reality shows that values and attitudes (e.g., social responsibility) influence behavior as well. From this, it is evident that behavior is determined by an interplay of automatic, rapid, and unconscious processes (i.e., impulsive system) as well as controlled and conscious processes (i.e., reflective system). Similar to

Kahneman & Frederick (2002), Strack and Deutsch (2004) assume that both systems are active at the same time and run in parallel, rather than being activated alternately in sequence. To illustrate this, we can refer to the example of the temptation to buy a new iPhone. Seeing the iPhone in the store activates the impulsive behavioral schema with the goal of buying the device. At the same time, the reflective system makes the behavioral decision not to buy the device, based on the previously made decision to save money. However, which system ultimately runs in the foreground and triggers the decision is unclear. Thus, the impulsive, as well as the reflective system, can be responsible for making a behavioral decision.

Reflective and impulsive systems differ in the way decisions are made and their influence on subsequent behavior. The reflective system makes behavioral decisions based on existing knowledge about values and facts. Impressions and information resulting from the environment situationally are processed, whereby "behavior is elicited as a consequence of a decision process" (Strack & Deutsch, 2004, p. 222). Thus, the reflective system revolves around facts generated from the environment and causes the individual to reflect by linking existing knowledge to current input, thus avoiding habitual or standardized behavior. Behavioral decisions according to the impulsive system, on the other hand, are based on learned ideas corresponding to an issue and the behavior that accompanies them. Decisions are made based on schemata, resulting in an automated and rapid response that does not require reflection.

21.2.3 Perspective taking

Perspective taking is the attempt to enable a person to take the perspective of another person (Boland Jr. & Tenkasi, 1995). The psychological concept of perspective taking (Davis, 1980, 1983) is frequently used in technology-related contexts (e.g., Dickey et al., 2007; Ryokai et al., 2022). The purely psychological perspective taking was applied through instructions such as "Imagine yourself in the other person's position [...]". Innovative technologies such as VR offer the possibility to put a person in the simulated position of another person. For product development, increased customer and user orientation can be addressed by adopting their perspectives, which in turn can have a positive effect on the design of new products (Salomo et al., 2003).

Technology-supported perspective taking through VR can be a key technology for putting one in another person's shoes and being confronted with their views or challenges. This is accompanied by the challenge that the perspective taker and the simulated perspective draw on a different body of knowledge. The seemingly easier availability of the simulated perspective through VR and the interpretations that accompany it can lead to an overestimation of the likelihood that the perspective will be shared by others (Ross et al., 1977; Weigel et al., 2020). Other challenges may arise, for instance, when the concerns and intentions of the simulated perspective are hidden and its complexity is underestimated (Boland Jr. & Tenkasi, 1995). Creating and sharing representations of one's own knowledge and understanding allows others to better anticipate the different types of knowledge and capabilities as they seek to develop or improve products. The diversity of knowledge must be explicitly emphasized, and perspectives must be sufficiently differentiated and distinguished. In the past, most technology solutions were text-based, so they relied on the mental adoption of perspectives.

Nowadays, people can rely on innovative technologies as VR to place themselves in the perspective of others. However, research on the use of VR for technology-supported perspective taking is limited. In particular, emerging technologies such as VR offer the opportunity of simulating perspective taking (Jestice, 2016; Weigel et al., 2020). Based on the literature it is unclear whether increased levels of perspective taking have the potential to influence behavioral change/decision making.

21.2.4 Environmental Congruence

With its origin in vocational psychology and person-environment psychology, environmental congruence “means that an individual’s personality type corresponds with that of the majority (dominant type) of persons within his or her environment” (Spokane et al., 2000, p. 141). Here, the definition relies on the person-environment fit (i.e., congruence) (Spokane et al., 2000). This is primarily concerned with the individual per se (e.g., satisfaction) and the influence of the surrounding ones (i.e., person-environment). Fewer are concerned with shaping the environment, i.e., the influence of the environment on the individual (e.g., decision making). For instance, according to psychology, a good congruence exists when personal desires or needs coincide with supplies or rewards.

External conditions can support in developing a more comprehensive understanding of products. For retail, environmental congruence is a major factor (Berger & Fitzsimons, 2008; Naderi et al., 2020). Positive associations with products are created based on the shopping environment, with the result that a positive evaluation of the products encourages people to purchase them. In general, environmental congruence describes “the degree of match between visual design elements in a product and those in its environment” (Naderi et al., 2020, p. 940). As “high levels of cognitive fit between perceptions of the environment […] and those of the product in a consumer's mind" (Naderi et al., 2020, p. 940), environmental congruence is responsible for the influence of the shopping environment on consumer behavior as well as the purchase willingness.

Within VR usage environmental congruence is still an almost new research angle. Preliminary approaches show, for example, how learning performance can be positively influenced by environmental congruence (Jahn et al., 2018). Compared to an environment of immersive VR, which is not related to the learning context, presenting contextual information in the environment benefits the learning performance. Additionally, research shows that VR is much closer to real circumstances than two-dimensional (2D) screens. Perceiving an immersive experience enables individuals to "form a better and more complete understanding" (Naderi et al., 2020, p. 949) of environments and their objects. Other research has shown that the perception of objects presented in a congruent environment is positive for individuals' behavior (Berger & Fitzsimons, 2008). This suggests that matching the presentation of the environment with objects that fit into the environment influences how objects are perceived and are compatible with one's beliefs. Therefore, we define environmental congruence in VR as the congruence of the virtualization of objects within a virtual environment with the representation of an object in a real environment. In this case, we define high environmental congruence when the mental expectation of the object's appearance matches the perceived representation in VR.

21.3 Research Model and Hypotheses

21.3.1 Research Model

The motivation for this study is to investigate whether environmental congruence, perspective taking, and the reflective system can be addressed through VR technology in such a way that a desired change in behavior / decision quality occurs according to objective criteria. To this end, a research model was developed. The aim is to identify points of contact in the existing literature that have the potential to elicit objectively desired behavior change. In this study, this objectively desired behavior change relates to a decision that with the use of VR and its situational simulation of the environment influences the decision quality. To this end, the constructs of behavioral change / decision quality (Morgeson & Humphrey, 2006; Ogden et al., 2007), environmental congruence, perspective taking (Davis, 1980, 1983), and the reflective system (Strack & Deutsch, 2004) were used whose definition and previous use are described below. Based on this main hypothesis, this study developed the following research model (Fig. 21.1).

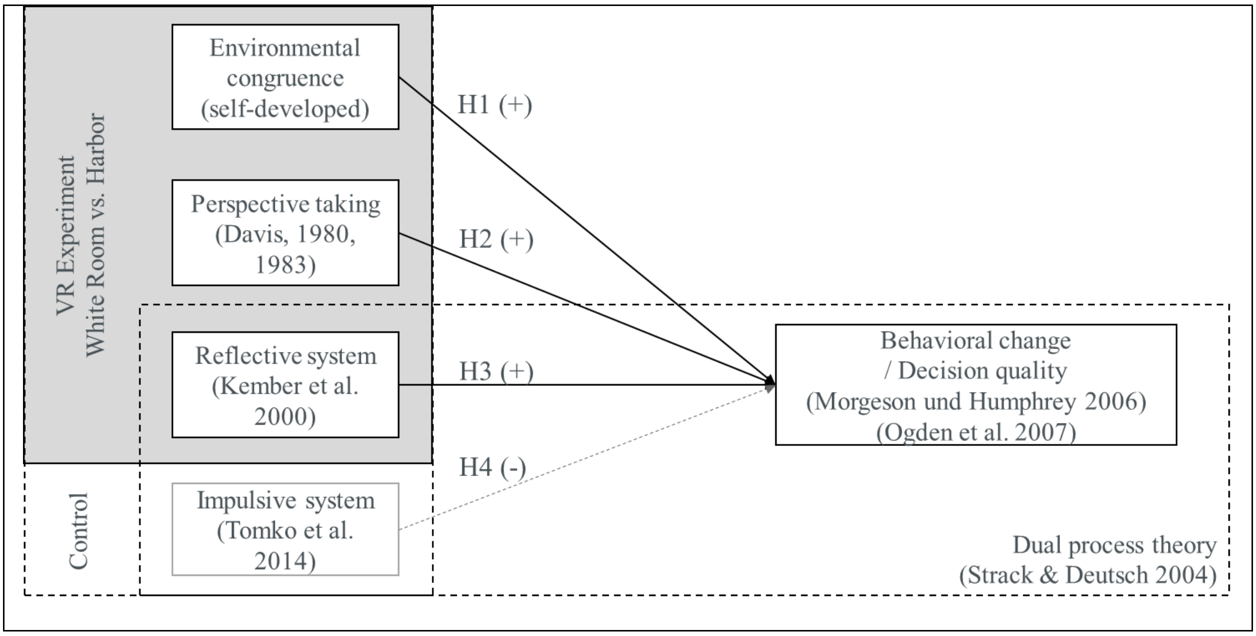

Figure 21.1 Research Model

21.3.2 Research Hypotheses Development

21.3.2.1 Environmental Congruence

Generally, good congruence is achieved when personal desires or needs match the offer or reward (Downey et al., 1975). Thus, when transferred to the simulation of an environment in VR, an environment that is congruent with the user's expectations can lead to good congruence. The relationship between congruence and learning in VR has already been studied (Naderi et al., 2020). In relation to this research, it can be assumed that a higher congruence can contribute to a better understanding of contexts and properties. Hereby, an objectively better behavior change should be caused by a decision.

H1: Environmental congruence will have a positive effect on the behavioral change / decision quality.

21.3.2.2 Perspective Taking

Perspective taking describes the ability to put oneself in the thoughts, feelings, and spatial perspective of another person (Erle & Topolinski, 2015). VR allows users to experience situations from a different perspective (Herrera et al., 2018). VR visualization allows people to experience challenges by taking another person's perspective. The experiences people have when they take on another person's perspective are often novel. Such experiences can significantly influence individuals' decisions (Lee et al., 2018). However, traditional perspective taking reaches its limits when specific knowledge (e.g., knowledge about the process sequence) about the perspective taken is lacking. Perspective taking in immersive VR creates the opportunity to represent and experience the shaping of specific environmental conditions and constructs. A particular advantage of perspective taking with VR is that the user can focus entirely on acting and reacting in the VR experience. People do not have to invest mental resources to shape specific environments or situations because they are already defined and presented in advance.

H2: Perspective taking will have a positive effect on the behavioral change / decision quality.

21.3.2.3 Reflective and Impulsive System

Reflective and impulsive systems denote two different types of behavior. On the one hand, the reflective system makes decisions and resulting actions consciously. Existing knowledge is accessed and processed in conjunction with incoming situational information. On the other hand, acting according to the impulsive system results from a decision made spontaneously. Here, actions are based on existing experiences and behaviors that are not changed for the respective context (Kwasnicka et al., 2016). Considering the dual process theory according to Strack and Deutsch (2004) by breaking it down into two systems, it can be simplified that activating the systems results in behavior that is either a reflection of the circumstances (e.g., "How could I do something better.") or no reflection (e.g., "That's how I've always done it."). Whether and how information is processed and reflected affects behavior based on the intensity of engagement with the environment. By triggering the reflective system, decisions can change and have a positive effect on behaviors. By contrast, if the impulsive system is triggered, decisions are made according to a known pattern. Following the assumption of the dual process theory and its system-related influence on behavior we hypothesize that:

H3: The reflective system will have a positive effect on behavioral change / decision quality.

H4: The impulsive system will have a negative effect on behavioral change / decision quality. (control)

21.4 Method

21.4.1 Case Design

For our research, we refer to a research project that investigates how VR can be used in the industrial context. Including two organizations the focus is on the transfer of competencies and aligning processes between both organizations. To implement the research design, we surveyed employees of a group of organizations consisting of a manufacturing organization and a service organization. While the manufacturing part is responsible for designing and partly building cranes, the service one is responsible for the assembly and maintenance of the cranes. For the experiment, participants were selected regardless of age and gender. All participants were drawn from a group of employees of both organizations who are into the mentioned processes. The purpose of this experiment was to test how perception changes in different environments and therefore influences behavior. Eye-tracking was used to track which part of the VR scenario participants focused on visually. Attention was paid to whether and which objects were looked at and for how long. In order to be able to say whether the behavior change occurs, it was important to observe whether the objects necessary for the behavior change were perceived at all.

The experimental setting was conducted as follows: First, participants were presented with an introductory text regarding the experimental context and got introduced to the use of the VR (e.g., movement controlling). Second, the HMD had to be calibrated for each participant, as eye-tracking was used as a perceptual control in VR. Third, participants had to perform two different scenarios (i.e., a white room and a harbor environment) whereby the order was randomly selected for each participant. Thus, participants started with either the white room or harbor environment and then switched to the other one. Both scenarios presented the same crane in a different environment. The white room (c.f., Fig. 21.2) corresponds to a CAD environment, neutral and unrelated to reality. The harbor mimics reality and shows the crane in an environment sensed to the reality in which the crane is used. In the scenarios, the participants could only view the environment and the object crane. Interaction was only possible by changing the position and thus the viewing angle. This was to keep the conditions between the individual experiments as equal as possible.

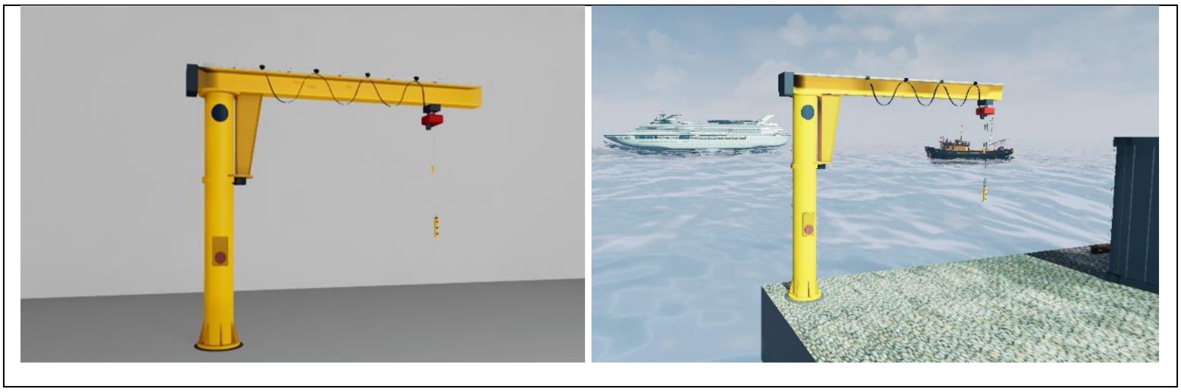

Figure 21.2 Screenshot of the White Room (Left) and the Harbor Environment (Right)

For each scenario, participants had 2 minutes to explore the crane and its environment. The position of the switch box was selected for measuring the behavior and the decision quality. This was positioned in such a way that, for example, maintenance of the crane is not optimally possible depending on the environment. While in the neutral white environment the position is not meaningful, the harbor environment shows deficits due to the positioning of the crane. In addition, the participants' field of view was recorded using a screen recording for tracking their eye movements. Directly following the VR experiment, participants were instructed to answer a questionnaire to test our hypothesis with corresponding items. For the whole experiment, participants were in a quiet room and the VR usage was supervised by two researchers.

21.4.2 Demographic Data

We collected data from 97 participants which were recruited from two German organizations, which are organizational separated but deal with the same product portfolio including cranes for the industrial context. Among the participants, 32,99% were female and 67,01% were male, which approximately corresponds to the ratio of men and women in the industrial sector in Germany. Participants were between 17 and 60 years old. The average age was 37,08 years (SD = 12,25). The majority (78,35%) works full-time, whereas the job experience ranges from 0 to 45 years with an average of 15,77 years (SD = 12,72).

21.4.3 Manipulation Checks

For our experimental treatments, we conducted different manipulation checks in our post-experiment survey. First, two general items that address the experimental setting were included. For “During the experiment, I considered a crane in two different environments”, one participant answered “Disagree” and for “How many ships have you seen within the harbor environment?” one participant answered six ships, which differed greatly from the actual number of ships (i.e., 3 ships). Second, we implemented a yellow rubber duck in both environments and asked participants which type of figure they saw ("Which of the following figures have you seen within the white room?", "Which of the following figures have you seen within the harbor environment?"). One participant answered "Red Bear" for both environments. If participants indicated that they saw no figure this was checked based on the screen recordings. As a result, we indicated if participants do not recognize the rubber duck, regarding the questionnaire, the focus of perception was on the crane and its immediate environment. For example, in the harbor environment ships on the water were implemented in the front field of view, while the rubber duck was in the back. Thus, for recognition, participants had to turn around and move in the environment. Third, an item regarding participants' honesty ("How honestly did you answer the survey questions?") was included. Two participants indicated that they had answered the questions "Very dishonestly". Additionally, for our manipulation checks, two researchers screened the dataset independently regarding patterns in response structure. Thus, we had to exclude six more participants from our dataset, totaling in eleven exclusions. In total 86 participants were used for data evaluation.

21.4.4 Measurement

In order to identify the relationships of our research model and examine the hypotheses, a self-report measurement was obtained by means of a survey. Except for the items of environmental congruence that were self-developed, items were adapted from previously validated scales and adjusted to the experimental setting to ensure construct validity; items are listed in appendix. All items were measured on a 7-point-Likert scale. We developed the six items of environmental congruence by ourselves referring to research on Jahn et al. (2018). Based on prior research (e.g., Grant & Berry, 2011; Kamdar et al., 2006), we used the established scale by Davis (1980, 1983) to measure perspective taking. The reflective system was measured by adapting the four reflective system variables by Kember et al. (2000): habitual action, understanding, reflection, and critical reflection. The four items concerning the impulsive system were used from Tomko et al. (2014). For the behavioral change scale, four items were included, based on the measurement of decision-making autonomy (Morgeson & Humphrey, 2006) and success (Ogden et al., 2007). Along with the measurement items, demographic measures for age, gender, education level, employment, profession, and job experience were included.

In addition, eye-tracking was used as a control condition. It allowed us to track the perception of the white room and harbor environment as well as the participants' focus. Eye-tracking was conducted by the tracking system of the HTC VIVE Pro Eye and realized by the software SRanipal. Eye movements were analyzed using a screen recording of the participant´s field of view. Each eye movement and also the gaze were invisible to the participant, but visible to the researcher and on the screen recording. The size and color of the "circles", represent the gaze and become more intense (green to yellow to red) or larger the longer the participant looks at a certain space (e.g., crane part or environmental detail). In addition, the time of each gaze point is displayed in the upper left corner. (c.f., Fig. 3)

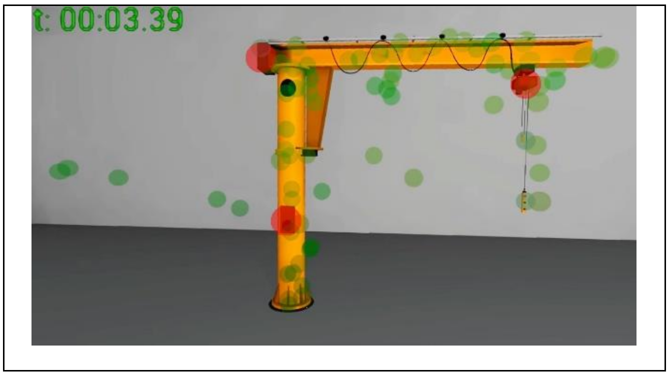

Figure 21.3 Screenshot of the Eye-Tracking Summary

21.5 Results

For the measurement, the items were checked regarding their reliability. In this research, we follow the approach of Hair (2009). According to this, a cronbach's alpha value above .600 is acceptable for the reliability of the items in our exploratory research setting (e.g., Gallais et al., 2017; MacCallum et al., 1994; Ramli, 2019). Initially, all items of the constructs were checked. Environmental congruence (α = .898), perspective taking (α = .592), the reflective system (α = .726), the impulsive system (α = .640), and behavior change (α = .653) were examined in more detail to possible increase the reliability. To increase internal consistency, we considered whether items of the constructs could be excluded. Therefore, we remove the items IS2 and IS3 for impulsive system, which yield in α = .700, as well as the items PT4 and PT5 for perspective taking, yielding in α = .739. As we had to translate the items it became apparent that the excluded items may have been translated misleadingly, further justifying the exclusion of these items from the results. After exclusion, the values for cronbach's alpha showed good internal consistency. Evaluation of the demographic measures of age, gender, education level, employment, occupation, and work experience as control variables was included but did not reveal any significant influences. Therefore, it is not necessary to explore this point further in this research.

To review the data according to the constructs we conducted a correlation analysis. Table 21.2 provides the correlations between all constructs. We found that behavioral change was significantly related with environmental congruence ($p < .01$), perspective taking ($p < .001$), the reflective system ($p < .001$), and the impulsive system ($p < .05$). In addition, we found a significant relatedness between perspective taking and environmental congruence ($p < .05$) and between perspective taking and the reflective system ($p < .01$).

Variable	**EC**	**PT**	**RS**	**IS**	**BC**
EC	-				
PT	0.273*	-			
RS	0.024	0.292**	-		
IS	-0.112	-0.107	0.024	-	
BC	0.298**	0.395**	0.398***	-0.260*	-
Notes: EC: environmental congruence; PT: perspective taking; RS: reflective system; IS: impulsive system; BC: behavioral change * p < .05, ** p < .01, *** p < .001					

Table 21.2 Correlation Table

To test our hypothesis a multilinear regression was conducted. Thereby, we followed the Gauss-Markov assumptions. Thus, we checked the data: 1) for linearity of the dependent variable and the independent variables; 2) for using a random sample for the hypothesis testing; 3) for the expected value, whether the error value is 0 for each of the independent variables' values; 4) for inconsistencies of the independent variables' values; and 5) with the Breusch-Pagan test for homoscedasticity ($p = .32$). In addition, data were checked for autocorrelation between the residuals with the Durbin-Watson test (= 1.932), for normal distribution (also in line with the Breusch-Pagan test), and for multicollinearity with the variance inflation factor (VIF). After the conditions were satisfactory, statistical significance was checked.

According to Cohen (1988) our overall model indicated a high goodness-of-fit with a R2 of 0.338 and an adjusted R2 of 0.306. For the multiple-linear-regression analysis we checked the regression coefficients (beta-value) and t-values for each regression coefficient. The values for environmental congruence ($t = 2.179$, $p < .05$), perspective taking ($t = 2.203$, $p < .05$), the reflective system ($t = 3.532$, $p < .001$), and the impulsive system ($t = -2.426$, $p < .05$) show a significant effect on behavioral change. Therefore, we were able to provide support for all hypotheses (i.e., H1, H2, H3, H4). With $F(4, 81) = 10.357$, $p < .001$ we were able to statistical significant predict behavioral change by environmental congruence, perspective taking, the reflective system, and the impulsive system. While environmental congruence (ß = .206), perspective taking (ß = .218), and the reflective system (ß = .335) show a positive effect on behavioral change, the impulsive system (ß = -.222) shows a negative effect (c.f., Fig. 21.3).

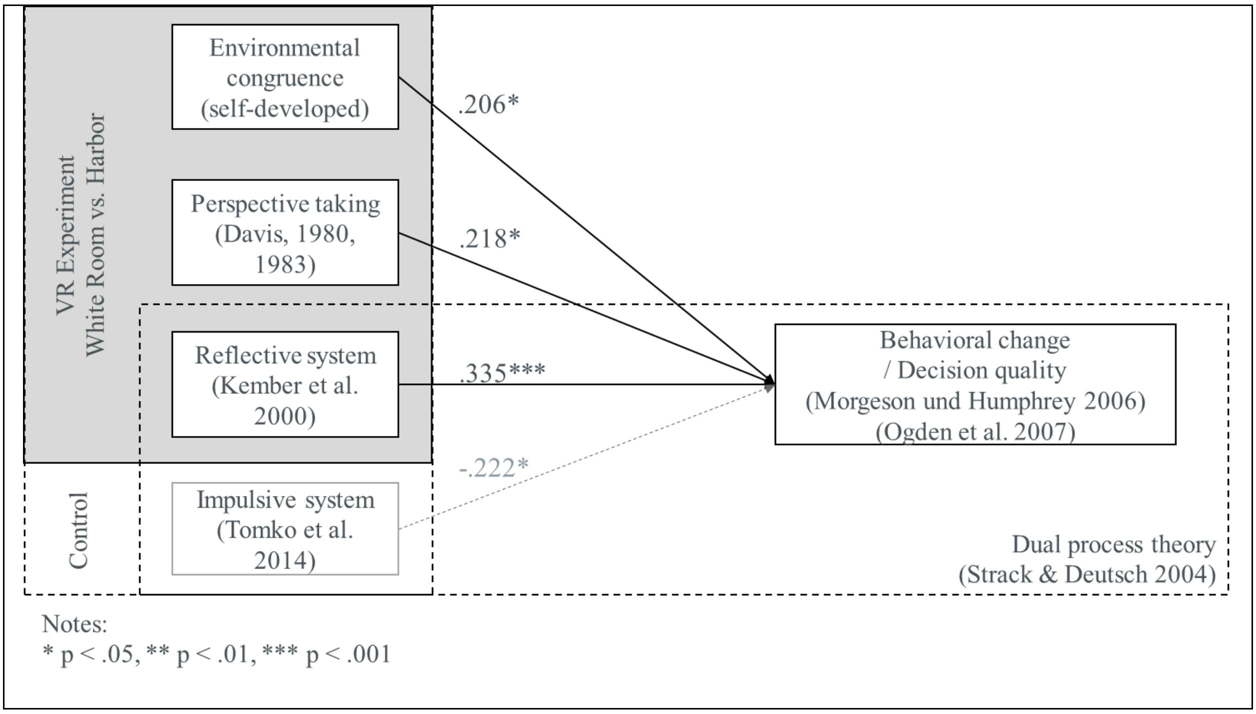

Figure 21.4 Results of Research Hypotheses

21.6 Discussion

The objective of our research was to develop and test a research model on promoting behavioral change / decision quality in VR. Drawing on previous literature, we used environmental congruence (Downey et al., 1975), perspective taking (Davis, 1980, 1983), and the dual process theory (Strack & Deutsch, 2004) to provide a research model to investigate the influence on behavior within a VR setting. Therefore, an experiment was conducted in which the participants were asked to observe a crane in two environments. While one scenario (i.e., white room) reflects a CAD environment that is neutral and contextless in its appearance and reflects construction context, the second scenario (i.e., harbor) shows an environment modeled on reality and thus an environment in which a crane is in fact used. To empirically test our model, we used data from 86 workers of two organizations. As hypothesized, we found significant relations between the independent variables and the dependent one. Using environmental congruence and perspective taking, we found a positive significant effect on behavioral change. Moreover, as expected, we found that both systems of the dual process theory by Strack and

Deutsch (2004) affect behavioral change. Interestingly, both systems show different effects. While the reflective system shows a significant positive effect on behavioral change, the impulsive system shows a negative effect. This supports our assumption that engagement with the environment requires more reflective thinking in order to positively influence behavior. Overall, our results provide empirical support for the influence on behavioral change due to the different variables for a VR setting offering a fruitful avenue for further investigations.

The change of environment reveals itself as an interesting observation criterion for human perception. Especially by using VR, a change of environment for viewing products or machines (e.g., cranes) can be implemented comparatively simple. For organizations, where for example manufacturing and service are separated, as in our case, the congruence of the environment with the product (i.e., cranes) offers the advantage to take a closer and more detailed look regarding its application area. The environment mimicking reality makes it possible to identify interfering edges in advance of production and to take them into account within the design process (i.e., behavioral change in design opportunities). Our research has shown that environmental congruence has a positive effect on behavior. Moreover, the significant correlation between environmental congruence and perspective taking ($r = .273$, $p < .05$) shows that the congruence of the environment with the product acts positively for perspective taking. Another significant correlation between perspective taking and reflective system ($r = .292$, $p < .01$) shows that the more another's perspective is taken, the more reflection is stimulated.

21.6.1 Implications for Theory

The previous measurement of environmental congruence was expanded through our research. We identified that environmental congruence can be applied in the context of VR application. That it is applied can be seen, for example, in the context of commerce (Naderi et al., 2020). However, while this is purely about the presentation of the product, our research presents a measurement that examines the congruence between the actual real-world presentation and representation in VR. Thus, our research draws on previous efforts to measure environmental congruence. For this purpose, we developed six items that have a good items reliability ($a = .898$) to be able to measure environmental congruence in VR. This serves to provide a measurement tool to investigate further research of environmental congruence and as an initial basis for the formation of an environmental congruence theory for a VR setting.

Previous research has only been able to provide circumstantial evidence of perspective taking based on qualitative studies (e.g., Jestice, 2016; Weigel et al., 2020). Based on the results of this experiment, it can be shown that the adoption of a different perspective through VR was successful. This ties in with previous research and extends previous findings, which have often been related to product development rather than service activities (Salomo et al., 2003). Moreover, the experiment conducted allowed us to transfer the more social science quantitative research on perspective taking to business information systems (Herrera et al., 2018). By incorporating perspective taking into the VR context, we were able to show that perspective taking can also be quantified in VR. From this, it can be inferred for theory that perspective taking in virtual realities has an effect to be explored.

This research shows that the dual process theory (Strack & Deutsch, 2004) can be addressed with VR. The reflective systems can be significantly affected by the VR experiment, showing that VR promotes reflective behavior. At the same time, the impulsive system was implicitly addressed, which transfers Kahneman & Frederick's (2002) research to the context of VR. Moreover, acting according to the impulsive system, which emerges from a spontaneous decision, could be negatively influenced by a strengthened reflexive system (Kwasnicka et al., 2016). This is the basis for reconsidering impulsive actions (e.g., “we have always done it this way”) without completely discarding the impulsive action. In terms of behavior change and decision quality, the study supports the hypotheses derived from the theory (Strack & Deutsch, 2004).

Behavior change in a VR environment is influenced by factors that arise from the use of a VR. Assuming the dual process theory by Strack and Deutsch (2004), decisions and the resulting behavior are influenced by two systems operating in parallel but influencing the behavior differently. By using a virtual space, we were able to incorporate environmental congruence and perspective taking into the decision-making process. Thus, we were able to extend the theory and contribute to a closer understanding of behavioral change. By means of VR, environmental congruence and perspective taking could be visualized appropriately and have a positive effect on behavior alongside the reflective system. Our example demonstrates that by incorporating innovative technologies, theories can be examined in a new light and opportunities for further exploration emerge. Our research contributes to the existing theory of examining dual process theory by incorporating new constructs and using them as a basis for further research. Significant results underpin that the theory can be extended and serve as a basis for further investigation in the future.

21.6.2 Implications for Practice

For practical purposes, this study shows that it can be worthwhile for designers or design-related employees to slip into the role of service technicians using VR in order to experience the service processes on the machines and systems. A design opportunity that was objectively useful for service was replicated by participants in VR, and these positive insights were applied to their work after the VR experience. This shows that environmental congruence, perspective taking, and engagement with the reflective system are important in this context. Other areas than those presented in the experiment could also be considered; the use of VR in the field of mechatronics or architecture would be conceivable.

VR developers can address the studied constructs based on this research. In the case of environmental congruence, varying an environment with a low and a high environmental congruence indicates an influence on the way how products are perceived. This impact is also shown to be independent of the order in which participants experienced the VR, underscoring a positive effect. Another positive aspect that can be picked up by practitioners is the adoption of perspectives from other professions. The perception of other perspectives is a promising possibility to develop scenarios in future, which allow a consideration and evaluation of all relevant stakeholders. Examples of work activities in which CAD models and real products are perceived differently and separately from each other shows the potential of developing and implementing VR environments that mimics the real and application environment.

21.7 Future Work

Our research has shown the influence of environmental congruence, perspective taking, and both systems of the dual process theory on behavior change in a VR setting. However, as with every research, this research provides limitations, that future research can build on. First, in this research the experiments were conducted with a specific group of participants. Participants were drawn from two separate organizations, which, although heterogeneous in their profession (e.g., service technician, designer for CAD, etc.), all had a reference with the considered object (i.e., crane). However, for our research approach and the related consideration of the design aspect of a crane, these circumstances were necessary. Nevertheless, for future research, it is important to include context-free participants in the experiment, or to choose objects that are commonly known, in order to strengthen the results, we identified. Also, the experiment could be applied to broader industry scenarios where there are discrepancies between CAD models and reality. Second, we used eye-tracking only as a control measure of participants' perception. A closer look at the field of view or eye movements (e.g., heatmaps) might have generated further interesting insights into human perception. For example, attention in VR, or behavior in general can be evaluated in a dedicated way using objective evaluation criteria. Future research can tie in here and investigate these and other aspects of VR. Moreover, we would like to draw the attention of the research community to the eye dominance. During our experiments, we identified a difference between the dominance of the participant eyes. Here, participants had either a right dominant eye or a left dominant eye. This is important for the valid measurement of eye movements and needs wiser attention in VR research. For our experiment, a corresponding setting for eye dominance was implemented in the SRanipal software. Finally, our research model has examined direct connections between the independent variables (i.e., environmental congruence, perspective taking, the reflective system, and the impulsive system) and the dependent variable (behavioral change). However, the data provide evidence that there are relationships between the variables as mediations. For example, environmental congruence appears as a mediator of the relationship between perspective taking and behavioral change. Additionally, perspective taking seems to be a mediator of the relationship between the reflective system and behavioral change. Based on these assumptions, an extension of the research model is aimed for further investigation. With our research, we would like to motivate further research to address our limitations in order to further investigate the behavior in VR, establish additional links, as well as identify additional independent variables to expand knowledge within the information systems (IS) community.

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21.9 Appendix: Research Items

Item	Original	Adapted/Own Creation
Environmental congruence (Self developed)		
EC1		My idea of reality matches the visualization in virtual reality.
EC2		The environment in virtual reality corresponds to an environment modeled on reality.
EC3		The operating conditions of the crane depicted in virtual reality correspond to those in reality.
EC4		The design in virtual reality corresponds to reality.
EC5		The design in virtual reality reproduces a case based on reality.
EC6		The design in virtual reality meets my expectations of a realistic representation.
Perspective taking (Davis, 1980, 1983)		
PT1	I believe that there are two sides to every question and try to look at them both.	I believe that every design offers several design possibilities and I try to look at them.
PT2	When I'm upset at someone, I usually try to "put myself in their shoes" for a while.	When I get angry about something, I usually try to imagine the circumstances.
PT3	I sometimes try to understand my friends better by imagining how things look from their perspective.	Sometimes I try to understand the design better by imagining that other people will use it later.
PT4*	If I'm sure I'm right about something, I don't waste much time listening to other people's arguments.	If I'm sure I'm right about design, I don't waste much time trying other designs.
PT5*	I sometimes find it difficult to see things from the "other person's" point of view.	I sometimes find it difficult to see the crane design from another point of view.
PT6	I try to look at everybody's side of a disagreement before I make a decision.	I try to consider all consequences of a design option before making a decision.
PT7	Before criticizing somebody, I try to imagine how I would feel if I were in their place.	Before I criticize something, I try to imagine how I would feel if I were responsible for it.
Reflective system (Kember et al. 2000)		
HA1	When I am working on some activities, I can do them without thinking about what I am doing.	When I am considering the crane, I did it without thinking about what I am doing.
HA2	In this course we do things so many times that I started doing them without thinking about it.	In virtual reality I do things so often that I started doing them without thinking about it. In VR, I do things so often that I started doing them without thinking about it.
HA3	As long as I can remember handout material for examinations, I do not have to think too much.	As long as I could remember the introduction for the design, I do not have to think too much.
HA4	If I follow what the lecturer says, I do not have to think too much on this course.	If I followed the introduction, I did not have to think too much on the design.
U1	This course requires us to understand concepts taught by the lecturer.	The design requires an understanding of the content conveyed in the introductory scenario.
U2	To pass this course you need to understand the content.	To consider the design, you need to understand the contents of the introductory scenario.
U3	I need to understand the material taught by the teacher in order to perform practical tasks.	I need to understand the process mentioned in the introductory scenario in order to perform the consideration task.
U4	In this course you have to continually think about the material you are being taught.	During the consideration I have to continually think about the material you are being taught.

Item	Original	Adapted/Own Creation
R1	I sometimes question the way others do something and try to think of a better way.	During the consideration I sometimes questioned the way others do something and tried to think of a better way.
R2	I like to think over what I have been doing and consider alternative ways of doing it.	During the consideration I liked to think over what I did and consider alternative ways of doing it.
R3	I often re-appraise my experience so I can learn from it and improve for my next performance.	During the consideration I often re-appraised my experience so I can learn from it and improve for my next performance.
R4	As a result of this course I have changed the way I look at myself.	As a result of the virtual reality experience, I have changed my self-perception.
R5	This course has challenged some of my firmly held ideas.	The virtual reality experience has challenged some of my firmly held ideas.
R6	As a result of this course I have changed my normal way of doing things.	As a result of the virtual reality experience, I have changed my normal approach.
R7	During this course I discovered faults in what I had previously believed to be right.	Within the virtual reality environment, I discovered errors in what I previously thought was correct.
Impulsive system (Tomko et al. 2014)		
	Since the last prompt, …	During the consideration of the design …
IS1	… I ate so much I had stomach pain or had to throw up.	… I felt uncomfortable with the situation.
IS2*	… I said things without thinking.	… I considered things without thinking.
IS3*	… I spent more money than I meant to.	… I spent more time than I meant (intended) to.
IS4	… I felt bored with what I was doing.	… I felt bored with what I was doing.
IS5	… I have felt impatient.	… I have felt impatient.
Behavioral change (Ogden et al., 2007)		
BC1		The consideration gives me a chance to use my personal initiative or judgment in carrying out the work.
BC2	I was successful at making this change in my behavior.	I was successful at making a change in my way of considering the design.
BC3	I was able to stick to my decision to change.	I was able to stick to my decision to change the design.
BC4	I kept breaking my rules.	I kept breaking my design rules.
* Items were excluded for reliability.		