Beyond Human Creativity

Information-System-Driven Creativity in the Context of a Digital Public and Digital Design

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Table of Contents

List of Figures

List of Tables

List of Abbreviations and Acronyms

ACT	Adaptive Control of Thought Theory
ADSS	AI-driven Architectural Design Support System
AEC	Architecture, Engineering, and Construction
AI	Artificial Intelligence
AMCIS	American Conference on Information Systems
ANOVA	Analysis of Variance
AR	Augmented Reality
BIM	Building Information Modelling
BMI	Bundesministerium des Inneren, für Bau und Heimat
CA	Cognitive Absorption
CAAD	Computer Assisted Architectural Drawing
CM	Cogntive Misperception
CNM	Cognitive Network Model
COLLA	International Conference on Advanced Collaborative Networks, Systems and Applications
CSS	*Creativity Support Systems*, Creativity Support System
CV	Control Variables
DFs	Design Feature(s)
DK	Design Knowledge
DOI	Diffusion of Innovation Theory
DP	Design Principle
DSR	Design Science Research
DSS	Decision Support System
DT	Design Thinking
DTPB	Decomposed Theory of Planned Beahviour
F	Framing
GANs	Generative Adversial Networks
GovLab	Governance Laboratory

GR	General Requirement
GSS	Group Support System
H	Hypothesis
HICSS	Hawaii International Conference on Information System
HPI	Hasso-Plattner-Institut
HSD	Tukey’s Honestly Significant Difference
IADIS	International Conference on ICT, Society and Human Beings
ICIS	International Conference in Information Systems
ICT	Information and Communication Technologies
IKT	Informations- und Kommunikationstechnologien
ILP	Individual Learning Performance
IS	Information Systems
IT	Information Technology
IVR	Immersive Virtual Reality
KG	Knowledge Graph
KiA	Knowing in Action
KMS	Knowledge Management System
LL	Lessons Learned
LTM	Long Term Memory
ML	Machine Learning
MM	Motivational Model
MPCU	Model of Personal Computer Utilisation
NRW	North-Rhine Westphalia
OSI	Organisational and Social Influence
PACIS	Pacific Conference on Information Systems
PC	Psychological Commitment
RDM	Rational Decision-making
RF	Re-framing
RiA	Reflection in Action

RoA	Reflection on Action
RQ	Research Question
SAM	Search of Associative Memory Theory
SCT	Social Cognitive Theory
SD	Standard Deviation, Standard Deviation
SQB	Status Quo Bias
SWOT	Strenght, Weakness, Opportunities, and Threats
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UTAUT	Unified Theory of Acceptance and Use of Technology
UTAUT2	Extended Unified Theory of Acceptance and Use of Technology
WM	Working Memory
WMC	Working Memory Capacity

Part A

1 Introduction

1.1 Creativity and Technology

Creativity has always been a critical tool that organisations and individuals alike can use to solve unstructured and complex problems. Without human creativity, most social achievements would be inconceivable. Indeed, creating something new makes progress possible. Through globalisation and interconnectedness, our world is becoming more complex. While technologies such as artificial intelligence (AI) are able to solve logical, structured tasks faster and more reliably, the question arises as to whether creativity remains a purely human capability.

In order to remain competitive as an organisation and to survive under constantly changing conditions, companies must be able to develop creative solutions to their problems. In addition to economic challenges, creativity is also a crucial factor from a social perspective. Issues such as waves of refugees and pandemics (e.g. COVID-19) also pose a variety of challenges that must be solved on an individual, organisational, and societal level.

Creativity is therefore of enormous importance when it comes to designing innovative solutions. In this context, creative ideas are generally understood to be ideas that are new (or original) and appropriate (or useful) (Althuizen & Reichel, 2016; Althuizen & Wierenga, 2014; Finke, 1996; Hennessey, 2019; Wang & Nickerson, 2019). Innovative solutions can include new products, processes, or services that address users and their needs in the best possible way, thereby creating economic or social value (Brown, 2008; Gabriel, Monticolo, Camargo, & Bourgault, 2016). Due to its creative nature, design cannot be viewed in isolation from creativity, regardless as to whether we are dealing with "design" (with a lowercase "d") as a process or "Design "(with an uppercase "D") as a product.

Technological development offers great potential when it comes to supporting human creativity. For example, creativity support systems (CSSs) have the explicit goal of supporting human creativity. In addition, the influence of megatrends in the field of information technology – such as AI, machine learning, and knowledge graphs – provides new potential for these support systems, thereby rendering the field an important and relevant area for research.

Although the topic of creativity and information systems has been discussed extensively in information systems research as well as in related disciplines, the phenomenon remains incompletely understood (Fries, Pfluegler, Wiesche, & Krcmar, 2016; Gabriel et al., 2016). Moreover, technological development simultaneously offers new opportunities to go beyond human creativity with information-system-driven creativity.

1.2 Research Questions

The present dissertation aims to contribute to a better understanding of information-system-driven human creativity and to provide related knowledge about the design of artifacts for creativity support. The aim is to gain knowledge about how to design universal information systems on the one hand and to better understand how to design information-system-driven creativity in the context of two application areas (i.e. the public sector and architectural design) on the other hand. The work builds on previous research in the field of information systems and on insights from related disciplines (e.g. architectural design; the public sector; architecture, engineering, and construction (AEC)). Accordingly, three research questions (RQs) help to structure the investigation into information-system-driven creativity.

Research Question 1

Information technology and thus also the opportunities for designing an artifact are currently undergoing rapid development, as exemplified by the field of AI. Be it through KGs or ML, developments in AI (as an umbrella term) have great economic potential and can dramatically affect the way we work (Fink et al., 2010). Two paradigms exist when it comes to using AI: (1) human-level AI that aims to replace humans and (2) AI with the possibility of symbiotic collaboration (Licklider, 1960). The present thesis focuses on AI that is designed to support and assist humans.

IT-based interventions offer the possibility to support human creativity, with CSSs drawing on different approaches (Minas & Dennis, 2019). For example, stimuli may provide specific information related to the task of (1) generating new approaches to a solution, (b) supporting the process and thus influencing the user’s ability to generate new ideas through a structured process, or (c) priming (Minas & Dennis, 2019), which normatively influences the subject’s state of mind. However, results vary, and empirics are inconclusive. Stimuli providers have shown the strongest effects (Althuizen & Wierenga, 2014; Minas & Dennis, 2019) and offer good opportunities for integrating intelligent algorithms (Wang & Nickerson, 2019).

Technological advances on the one hand and the potential of IT-based interventions on the other hand both offer new opportunities to support human creativity through IT. Therefore, with the first meta-research question, we aim to explore the possibilities for designing IT-supported artifacts.

RQ 1: How can creativity support systems be designed?

Research Question 2

Information technology also plays an important role in the future viability of our cities (Gil, Cortés-Cediel, & Cantador, 2019; Portmann & Finger, 2015) by adding a digital dimension – that is, a *digital public*. Our cities are currently facing major challenges: While rural regions are being affected by a rural exodus, the issue of urbanisation is one of the greatest challenges of our time for urban regions. The concept of the smart city provides an overarching vision, and the use of information and communication technologies (ICTs) serves as the foundation for smart cities (Andrushevich, Wessig, Biallas, Kistler, & Klapproth, 2015). However, the use of ICTs also goes hand in hand with new challenges. After all, technology alone does not bring added value until costs can be reduced and the inequality of living conditions can be eliminated (Yigitcanlar et al., 2018), for example, by increasing the quality and efficiency of urban services.

The design and regulation of smart cities in the form of digital products, services, and processes based on IT is a governance task and goes hand in hand with the need for transparency, efficiency, and legitimacy ("Governance and Development", 1992). The complex and multi-faceted problems that arise in shaping our future cities can only be achieved through collaboration that goes beyond existing forms (Poocharoen & Ting, 2015). The participation of citizens – who become co-creators – plays an important role in designing smart cities (Allen, Tamindael, Bickerton, & Cho, 2020). Innovative collaboration is thereby a recognised strategy for meeting social needs while simultaneously addressing a problem that most organisations face (i.e. low resources) (Torfing, 2019).

Creativity as a driver and key competence of this innovative collaboration maintains two perspectives in the context of designing IT: First, the best possible design of IT can be achieved by leveraging human creativity through structured approaches, and second, the best possible support can be achieved by IT in the design process. Due to the ubiquity of online workshops and the use of technology that supports citizen participation (e-participation), for example, the topic of designing digital products, services, and processes can no longer be considered in the absence of IT.

New perspectives on and approaches to innovative collaboration in the form of methods, attitudes, and tools need to be explored, and the need for research and practice is thus high. Therefore, the second meta-research question focuses on the application of new, innovative tools when designing digital technologies.

> *RQ 2: How can digital services, processes, and products be designed in the context of smart cities?*

Research Question 3

In order to gain a more complete picture of the opportunities available for designing information-system-driven creativity, the present work additionally explores the field of architectural design as an example of professional design disciplines – namely *digital design*. The work deals with the application field of architecture, which – according to D. Schön (1983, p. 77) – is suitable for drawing conclusions on other design disciplines: "*It is perhaps the oldest recognized design profession and, as such, functions as prototype for design in other professions. If there is a fundamental process underlying the differences among design professions, it is in architecture that we are most likely to find it.*"

The phenomenon of creativity plays an important role in many professions. As the name suggests, the entire creative industry is built on creativity and design activity (or design thinking). In addition, the industry is also built on the actual understanding of design, with H. Simon having identified design as a core activity for many professions: "*Everyone designs who devises courses of action aimed at changing existing situations into preferred ones*" (Simon, 1967, p. 55). The key role that creativity plays in the design disciplines has also been confirmed by Nigel Cross (Cross, 1982, p. 7): "*The emphasis in these admonitions is on the constructive, normative, creative nature of designing*."

In architectural design, technological developments in recent decades have influenced the way buildings are created. CAAD (computer-assisted architectural drawing) (Hyde, 1989; Oxman, 2008), parametricism (Oxman, 2017), and AI (Chaillou, 2020) are some examples of the influence that technology has had on architectural design.

By studying architectural design, we can gain insights into the design of CSSs, and we can also design possible solutions to complex problems. This possibility gives rise to the general potential to design CSSs that add value to the user by supporting individual creativity. We contribute to this field of research by exploring the factors behind using – and the principles of designing – a system. These factors and principles are also transferable to other application examples.

> *RQ 3: How can creativity support systems be designed within architectural design?*

1.3 Thesis Structure

In order to provide this work with a clear structure, the present dissertation is divided into two sections (Part A and Part B) and includes a total of 14 research articles (see Table 1).

Part A describes the research background and the approach of the thesis and finally presents the results of the RQ. Subsequently, these results are discussed.

Part B consists of 14 research articles, nine of which are conference papers and five of which are journal papers. The conference papers in this dissertation were published at the *International Conference in Information Systems* (ICIS), the *American Conference on Information Systems* (AMCIS), the *Pacific Conference on Information Systems* (PACIS), the *Hawaii International Conference on Information Systems* (HICSSs), the *International Conference on Advanced Collaborative Networks, Systems and Applications* (COLLA), the *International Conference on ICT, Society and Human Beings* (IADIS), and the *New Perspectives on Digitalization: Local Issues and Global Impact*.

One journal paper each (total: three) was published in *Computers in Industry*, *Electronic Markets – The International Journal on Networked Business*, and *HMD – Praxis der Wirtschaftsinformatik*, and one journal article each (total: two) is currently under review in *Information & Management* and *CAIS – Communications of the Association of Information Systems*. The numbering of the chapters, figures, and tables has been adapted to the structure of the dissertation.

#	Citation	IF [a]	VHB [b]
P 1	Jahn K., Kampling H., **Klein H. C.**, Kuru Y., Niehaves B. (2018). Towards an Explanatory Design Theory for Context-dependent Learning in Immersive Virtual Reality. In: Proceedings of the 22th Pacific Asia Conference on Information Systems (PACIS 2018), Yokohama, Japan.	-	C
P 2	Röding, K., Oschinsky, F. M., **Klein, H. C.**, Weigel, A. Niehaves, B. (2019). Would you like to Participate? Stakeholder Involvement in the Development Process of Digital Strategies for Municipalities. In: Proceedings the 9th International Conference on Advanced Collaborative Networks, Systems and Applications (COLLA 2019), Rome, Italy.	-	-
P 3	Oschinsky, F. M., **Klein, H. C.**, Niehaves, B. (2019). Working in the Digital Age: Merging a Status Quo Bias Perspective and Reflective Practice. In: Proceedings of the 12th International Conference on ICT, Society and Human Beings 2019 (ICT 2019), Porto, Portugal.	-	-
P 4	**Klein, H. C.**, Oschinsky, F., Weber, S., Niehaves, B. (2020). MUSE – Towards a Concept of Inspiring Ambient Technology Driven by Artificial Intelligence. 24th Pacific Asia Conference on Information Systems (PACIS 2020), Dubai, UAE.	-	C
P 5	**Klein, H. C.**, Oschinsky, F., Weber, S., Kordyaka, B., Niehaves, B. (2020). Beyond the Obvious – Towards a Creativity Support System using AI-driven Inspiration. 26th Americas Conference on Information Systems (AMCIS 2020), Salt Lake City, USA.	-	D
P 6	**Klein, H. C.**, Weber, S., Schlechtinger, M., Oschinsky, F. M. (2020). Does one Creative Tool Fit All? Initial Evidence on Creativity Support Systems and Wikipedia-based Stimuli. In: Proceedings of the 41st International Conference on Information Systems (Virtual ICIS 2020), Hyderabad, India.	-	A
P 7	**Klein, H. C.** (2020). Reflective Practice in the Digital Age. In J. Radtke, M. Klesel, & B. Niehaves (Eds.), New Perspectives on Digitalization: Local Issues and Global Impact. Proceedings on Digitalization at the Institute for Advanced Study of the University of Siegen, Siegen, Germany.	-	-

P 8	**Klein, H. C.**, Oschinsky, F. M., Rubens, S. (2021). Cultivating Creativity: Insights from German Local Governments about the Drivers and Barriers of Change. In: Proceedings of the 54th Hawaii International Conference on System Sciences (HICSS-54), Koloa, Hawaii.	-	C
P 9	**Klein, H.C.**, Oschinsky, F. M., Stelter, A., Niehaves, B. (2021). Design Thinking als Werkzeug für Co-kreation und Co-design – Ein Erfahrungsbericht in 5 Thesen. In: HMD Praxis der Wirtschaftsinformatik.	-	D
P 10	**Klein, H.C.,** Weber S., Niehaves B. (2022) Designing AI-driven Inspiration for Design Professions. In: 17th International Conference on Design Science Research in Information Systems and Technology, St. Peterburg, Florida, USA.		C
P 11	Oschinsky, F. M., **Klein, H. C.**, Niehaves, B. (2022). Invite everyone to the table, but not to every course – How Design Thinking Collaboration can be implemented in Smart Cities to Design Digital Urban Services. In: Electronic Markets.	6.017	B
P 12	**Klein, H. C.**, Weber, S., Niehaves B. (under review – major revisions). InspAIred – Drivers and Barriers for AI-Driven Decision Support Systems: The Case of Architectural Design Assistance. In: Communications of the Association for Information Systems (under review – major revisions)	2.38	C
P 13	**Klein, H. C.**, Stelter, A., Oschinsky, F. M., Niehaves, B. (2022). Status quo bias-perspective on user resistance in building information modeling adoption – Towards a taxonomy. In: Computers in Industry.	11.245	C
P 14	**Klein, H.C.,** Weber, S., Wang, K., Kordyaka, B., Niehaves B. (under review). One Size Does Not Fit All – Towards a Taxonomy for Individualized Stimuli in Creativity Support Systems. In: Information & Management (under review).	10.328	B

[a] VHB-JOURQUAL3 (https://vhbonline.org/fileadmin/user_upload/JQ3_WI.pdf)

[b] IF (impact factor) according to Journal Citation Reports (released in 2021/2022)

Table 1. Overview of Publications

2 Research Background

2.1 Creativity

Creativity is the subject of research in various disciplines and also has a long tradition in information systems research (Couger, Higgins, & McIntyre, 1993; Seidel, Müller-Wienbergen, & Becker, 2010). While the common understanding of what is considered creative in research initially had to do with the *new* and *the process of bringing something new into creation*, Amabile defines creativity in the context of business by stating that "*in business, originality isn't enough. To be creative, an idea must also be appropriate, useful and actionable*" (1998, p. 78).

As the concept of creativity is highly complex, other models can be found in IS research in addition to the definition above, and these models can be used to better grasp creativity (Seidel et al., 2010). While some understandings of creativity emphasise it as something that occurs in a "eureka moment", these models can help us to understand creativity as a working method and a working style that is available to everyone and that can be both influenced and understood. One such model is Rhodes' (1961) 4-P model (person, process, product, and press), in which a creative person is studied by examining their abilities, personality, and individual background. The creative process is also widely used in research and can be found in contemporary creative techniques. The process is often seen in connection with creative problem-solving strategies and thus ties in with considerations such as innovation management and design (thinking). Research on the creative product is concerned with the output of creative efforts. Such research involves making results measurable and also concerns discipline-specific paradigms and ideas. The fourth category – press – examines the interaction between creative actors and their environment and includes both spatial and social/societal implications. According to Couger et al. (1993), Seidel et al. (2010), and Gabriel (2016), the 4-P model is well suited as a structure for examining creativity in the context of IS in relation to different levels of inquiry (individual, team, and organisation) and the connection of these levels to the IT artifact.

In understanding the effect of information technology on creativity, it is important to note that several factors have an influence on creativity and therefore serve as starting points for designing CSSs. Ability varies from person to person (dispositional factors) and from situation to situation (situational factors) and therefore influences creativity (Nijstad, De

Dreu, Rietzschel, & Baas, 2010). Moreover, dispositional elements influence creativity, for example, because states of mind affect our creative ability differently (Baas, De Dreu, & Nijstad, 2008). However, motivational elements also have an impact on our creativity and can vary from situation to situation (Nijstad et al., 2010).

2.2 Creativity Support Systems

Many information systems maintain the potential to support human creative endeavours (Klinker, Wiesche, & Krcmar, 2018) and have a long history in information systems research. Group support systems (GSSs) (Kuo & Yin, 2011), for example, aim to support groups in various aspects of collaboration. GSSs are computer-based systems in the form of information systems that aim to support groups in forming and solving problems, thereby contributing to the creative problem-solving process. Decision support systems (DSSs) (Barkhi & Kao, 2011) help by assisting in decision-making and thus make decision-making more effective and efficient. Knowledge management systems (KMSs) (Klinker et al., 2018) are another type of information system that help to organise existing knowledge and to support it in the context of creative tasks. First and foremost, the CSS class investigates information-system-driven creativity in information systems research (Wang & Nickerson, 2017).

Research on CSSs – that is, information systems that support human creativity – has a long history in the field of information systems (Couger et al., 1993; Elam & Mead, 1990; MacCrimmon & Wagner, 1991; Minas & Dennis, 2019; Nevo, Nevo, & Ein-Dor, 2009). Research on CSSs can be divided into two classes (Wang & Nickerson, 2017): CSSs that aim to support individuals (Mueller-Wienbergen, Mueller, Seidel, & Becker, 2011) and CSSs that aim to support groups. Research on individual CSSs has a special significance (Wang & Nickerson, 2017) because individual creativity is also essential to group creativity processes and is thus a necessary condition for developing creative solutions in a group. Furthermore, decisions and creative works within organisations are also carried out by individuals.

Different approaches to information-system-driven creativity support exist (Mueller-Wienbergen et al., 2011; Wang & Nickerson, 2017). One such approach is to deliver stimuli and information that provide specific information related to the task, thereby both supporting new approaches to the solution and helping in the search for these approaches. Another approach is to support the process, thereby influencing the user's ability to develop new ideas through a structured process. Further priming (Minas & Dennis, 2019) is a third category of supporting human creativity in which an individual receives information but – in contrast to the situation with context-related stimuli – processes it subconsciously.

2.3 Design Disciplines

Research on supporting human creativity in IS cannot be considered in isolation from design because human creativity plays an important role in the context of both the professional practice of design disciplines (e.g. architecture, industrial design, design thinking) and innovation processes (Gabriel et al., 2016) as well as in the context of scientific design research (Baskerville, Kaul, & Storey, 2015).

The Science of the Artificial, Herbert Simon stated, "*Everyone designs who devises courses of action aimed at changing existing situations into preferred ones*" (1967, p. 55). This view of design has shaped our current understanding of the concept and laid the foundation for research on and with design. This understanding of design differs from the common German usage, in which design refers instead to external form and appearance (superficially) and is used as a noun (e.g. "a good design"). In English-language usage, the term has always described a design-like approach and has thus primarily been a verb.

For professional practice in design disciplines, digital transformation is accompanied by new opportunities and challenges. In terms of design as a practical discipline and profession, digital transformation has two meanings: (1) target parameters for the artifact change due to new framework conditions ("Design" with an uppercase "D"; noun) and (2) technological possibilities change when designing new artifacts ("design" with a lowercase "d"; verb). What professional designers "*[...] especially know how to do [is to] propos[e] additions to and changes to the artificial. (Not 'the sciences of the artificial.') Thus, design knowledge is of and about the artificial world and how to contribute to the creation and maintenance of that world*" (Cross, 2001, p. 5).

Practical work in the design disciplines is affected by the digital transformation as new guiding principles emerge around which the artifacts (i.e. what is designed) are oriented. For example, the ideas that exist in our constructed environment are currently changing with the introduction of new models for cities and new working environments. While architects predominantly planned and created single offices and fixed workplaces only a few decades ago, the idea of *New Work* fundamentally changed the requirements for workplaces. It is now much more commonplace to design working landscapes that respond to new needs. Architects' designs must react to these new needs or develop them further. Smart cities are also providing new guiding principles around which the design of our future cities is being oriented.

In addition, technology is changing the way we work, for example, by introducing new tools. The use of technology plays an important role in terms of design research – that is, in terms of how an artifact is created and designed. New information technology (e.g. software) is available to architects, with building information modelling (BIM) being one such innovation. However, virtual reality (VR), augmented reality (AR), and AI are also changing design disciplines in fields such as architecture, urban development, and industrial design. Even in disciplines that are not known as design disciplines at first glance but that have a decades-long tradition in research on design and in the scientific discourse, the digital transformation is changing everything. This is also the case in the field of educational design, in which technologies are also playing an increasingly important role in addition to new guiding principles. Thus, when dealing with new tools, it is important to consider the link between the technological possibilities and the social and societal conditions of the respective design discipline when sustainably shaping professional practices.

Additionally, the innovation approach of design thinking (DT) takes on a special role in this field and highlights the importance of such changes and opportunities. DT transfers designers' working methods to the economic context. For this purpose, the process is formalised and runs less intuitively, with the goal being to develop innovative solutions to complex problems that focus not on technical feasibility, but on users or customers and their needs.

3 Research Design

3.1 Overview

In order to address our research questions and thus obtain a holistic view of the potential for designing CSSs and creativity-enhancing initiatives in IS, the present thesis builds on the foundations of CSSs in the field of IS and transfers the findings on universal CSSs to two application areas: (1) the public-sector domain of designing smart cities and (2) the domain of architectural design.

In Track 1, the dissertation lays the groundwork for further design-oriented research and addresses possible design principles as well as the theoretical mechanisms behind them, which are both universal and universally applicable. The research focuses on the individual level – that is, on individual CSSs. Furthermore, in this track, the thesis focuses both on the potential technological possibilities of AI and on practical methods, such as ML and GANs.

In Track 2, the thesis focuses on the application area of innovative collaboration in the context of smart cities. Creativity is embedded in the context of the design thinking approach, and the factors of the public sector are considered. The role of the technological artifact is assessed from a practical perspective that investigates how the technological artifact can be designed in the best possible way in the public sector. In so doing, the thesis views the innovation approach of DT both as a strategic approach to innovative collaboration and as a social artifact that is designed.

In Track 3, the thesis focuses on the profession of architecture as an example of an established design discipline. In so doing, the research focuses on identifying factors that influence the use of IT-driven and possible designs of such systems in order to provide a better understanding of design thinking based on reflective practice and the work of D. Schön (1983). Finally, an artifact is developed by means of design science research, which is evaluated in the context of architectural practice. In so doing, the work develops an approach to a symbiotic system between humans and machines (i.e. between architects and AI) using GANs.

Research on design (i.e. design research) is prevalent in many disciplines (Maedche, Gregor, & Parsons, 2021). However, no single research discipline exclusively tackles design (Daly, 2008), which means that different interdisciplinary (or multidisciplinary) design research projects can benefit from one another (Yilmaz & Seifert, 2011). However, this situation does not contribute to gaining a clearer understanding of design. Both in *Wirtschaftsinformatik* (i.e. the German discipline of "information systems") and in its English-language sister discipline of information systems, design research reflects an independent paradigm. This can be seen, for example, in Maedche's (2021, p. 5) definition of design research: "*Broadly speaking, design research in the information* *systems (IS) discipline aims to add to knowledge of how things can or should be constructed or arranged (i.e., designed), usually by human agency, to achieve some desired goal.*" However, no shared understanding of the nature and boundaries of design research exists, even though the importance of design is increasing due to the growing digital transformation (Maedche et al., 2021).

In this context, design science research (DSR) describes an approach in IS that obtains prescriptive knowledge about the design of IT artifacts (e.g. Gregor, 2006; Gregor & Hevner, 2013; Hevner et al., 2004; Maedche et al., 2021; Sonnenberg & Vom Brocke, 2012). DSR has a 30+ year tradition as a research method in IS, and foundational work in the field – such as that of March and Smith (1995) and Hevner et al. (2004) – has had a significant impact on our understanding of the distinct research paradigm. Buckminster Fuller introduced the term "design science" as early as in the 1960s in reference to a combination of technology, science, and rationalism (Maedche et al., 2021), and Herbert Simon also laid an important foundation for – and established a precursor to – DSR in IS with his work Science of the Artificial (Peffers, Tuunanen, & Niehaves, 2018).

"*Design science research (DSR) aims to generate prescriptive knowledge about the design of Information Systems (IS) artifacts, such as software, methods, models, or concepts (Hevner, March, Park, & Ram, 2004). Design knowledge (DK) is about means–end relationships between problem and solution spaces (Venable, 2006)*" (Vom Brocke, Winter, Hevner, & Maedche, 2020, p. 2). The difference with practical design activities is that new knowledge (i.e. prescriptive) knowledge about the design of an artifact is gained, whereas in practical design activities, this knowledge is available, and routine designs are used (Gregor & Hevner, 2013; Kuechler & Vaishnavi, 2008). The IT artifact plays a central role in IS research and is therefore the focus of the present study. In order to provide a better understanding of the artifact, we use the structure created by Lee et al. (2015), who proposed that the concept of the IT artifact has three subcategories: the information artifact, the technology artifact, and the social artifact. An IT artifact can be software, a construct, a model, a method, or an instantiation.

The contributions and approaches of a DSR project can be quite diverse (Gregor & Hevner, 2013; vom Brocke & Maedche, 2019), and a variety of guidelines, rules, and frameworks have been published (Peffers et al., 2018). Most DSR approaches consist of the two activities of (1) building/constructing and (2) evaluating/testing (March & Smith, 1995; vom Brocke & Maedche, 2019). In addition to evaluating designs, processing designs in DSR represent an important aspect of proceeding with a research project (Hevner et al., 2004). A common approach is that proposed by Peffers et al. (2008): "*This process is structured in a nominally sequential order; however, there is no expectation that researchers would always proceed in sequential order from activity 1 through activity 6. In reality, they may actually start at almost any step and move outward*" (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2008). This approach consists of two superordinate phases: (1) building and (2) evaluating. These phases – in turn – are subdivided into three process steps each: The first phase – building – consists of **(A)** identifying the problem & motivation, defining the problem, and showing its importance, **(B)** defining the objectives of a solution, and **(C)** designing & developing, and the second phase – evaluating – consists of **(D)** demonstrating, **(E)** evaluating, and **(F)** communicating.

Due to the high risk of DSR, Sonnenberg and vom Brocke (2012) suggest a sub-part evaluation, which results in a design–evaluate–construct–evaluate pattern. The process consists of the activities of identifying the problem (**A**), designing (**C1**), constructing (**C2**), and using (**D**), each of which is followed by an evaluating phase (**E**). Depending on the process step, different methods can be used for the evaluation. Some articles in this thesis were guided by such an approach.

Projects are often complex, and designing a relevant solution to problems thus frequently requires several iterations and possibly also several contributions from different stakeholders (Vom Brocke et al., 2020). This makes it even more important to communicate (see Step **F** (*communication*)) the contributions made by the individual steps of the phases. The form in which knowledge is captured and thus communicated within a study can vary. According to vom Brocke et al. (2020), this form can be a designed artifact (Hevner et al, 2004) (Hevner et al., 2004), design principles (Chandra, Seidel, & Gregor, 2015), or design theories (Gregor and Hevner, 2013): "*The three components of DK can be used in order to plan, coordinate, and communicate complex design research activities over time and space*" (Vom Brocke et al., 2020, p. 11).

Based on the characteristics of DSR, we propose the following three dimensions for classifying and describing each article's contribution to this thesis: (1) The **problem space** (i.e. context and goodness criteria) is an important starting point for a design project. Understanding the context is critical, and it is furthermore necessary to define the criteria in the problem space in order to create a relevant design solution to the problem. (2) The **solution space** and (3) the **process** (i.e. results and process) are dimensions in which design knowledge (DK) helps to design a solution for identified problems. In Sections 3.2, 3.3, and 3.4, the articles in this thesis are listed in terms of the three dimensions of problem space, solution space, and process, respectively.

Table 2 displays the articles of the dissertation organised in three tracks.

#	Title	
Track 1: Individual Creativity Support Systems		
P 1	Jahn K., Kampling H., **Klein H. C.**, Kuru Y., Niehaves B. (2018). Towards an Explanatory Design Theory for Context-dependent Learning in Immersive Virtual Reality. In: Proceedings of the 22th Pacific Asia Conference on Information Systems (PACIS 2018), Yokohama, Japan.	(Jahn *et al.*, 2018)
P 4	**Klein, H. C.**, Oschinsky, F., Weber, S., Niehaves, B. (2020). MUSE - Towards a Concept of Inspiring Ambient Technology Driven by Artificial Intelligence. 24th Pacific Asia Conference on Information Systems (PACIS 2020), Dubai, UAE.	(Klein, Oschinsky, *et al.*, 2020)
P 5	**Klein, H. C.**, Oschinsky, F., Weber, S., Kordyaka, B., Niehaves, B. (2020). Beyond the Obvious – Towards a Creativity Support System using AI-driven Inspiration. 26th Americas Conference on Information Systems (AMCIS 2020), Salt Lake City, USA.	(Klein, Oschinsky, Weber, *et al.*, 2020)
P 6	**Klein, H. C.**, Weber, S., Schlechtinger, M., Oschinsky, F. M. (2020). Does one Creative Tool Fit All? Initial Evidence on Creativity Support Systems and Wikipedia-based Stimuli. In: Proceedings of the 41st International Conference on Information Systems (Virtual ICIS 2020), Hyderabad, India.	(Klein, Weber, *et al.*, 2020)
P 14	**Klein, H.C.**, Weber, S., Wang, K., Kordyaka, B., Niehaves B. (under review). One Size Does Not Fit All – Towards a Taxonomy for Individualized Stimuli in Creativity Support Systems. In: Information & Management (under review)	(Klein, Weber, Wang, *et al.*, 2022)

Track 2: Public Sector as a Design Discipline: Digital Public		
P 2	Röding, K., Oschinsky, F. M., **Klein, H. C.**, Weigel, A. Niehaves, B. (2019). Would you like to Participate? Stakeholder Involvement in the Development Process of Digital Strategies for Municipalities. In: Proceedings the 9th International Conference on Advanced Collaborative Networks, Systems and Applications (COLLA 2019), Rome, Italy.	(Röding *et al.*, 2019)
P 8	**Klein, H. C.**, Oschinsky, F. M., Rubens, S. (2021). Cultivating Creativity: Insights from German Local Governments about the Drivers and Barriers of Change. In: Proceedings of the 54th Hawaii International Conference on System Sciences (HICSS-54), Koloa, Hawaii.	(Klein, Oschinsky, *et al.*, 2021)
P 9	**Klein, H.C.**, Oschinsky, F. M., Stelter, A., Niehaves, B. (2021). Design Thinking als Werkzeug für Co-kreation und Co-design – Ein Erfahrungsbericht in 5 Thesen. In: HMD Praxis der Wirtschaftsinformatik.	(Klein, Oschinsky, Stelter, *et al.*, 2021)
P 11	Oschinsky, F. M., **Klein, H. C**., Niehaves, B. (2022). Invite everyone to the table, but not to every course – How Design Thinking Collaboration can be implemented in Smart Cities to Design Digital Urban Services. In: Electronic Markets	(Oschinsky *et al.*, 2022)
Track 3: Creativity Support Systems for Architectural Design: Digital Design		
P 3	Oschinsky, F. M., **Klein, H. C.**, Niehaves, B. (2019). Working in the Digital Age: Merging a Status Quo Bias Perspective and Reflective Practice. In: Proceedings of the 12th International Conference on ICT, Society and Human Beings 2019 (ICT 2019), Porto, Portugal.	(Oschinsky *et al., 2019)*
P 7	**Klein, H. C.** (2020). Reflective Practice in the Digital Age. In J. Radtke, M. Klesel, & B. Niehaves (Eds.), New Perspectives on Digitalization: Local Issues and Global Impact. Proceedings on Digitalization at the Institute for Advanced Study of the University of Siegen, Siegen, Germany.	(Klein, 2020)
P 10	**Klein, H.C.**, Weber S., Niehaves B. (2022) Designing AI-driven Inspiration for Design Professions. In: 17th International	(Klein, Weber, *et al.*, 2022)

	Conference on Design Science Research in Information Systems and Technology, St. Peterburg, Florida, USA.	
P 12	**Klein, H. C.**, Weber, S., Niehaves B. (under review – major revisions). InspAIred - Drivers and Barriers for AI-Driven Decision Support Systems: The Case of Architectural Design Assistance. In: Communications of the Association for Information Systems (under review – major revisions)	(Klein, Weber, Niehaves, 2022)
P 13	**Klein, H. C.**, Stelter, A., Oschinsky, F. M., Niehaves, B. (2022). Status quo bias-perspective on user resistance in building information modeling adoption – Towards a taxonomy. In: Computers in Industry	(Klein, Stelter, *et al.*, 2022)

Table 2. Articles Included in the Dissertation

3.2 Studies on Individual Creativity Support Systems

The present thesis includes five articles (Paper 1: Jahn *et al.*, 2018; Paper 4: Klein, Oschinsky, *et al.*, 2020; Paper 5: Klein, Oschinsky, Weber, *et al.*, 2020; Paper 6: Klein, Weber, *et al.*, 2020; Paper 14: Klein, Weber, Wang, *et al.*, 2022) that deal with identifying the potential for individual CSSs (see Table 3). Specifically, the aim is to identify related phenomena, different understandings of creativity, and possible interventions related to explanatory mechanisms.

Accordingly, the first study in Track 1 (Paper 1: Jahn *et al.*, 2018) investigates context-dependent learning in the context of virtual reality (VR) and addresses the difficulty of implementing environmental congruence in practice even though this congruence can improve learning outcomes. The study develops an explanatory design theory and design variables and proposes an experiment for evaluating the theory. In so doing, it contributes to this thesis by using VR, which helps to simulate the environment in which knowledge is retrieved. Inferences can be made about creativity based on the relationship between learning and creativity by using the VR environment to deliver stimuli.

The second study in Track 1 (Paper 4: Klein, Oschinsky, *et al.*, 2020) explores the possibilities for designing an information system based on AI that takes spatial design into account. Accordingly, the work addresses the problem that weak inspiration in idea generation can lead to poor creative performance. In so doing, the system suggests that stimuli (i.e. expansive and restrictive examples) can be used to inspire the subject. In the article, we distinguish between restrictive and expansive examples as well as between presentation as text and as images. Expansive and restrictive stimuli can be planned in conjunction with exploiting the space as an AI-driven system. The work concludes with a conceptual proposal of instantiation.

The third article in Track 1 (Paper 5: Klein, Oschinsky, Weber, *et al.*, 2020) focuses on the cognitive phenomenon of mental blockage (fixation) as a serious problem in the context of creative problem-solving tasks – a phenomenon that has a negative impact on individual creativity. Specifically, mental blockage (fixation) means that an individual is not able to generate new ideas or approaches to a solution. We investigate the design possibilities of a CSS that helps to resolve this fixation using visual stimuli (abstract to realistic). The system provides individual stimuli using AI (abstract to realistic) that can be used to avoid and resolve mental blockage. Thus, the work develops a way of responding to mental blocks through a system's specific design principles.

The fourth study in Track 1 (Paper 6: Klein, Weber, *et al.*, 2020) explores the approach of providing contextual stimuli to assist individuals in idea generation. In so doing, the study considers the concept of the relatedness of the contextual stimuli with respect to the task at hand. For this purpose, the relatedness of a computer-based method (i.e. Wikipedia-based) was investigated in comparison with an individually perceived method. The work contributes to the need to develop computer-based definitions and algorithms and to provide contextual stimuli. The KG used for Wikipedia (DBpedia) served as the basis for the computer-based definition in the investigation.

The fifth study in Track 1 (Paper 14: Klein, Weber, Wang, *et al.*, 2022) is an article that examines the individual factors involved in the perceived relatedness of computational methods for defining the relatedness of stimuli. While individual factors are important for individualising context-related stimuli, these factors have been mainly neglected by previous research. In this article, a taxonomy (n=202) was designed and evaluated that provides characteristics of perceived relatedness that allow for individual differences based on specific dimensions.

Track 1: Individual Creativity Support Systems			
#	**Problem Space**	**Solution Space**	**Process**
P1 (Jahn *et al.*, 2018)	Environmental congruence can improve learning outcomes, but it is very difficult to implement in practice.	VR can help simulate the environment in which knowledge is retrieved.	A–B–C / (–)–(–)–F
P4 (Klein, Oschinsky, *et al.*, 2020)	Weak inspiration in idea generation can lead to poor creative performance.	Technology can be used in the environment to provide restrictive and expansive examples as stimuli and to improve results.	A–B–C / (–)–(–)–F
P5 (Klein, Oschinsky, Weber, *et al.*, 2020)	Mental blocks in terms of idea generation can cause individual creativity to decrease.	Individual stimuli based on AI (abstract to realistic) can be used to avoid/resolve mental blockages.	A–B–C / (–)–(–)–F
P6 (Klein, Weber, *et al.*, 2020)	There is a need to develop computer-based definitions and algorithms and to provide context-related stimuli.	KGs (e.g. DBpedia) can be used to define relatedness and to derive concepts while taking individual factors into account.	A–B–C / D–E–F
P14 (Klein, Weber, Wang, *et al.*, 2022)	Existing solutions that use computational stimuli in terms of relatedness do not provide individualised solutions.	The developed taxonomy provides characteristics in terms of perceived relatedness that allow for individual differences based on specific dimensions.	A–B–C / D–E–F

Table 3. Papers from Track 1, and DSR-Specific Characteristics

3.3 Studies on the Public Sector as a Design Discipline: Digital Public

Track 2 includes four articles (Paper 2: Röding *et al.*, 2019; Paper 8: Klein, Oschinsky, *et al.*, 2021; Paper 9: Klein, Oschinsky, Stelter, *et al.*, 2021; Paper 11: Oschinsky *et al.*, 2022) that deal with identifying the potential for creativity support in the public sector (see Table 4). In particular, the aim is to identify design opportunities and approaches to designing digital services, processes, and products in the context of smart cities that involve user participation.

The first study in Track 2 (Paper 2: Röding *et al.*, 2019) identifies success factors in the development and implementation of digitisation strategies in the context of the municipal development of smart cities. To that end, all 396 municipalities and 31 districts in the state of North Rhine-Westphalia were surveyed, and 22 national and international municipalities were analysed. Additional expert interviews were conducted. The study focuses on the questions of (1) how a digitisation strategy can be developed that involves the participation of relevant stakeholders and (2) which stakeholders are important and should be involved in the strategy development process. In so doing, the work addresses the problem of strategically designing smart cities. Further guidelines for designing digitalisation strategies are elaborated.

The second article in Track 2 (Paper 8: Klein, Oschinsky, *et al.*, 2021) examines creativity as an important competency in public administrations and addresses the problem of the low awareness of creative work in public administrations. In so doing, the study uses a focus group consisting of public administration employees to identify drivers and barriers related to creative ways of working. The work builds on the 4-Ps Model and sharpens the holistic view of the concept of creativity in German administrations. Moreover, it identifies projects on the topic of creativity in German administrations in order to improve our understanding of the topic. Subsequently, the study investigates creativity in an explorative case study using the example of German administrations. A focus group (n=4) was conducted that was divided into three phases.

The third article in Track 2 (Paper 9: Klein, Oschinsky, Stelter, *et al.*, 2021) examines design thinking as an approach to increasing the innovation capacity and design abilities of public administrations. The structured approach can make digitisation (e.g. digital services) inclusive, collaborative, and agile. The work addresses the need to implement collaborative innovation strategies. This potential of the innovation approach to DT is investigated using the example of rural areas. The work is intended as a practice-oriented experience report, and the findings suggest that DT has the potential to enable co-creation and co-production as a governance format. In so doing, the study summarises the experience in five theses.

The fourth study in Track 2 (Paper 11: Oschinsky *et al.*, 2022) uses DSR to investigate the collaboration between different stakeholders in the context of the smart city. In so doing, the work uses a four-step design process and connects evaluation phases in order to design an artifact. The study suggests that DT is a promising governance tool and that the DSR is suitable for studying collaboration in the context of public administrations. Accordingly, the study addresses the problem that existing DT approaches are difficult to adapt to the needs of municipalities. The article contributes to the field by designing a DT format for co-creation and co-design in municipalities.

Track 2: Public Sector as a Design Discipline: Digital Public			
	Problem Space	**Solution Space**	**Process**
P2 (Röding *et al.*, 2019)	Digitisation strategies are important elements and instruments that the public sector needs in order to successfully navigate the path to the smart city.	Guidelines are developed and proposed based on a survey, and they help in developing a digitisation strategy.	A–B–C / (–)–(–)–F
P8 (Klein, Oschinsky, *et al.*, 2021)	Creativity in public administrations must be designed and is not yet a matter of course.	Drivers and barriers are identified in order to design possible interventions.	A–B–C / (–)–(–)–F
P9 (Klein, Oschinsky, Stelter, *et al.*, 2021)	Municipalities need to implement collaborative innovation strategies.	Design thinking is a tool for implementing collaborative innovation strategies and concrete theses. The lessons learned are designed with the goal of supporting municipalities in	A–B–C / D–E–F

		implementing DT in practice.	
P11 (Oschinsky *et al.*, 2022)	Existing design thinking approaches are difficult to adapt to the needs of municipalities.	A design thinking format for co-creation and co-design in municipalities is developed.	A–E–C1–E–C2–E D–E

Table 4. Papers from Track 2, and DSR-Specific Characteristics

3.4 Studies on Creativity Support Systems for Architectural Design: Digital Design

Track 3 includes five articles (Paper 3: Oschinsky *et al.,* 2019; Paper 7: Klein, 2020; Paper 10: Klein, Weber, *et al.*, 2022; Paper 12: Klein, Weber, Niehaves., 2022; Paper 13: Klein, Stelter, *et al.*, 2022) that examine opportunities for designing CSSs in the domain of architectural design (see Table 5). Specifically, the aim is to investigate the underlying patterns of design practice and to further identify opportunities both for AI-driven CSSs and for architects.

The first work in Track 3 of this dissertation (Paper 3: Oschinsky *et al.,* 2019) examines the concept of reflective practice. When deciding to use technology, there is a danger of sticking to familiar ways of working, methods, and tools (i.e. the status quo bias) and thus of disregarding the potential of new technologies and methods.

The second article in Track 3 (Paper 7: Klein, 2020) develops a framework of reflective practice in the digital age that uses the example of the foundational work of D. Schön and specifically the way that Schön describes architects in professional practice. This method enables us both to examine factors that are now fundamentally changing due to the digital transformation and to address the problem. The framework serves as a basis for possible later design activities (e.g. AI-driven support) that can serve to transfer design per se both to other areas and to design systems that in turn help in designing (e.g. designing buildings).

By identifying opportunities to support architectural design, the third article in Track 3 (Paper 10: Klein, Weber, *et al.*, 2022) identifies theory-based DPs in order to design AI-driven CSSs as inspiring stimuli providers for architects. We address the problem that people rely on creativity in design professions such as architectural design engineering, product design, urban design, and systems design. However individual creativity is not inexhaustible, and creativity support is thus essential for these professions. AI offers new possibilities and also goes hand in hand with new questions about designing symbiotic human–AI systems. The DPs we present are based on the theoretical underpinnings of fixation and mental representation abilities. These theoretical assumptions guide the design of the GANs that were used to deliver AI-based stimuli for architects.

The fourth study in Track 3 (Paper 12: Klein, Weber, Niehaves., 2022) developed and evaluated an IS artifact that supports architects in the initial design phase through symbiotic collaboration with AI and that addresses the problem of architects' bounded individual repertoire. For this purpose, GANs were used to enable architects to explore the solution space for the design task in the best possible way. In this way, the AI-driven CSS succeeded in supporting architects by expanding their personal repertoire of solutions. In order to design the IT artifact, DSR was applied, findings were gained via evaluation (i.e. through a literature review, a focus group (n=5), a demonstration, and expert interviews (n=2)), and the IS artifact was developed iteratively during the process.

The fifth study in Track 3 (Paper 13: Klein, Stelter, *et al.*, 2022) examines the rapid development and digital transformation of the architecture, engineering, and construction industry. In the paper, a quantitative survey (n=155) was conducted among architects in Germany. The focus was on exploring resistance to technology in building information modelling (BIM) technology. The study explores the status quo bias as an example of irrational decision-making. The article contributes to the field by designing a taxonomy that classifies different reasons for user resistance to BIM.

Track 3: Creativity Support Systems for Architectural Design: Digital Design			
	Problem Space	**Solution Space**	**Process**
P3 (Oschinsky *et al.,* 2019)	Irrational decisions regarding the use of new technologies can cause these technologies to not be fully exploited.	A framework of possible points of contact of irrational action is designed using the theoretical basis of reflective practice.	A–B–C / (–)–(–)–F

P7 (Klein, 2020)	Previous ways of working are changing due to the digital transformation.	A framework of reflective practice can help us to understand and design digital transformation.	A–B–C / (–)–(–)–F
P10 (Klein, Weber, *et al.*, 2022)	Designers are dependent on creative solutions. CSSs that use AI can be a solution, but there are no solutions for architectural design and no design theories that guide the design of these CSSs.	GRs and DPs are adapted to the context of architectural design, and an explanatory design theory is developed on the theoretical basis of fixation and mental representation abilities.	A–B–C / D–(–)–F
P12 (Klein, Weber, Niehaves., 2022)	Architects' individual repertoire of solutions is determined by individual factors (e.g. experience) and thus always offers the possibility for optimisation with respect to what is theoretically possible.	AI can help to expand architects' repertoires. Using GANs, stimuli are developed and made available to architects in the design process.	A–B–C / D–E–F
P13 (Klein, Stelter, *et al.*, 2022)	Architects' acceptance of BIM is low, but the reasons are not always obvious.	Architects sometimes act irrationally when deciding on BIM use, and a taxonomy is designed that provides a more nuanced view of possible sources of user resistance.	A–B–C / D–E–F

Table 5. Papers from Track 3, and DSR-Specific Characteristics

4 Findings

In the following section, the main results of the thesis are presented. One section each is devoted to the three research questions. The thesis refers to the respective papers of each track with the corresponding research questions. Only the general results of the papers are presented. The figures and tables in this chapter may differ from those in the published articles and from those in the articles in Part B due to revisions, readability, or graphical reasons. For a more detailed presentation of the results, the papers can be found in Chapters 7–20.

Accordingly, in Section 4.1, the universal basics of CSSs are presented. Subsequently, in Section 4.2, the concept of creativity is applied to the public sector. Finally, Section 4.3 presents the results of the study on CSSs in relation to the context of the profession of architecture.

4.1 Individual Creativity Support Systems

In order to answer RQ 1 (i.e. *How can creativity support systems be designed?*), we present five research papers (Paper 1: Jahn *et al.*, 2018; Paper 4: Klein, Oschinsky, *et al.*, 2020; Paper 5: Klein, Oschinsky, Weber, *et al.*, 2020; Paper 6: Klein, Weber, *et al.*, 2020; Paper 14: Klein, Weber, Wang, *et al.*, 2022).

The first short paper from Track 1 (Paper 1: Jahn *et al.*, 2018) proposes an explanatory design theory (see Figure 1) and an evaluation procedure.

The article hypothesises (H1) that environmental congruence leads to higher individual learning performance than does environmental incongruence, (H2) that cognitive absorption (tasks) moderates the relationship between environmental congruence and individual learning performance, and (H3) that cognitive absorption (technology) moderates the relationship between environmental congruence and individual learning performance. Next, the article hypothesises (H4a) that an interaction effect of sensory immersion and environmental congruence influences individual learning performance and (H4b) that the interaction effect of environmental congruence and sensory immersion is mediated by cognitive absorption (technology) for sensory immersion.

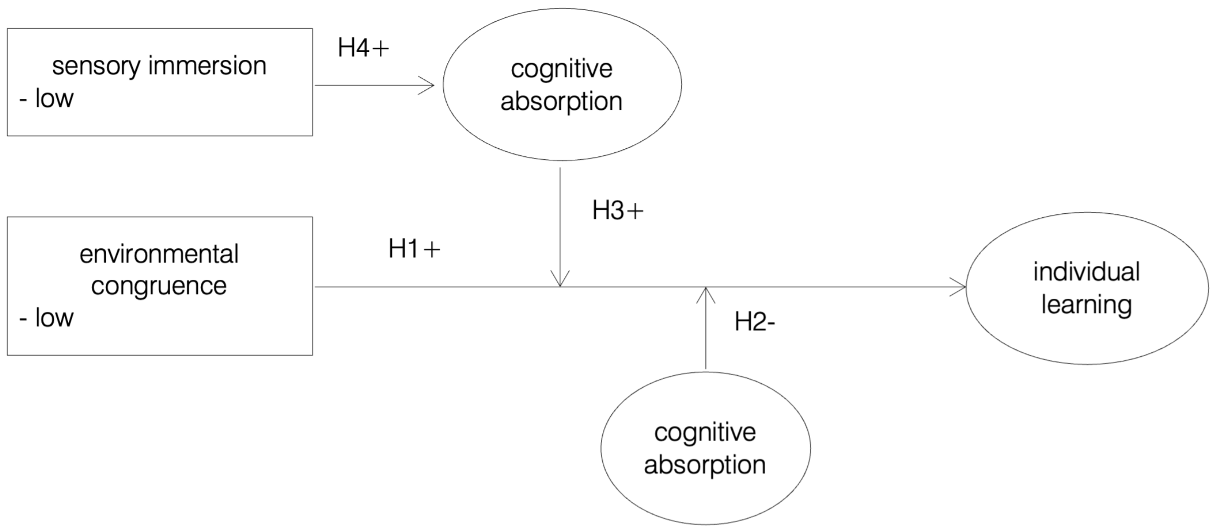

Figure 1. Explanatory Design Theory for Context-Dependent Learning (P1)

The second short paper from Track 1 (Paper 4: Klein, Oschinsky, *et al.*, 2020) makes an initial proposal for a system that supports individual creativity by providing stimuli based on the principle of C-K theory. A distinction is made between expansive and restrictive examples. Design knowledge is derived in terms of GRs and DPs. The general requirements for ambient-technology AI-driven CSSs are that they (1) support the connection between long-term and short-term memory, (2) support iterations, and (3) activate independent frames. The design principles are as follows: (1) The system must present content that builds on what the participants are talking about, (2) the system must create/present more expansive examples or "original elements" as stimuli, and (3) the system must visualise examples and show different groups of examples that do not cause too much mental effort for users. For instantiation, the study proposes an information system architecture that consists of three elements: information input, information processing, and information output. The graphic (Figure 2) below displays a schematic representation of the system.

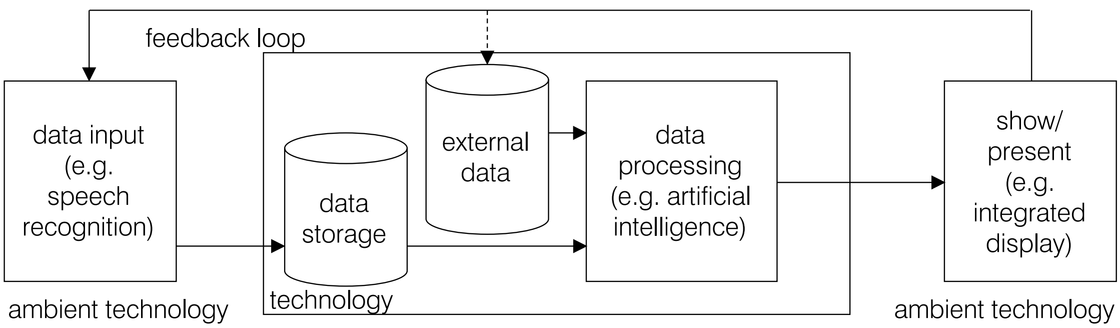

Figure 2. Ambient-Technology AI-Driven CSS (P4)

Another result of the study is its proposed research model for further designing and evaluating the system. The model distinguishes between the two characteristics of expansive and restrictive examples as well as between the two characteristics of text representation and image representation. The characteristics are expected to influence cognitive flexibility or persistence and thus also to influence creative results. Figure 3 presents a schematic representation of the research model.

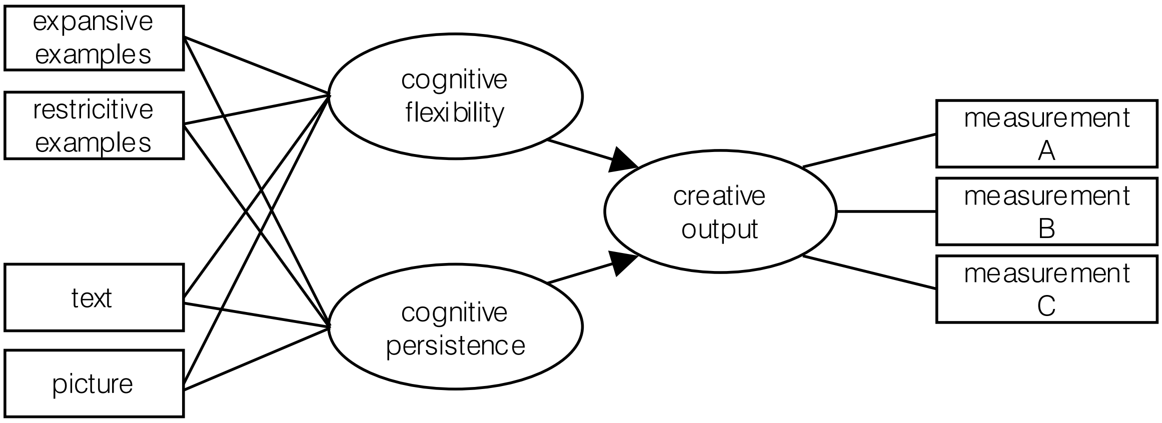

Figure 3. Research Model (P4)

The next article from Track 1 (Paper 5: Klein, Oschinsky, Weber, *et al.*, 2020) makes an initial proposal for designing a CSS. The work identifies the cognitive network model (CNM) as a theoretical model for understanding the idea generation process, and it identifies Perner's model of representational capabilities as an approach for possible stimuli design. Based on these theoretical foundations, the general requirements are that the system (1) support the iterative combinations of frames, (2) activate secondary representations and meta-representations, and (3) help participants to interpret the given stimuli and objects (e.g. by asking "What else could the object be?"). The general components (GCs) and design principles (DPs) of the system are that it must (1) provide stimuli that are generic rather than detailed and realistic and (2) provide stimuli that make relationships between different objects visible. As an instantiation, the work proposes that keywords and concepts be identified through speech recognition and that images of related terms then be presented on a display through a real-time Google search. AI algorithms (e.g. DeepDream, ArtBreeder, and DeepArt) graphically manipulate the images.

The fourth study from Track 1 (Paper 6: Klein, Weber, *et al.*, 2020) used a survey (n=167) to compare individually perceived relatedness and computer-based relatedness. The results suggest that individuals evaluate the relatedness of two concepts differently than the computer-based method (DBpedia) defines this relatedness in certain areas. Through the KGs, there is the possibility to define the relatedness of stimuli and instruments based on algorithms. However, the KGs may differ from individual and individually perceived relatedness. This difference is the subject of the study and was investigated using a survey in which n=167 participants rated computer-based stimuli. We then evaluated the differences and found that significant differences were particularly present for both the second-order concepts and the randomly chosen concepts. Conversely, computer-based relatedness did not always correspond to individual cognitive networks. Figure 4 displays the results.

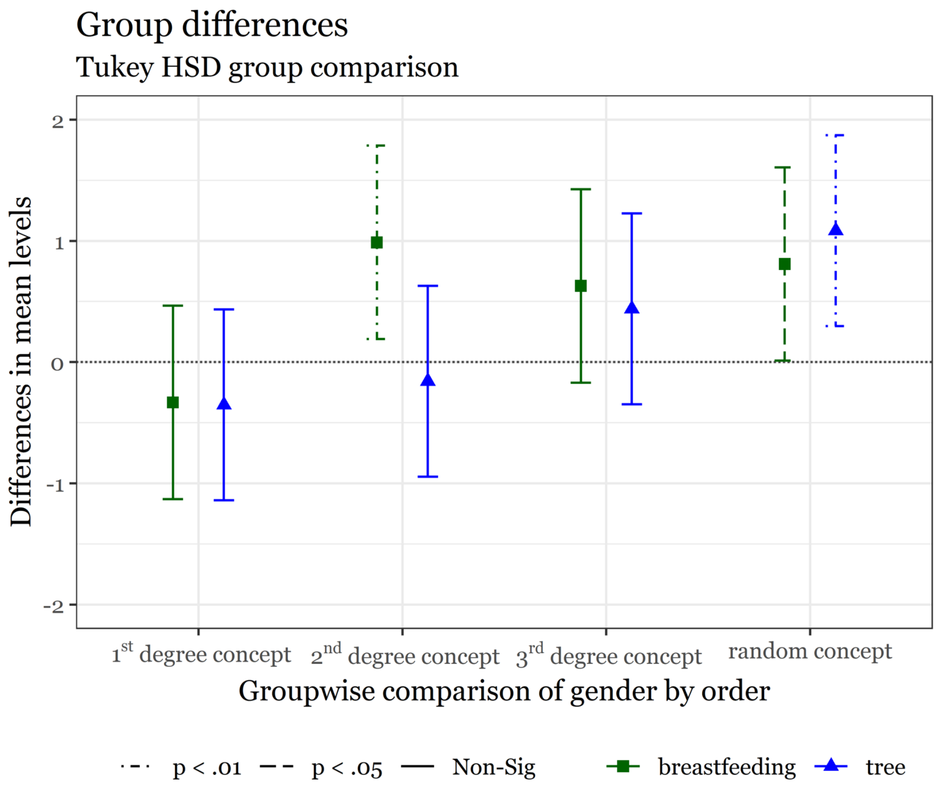

Figure 4. Groupwise Differences (P6)

The fifth study from Track 1 (Paper 14: Klein, Weber, Wang, *et al.*, 2022) used DSR to design a taxonomy for developing contextual stimuli. Our research revealed that perceived relatedness is highly individual. The main aim of the paper was to identify the respective characteristics that constitute different user groups. To do this, we asked 202 people to evaluate computationally derived concepts and found that the dimension of domain knowledge, the personality traits of stability and plasticity, and task-specific variables yielded different perceptions of computational relatedness (see Figure 5). In a subsequent cluster analysis, we developed two variants: Variant 1 is a two-cluster solution, and Variant 2 is a four-cluster solution. From these two variants, different archetypes can be derived based on which individualised stimuli are developed.

Category	Dimension	Characteristics
Relatedness fit	Relatedness fit	Underestimate/overestimate
Knowledge-/Experience-based variables	Domain knowledge	Low/high
Personality traits	Stability	Low/high
	Plasticity	Low/high
Task-specific variables	Task perception	Utilitarian/hedonic
	Task complexity	Low/high

Figure 5. Revised Taxonomy for Individualised Stimuli

4.2 Public Sector as a Design Discipline: Digital Public

In order to answer RQ 2 (i.e. *How can digital services, processes, and products be designed in the context of smart cities?*), we published four research papers (Paper 2: Röding *et al.*, 2019; Paper 8: Klein, Oschinsky, *et al.*, 2021; Paper 9: Klein, Oschinsky, Stelter, *et al.*, 2021; Paper 11: Oschinsky *et al.*, 2022).

The first article from Track 2 (Paper 2: Röding *et al.*, 2019) examined digitisation strategies in the public sector. A study of the documents revealed that citizens were involved in the development of the strategy in 43% of cases, that stakeholders from the business community were involved in 29% of cases, and that stakeholders from academia were involved in 52% of cases. The survey found that mayors were responsible for developing the digitisation strategy in 82% of cases and that mayors were responsible for implementing the strategy in 66% of cases. In terms of citizen involvement, 88% of the surveyed municipalities enabled questions from citizens, 62% involved citizens in decision-making, and 51% involved citizens in the implementation process. In addition, 87% of the surveyed municipalities involved outside experts in developing the strategy, 50% involved scientific participation, and 39% involved city-owned businesses. Based on these findings, the study derived the following recommendations for action: (1) Digitisation is a leadership issue, (2) digitisation requires participatory processes, (3) digitisation strategies require competencies, and (4) digitisation is a community task.

The second article from Track 2 (Paper 8: Klein, Oschinsky, *et al.*, 2021) aimed to identify drivers of and barriers to creativity in German administrations. The following four themes were identified (see Figure 6): (1) creativity and self-efficacy (i.e. the belief of being able to develop creative ideas is not self-evident in the administration), (2) complexity and application (i.e. it is not easy to transfer creative ways of working to daily tasks), (3) organisational structure (i.e. there is a lack of belief that creative ways of working are possible in rigid bureaucratic structures), and (4) mindset (i.e. there is a lack of a mindset and belief that creative ways of working are desired and allowed). The following four drivers and barriers were identified and assigned to the categories of the 4-Ps model: (1) process (i.e. due to the high complexity of problem-solving tasks, a structured process – such as design thinking – can be helpful in fostering individual creativity), (2) person (i.e. as administrative staff often lack creativity strategies, it can be helpful to foster individual self-efficacy through CSSs or teaching strategies, such as design heuristics/principles), (3) product (i.e. being user-centric and clearly defining the product – such as a digital service – can succeed in fostering individual creativity because administrators act in the interest of the public good), and (4) environment (i.e. administrations can foster individual creativity by systematically establishing a creativity-enhancing mindset).

Theme	Definition (provided by the authors)
T1: *Creative self-efficacy*	The belief of being able to produce creative ideas.
T2: *Complexity and application*	The barrier to transferring the principles of creative work to everyday work.
T3: *Organisational structure*	The belief that creative work is possible.
T4: *Mindset*	The belief that creative work is allowed and desired.

Figure 6. Thematical Overview (P8)

Article 3 from Track 2 (Paper 9: Klein, Oschinsky, Stelter, *et al.*, 2021) is a field report on the use of DT in co-producing and co-designing that summarises the results in five theses and associated lessons learned (LLs), which are discussed in the study. In Table 6, the theses and LLs are summarised. They were translated from German into English for better readability.

#	Theses with respective lessons learned (LLs)
1	Design thinking is inclusive: How design thinking creates a participation format for communities

	LL 1: The direct participation of affected groups can lead to limitations in the solution space. Therefore, it is worthwhile to thoroughly investigate the needs that potential users have even before they participate in the workshops.
2	Design thinking is collaborative: Why many perspectives help but there are some important things to keep in mind
	LL 2: Making a differentiated distinction between the involved stakeholders helps us to understand and appreciate the different perspectives of the involved actors and to integrate the stakeholders according to their backgrounds. We distinguish between the project team, content stakeholders, thematic experts, users/citizens, and framing stakeholders.
3	Design thinking helps with agile working: Why design thinking is based on agile principles but it is always necessary to consider the specific user context
	LL 3: Design thinking can overwhelm untrained stakeholders and exceed the timeframe for a workshop. It is therefore worthwhile to carry out certain phases of design thinking in advance or afterwards in smaller groups.
4	Design thinking is not only a means to an end: Why design thinking is also a good change management tool
	LL 4: In addition to its use in working on complex and multi-layered problems, design thinking is also a promising change management tool.
5	Design thinking combines planning and freedom: Why design thinking must offer openness to surprise but there should be no unwanted surprises
	LL 5: An open and agile way of working requires a controlled structure that enables orderly project management.

Table 6. Theses and Lessons Learned (P9)

The fourth article from Track 2 (Paper 11: Oschinsky *et al.*, 2022) used DSR to develop a DT format for implementing innovative collaboration strategies in administrations. The team-oriented findings reveal that it is very important to involve many different actors, but this finding is not dogmatic for all process steps. For this purpose, the work proposes making a distinction between actors as follows: project team, content-related stakeholders, users, framing stakeholders, thematic experts. The process-oriented findings indicate that a three-phase distinction should be made in the process and in the respective participation of the stakeholders (i.e. finding needs, ideation, testing). In this way, it is possible to meet the requirements of each phase. The workspace-oriented findings reveal that new requirements for a DT format arise when the format takes place purely online. These requirements include the notions that the tasks must be clearly defined, that interruptions should be avoided, and that the usefulness of digital tools (e.g. Mural and/or Zoom) should be optimised so that the stress caused to the participants by using the technology is as low as possible. Overarchingly, the work demonstrates that it is critical to involve the right stakeholders in the design of future smart cities when designing new products and services. In so doing, the tension between heterogeneity (i.e. all participants have a different position and perspective on the problem) and homogeneity (i.e. all participants have the same position and perspective) must be balanced. The developed project plan can be seen as a kind of canvas that can be used to help future projects develop their own design thinking format. Furthermore, we demonstrated that the DT approach is suitable for creating DT formats (artifacts).

4.3 Creativity Support Systems for Architectural Design: Digital Design

In order to answer RQ 3 (i.e. *How can creativity support systems be designed within architectural design?*), we developed five research papers (Paper 3: Oschinsky, *et al.*, 2019; Paper 7: Klein, 2020; Paper 10: Klein, Weber, *et al.*, 2022; Paper 12: Klein, Weber, Niehaves, *et al.*, 2022; Paper 13: Klein, Stelter, *et al.*, 2022).

The first short paper from Track 3 (Paper 3: Oschinsky, *et al.*, 2019) contributes to a better understanding of digital transformation (and thus also to a better understanding of the use of technology) in practice. The study designed a framework for identifying the points at which uncertainty, instability, uniqueness, and value conflicts can lead to irrational behaviour with technology in practice. To that end, the paper presents a framework that identifies possible cognitive biases at two points: First, irrational behaviour can occur when practitioners' existing solutions are applied without reflection. Using technology as an example, this means that new technologies are not even considered. At this point, rational decision-making, cognitive misperception, and psychological commitment can explain the bias. The second point occurs when possible "futures" are not evaluated neutrally and the solution or idea that has been developed is instead maintained. Again, rational decision-making, cognitive misperception, and psychological commitment can explain the bias.

The second article from Track 3 (Paper 7: Klein, 2020) identified three dimensions that influence architects' work and that thus serve as a basis for situating the changes brought about by digital transformation in the context of reflective practice (knowing in action (KiA), reflection in action (RiA), and reflection on action (RoA)) (see Figure 7).

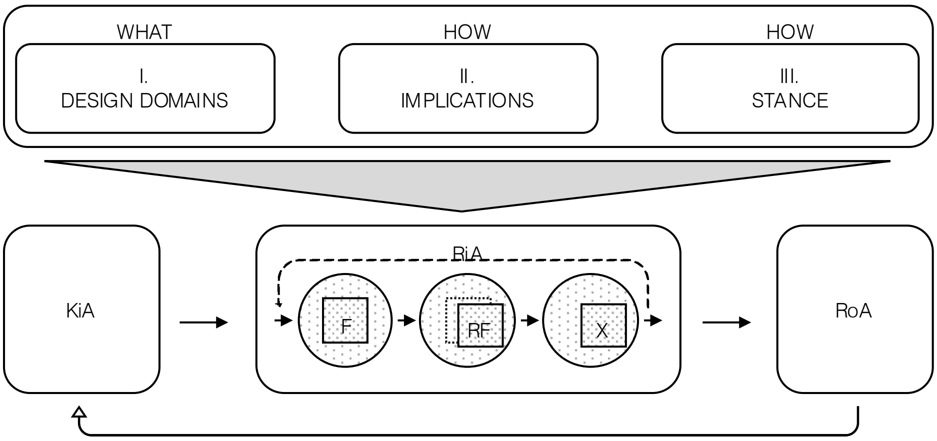

Figure 7. Framework of Reflective Practice (P7)

The third short paper from Track 3 (Paper 10: Klein, Weber, *et al.*, 2022) was presented at DESRIST. The work identifies new possibilities to design CSSs for designers and uses new theoretical assumptions about the concept of fixation and mental representation abilities to design CSSs. The GRs and DPs from prior research are adapted, and a design theory for AI-driven inspiration is proposed (see Figure 8). The paper's main conceptual underpinning is to use abstract stimuli to enable transfer and creative problem solving without trigger fixation.

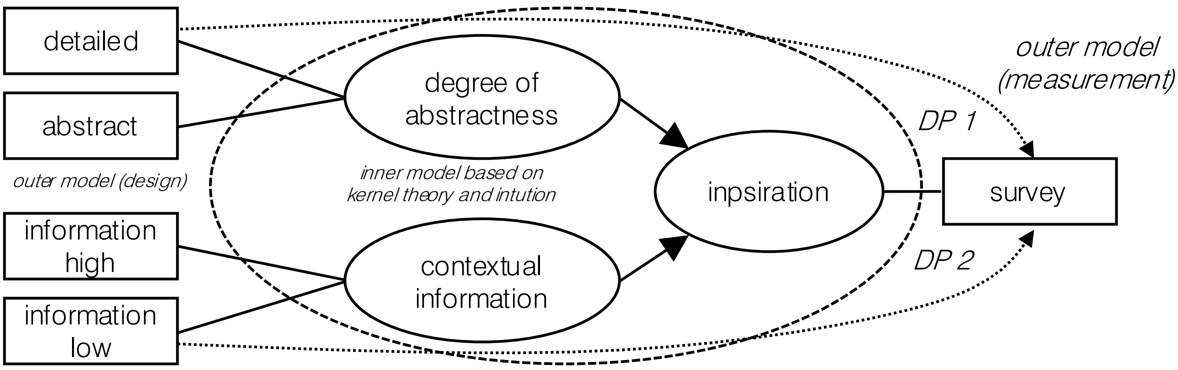

Figure 8. Design Theory (P10)

In the fourth study from Track 3 (Paper 12: Klein, Weber, Niehaves, *et al.*, 2022), a system for architects that uses AI was developed using DSR. The study identified three issues that are important when using such an artifact: the degree of freedom, trust, and variations. The evaluation revealed that these three variables have an impact on the use of such a system. We addressed these variables in the form of DPs. In addition, we implemented and evaluated the DPs. Table 7 below describes the variables.

Theme	Design Principle	Implementation
Degree of freedom	An AI-driven ADSS should provide a high degree of freedom.	In order to achieve a high degree of freedom, we considered the actual method of work performed by the architects. As architects use pen and paper as well as real models, we provided stimuli in the form of building floorplans in a printed catalogue, which allowed for manifold ways of using, manipulating, and ignoring the floorplans.
Trust in the system's creative performance	An AI-driven ADSS should provide information about the principles of ML, the dataset, and the principles of generating stimuli.	In order to facilitate trust in the system´s creative performance, we held an initial presentation and informed the architects about the principles of the AI-driven ADSS and about the database we had used to generate the stimuli.
Variations	An AI-driven ADSS should provide a high number of variations of the shown stimuli.	In order to achieve a high number of variations, we enabled our system to be fed with input. This was implemented via two additional parameters (i.e. a planned entrance to the site and a planned entrance to the building), which could be changed. Thus, we allowed for several items of output.

Table 7. Design Principles and Implementation

The fifth article from Track 3 (Paper 13: Klein, Stelter, *et al.*, 2022) provides empirical insights into architects' acceptance of building information modelling (BIM). The paper used a quantitative questionnaire study (n=450) that revealed that 59.2% of the surveyed architects did not use BIM, and the adoption rate among the respondents was low. The study identified and conceptualised important characteristics from the SQB perspective and classified different biases in a taxonomy (see Figure 9, which was adapted following the second round of revisions). Rational decision-making and psychological commitment are the two overarching concepts in which sunk cost and uncertainty costs arise with user resistance to BIM.

<table>
<tr><td colspan="2"></td><td colspan="2">Dimensions</td></tr>
<tr><td rowspan="6">Categories</td><td>Technical</td><td colspan="2">*e.g. data interoperability (Shehzad et al. 2021)</td></tr>
<tr><td>Financial</td><td colspan="2">*e.g. unclear roles (Becerik-Gerber et al. 2012) or no client demand (Heaton et al. 2019)</td></tr>
<tr><td rowspan="4">Organizational</td><td>Rational (decision-making)</td><td>*e.g. no time for training or lack of a legal framework (Becerik-Gerber et al. 2012)</td></tr>
<tr><td rowspan="3">Irrational (decision-making)</td><td>Position
(see Table 1. Control Variables (CV))</td></tr>
<tr><td>Uncertainty costs
(see Table 1. Rational Decision-Making (RDM))</td></tr>
<tr><td>Sunk costs
(see Table 1. Psychological Commitment (PC))</td></tr>
<tr><td colspan="4">* Dimensions that are identified in the literature</td></tr>
</table>

Figure 9. Taxonomy (P13)

5 Discussion

5.1 Main Contributions

The aim of the present work is to contribute to a better understanding both of the role that technology plays in human creativity and of related knowledge about information-system-driven creativity. The aim is thus to generate general knowledge about designing individual CSSs on the one hand and about designing creativity support in the two application areas of the public sector and architectural design on the other hand. The actual main contributions of each paper are discussed in detail in each of the individual articles. The present section answers the research questions that were formulated in Section 1.2.

Ad RQ 1: How can creativity support systems be designed?

With respect to Research Question 1, the present work contributes to the current literature in the field of IS in three ways: To begin, the first article (Paper 1: Jahn *et al.*, 2018) highlights promising opportunities for using VR to enhance individual learning performance through environmental congruence. From this line of research, opportunities emerge for designing individual CSSs using VR and for employing environmental congruence as a design variable in the design of individual CSSs.

Second, two articles (Paper 4: Klein, Oschinsky, *et al.*, 2020; Paper 5: Klein, Oschinsky, Weber, *et al.*, 2020) identify ways in which AI-based CSSs can be designed and thereby contribute to the current discussion on CSS design. The first article (Paper 4: Klein, Oschinsky, *et al.*, 2020) identifies theoretical foundations (C-K theory) and addresses the fundamental problem of lacking or low inspiration. Through restrictive and expansive examples in the form of stimuli, the paper finds that individual creative performance might be able to be enhanced. In addition, the paper also makes a proposal for implementing an information system in the form of ambient technology. The second article (Paper 5: Klein, Oschinsky, Weber, *et al.*, 2020) addresses the problem of mental blockage (fixation) in idea generation and contributes to the RQ through individual stimuli based on AI (abstract to realistic) that can be used to prevent or resolve mental blockage. Furthermore, the work also makes suggestions for DPs and GRs, thereby contributing to the solution space and thus also revealing another possibility for design. In so doing, this dissertation identifies theory-based opportunities for designing CSSs.

Third, two articles (Paper 6: Klein, Weber, *et al.*, 2020; Paper 14: Klein, Weber, Wang, *et al.*, 2022) point out possibilities for designs that take into account the phenomenon of relatedness, thereby identifying problems in the application of KGs and suggesting solutions. Paper 6 (Paper 6: Klein, Weber, *et al.*, 2020) tackles the disadvantage that computer-based methods of identifying context-related stimuli have in terms of the fact that individual factors in the perception of the stimuli are not considered with respect to the relatedness of the concepts. Paper 14 (Paper 14: Klein, Weber, Wang, *et al.*, 2022) builds on these findings and proposes a taxonomy that addresses individual factors that are important for perceived stimuli relatedness. Thus, both a fundamental contribution to the individualisation of CSSs and suggestions for the design of individualised CSSs are made.

Taken together, the above-mentioned articles highlight opportunities for designing individual CSSs, and they identify individual stimuli as well as individual context-related stimuli as promising opportunities for designing CSSs. Each of the three articles offers different ways of designing individual stimuli to enhance creativity. The theoretical underpinnings (i.e. cognitive absorption, CNM, fixation, and the relatedness of the stimuli) and design opportunities (i.e. environmental congruence, expansive and restrictive examples, abstract and realistic stimuli, and individualised stimuli) of the individual stimuli are identified. Future research in IS can build on this finding, and design-oriented research can find points of contact. In terms of practice, this work provides numerous possibilities for designing individualised CSSs.

Ad RQ 2: How can digital services, processes, and products be designed in the context of smart cities?

With respect to Research Question 2, the present work contributes in three ways: To begin, the first article in Track 2 (Paper 2: Röding *et al.*, 2019) provides guidelines for designing digitisation strategies in the context of the public sector. In so doing, the article identifies digitisation strategies as an important element in designing smart cities. In addition to highlighting the importance of digitisation strategies, the article also provides guidelines for designing these digitisation strategies.

The second article from Track 2 (Paper 8: Klein, Oschinsky, *et al.*, 2021) provides insights into drivers and barriers related to creative ways of working, which serve as an important basis for designing digital services, processes, and products in the context of both smart cities and participation. Thus, interventions and systems can take these drivers and barriers into account and point to better outcomes in terms of their impact. Furthermore, the work serves as a basis for further research into creative ways of working in the context of the public sector.

The third and fourth articles from this track (Paper 9: Klein, Oschinsky, Stelter, *et al.*, 2021; Paper 11: Oschinsky *et al.*, 2022) provide insights into how innovation strategies in the context of the public sector can be implemented with the help of the innovation approach of DT. Both articles provide important insights into how to implement creativity-supporting methods and initiatives while considering sector-specific factors of the public sector. The third article (Paper 9: Klein, Oschinsky, Stelter, *et al.*, 2021) provides lessons learned in the form of a field report on the possibilities for designing digital services, processes, and products in the context of both smart cities and participation. The fourth article (Paper 11: Oschinsky *et al.*, 2022) reveals opportunities in the form of a DT format for co-creation and co-design in municipalities.

Taken together, these articles demonstrate the importance of creative ways of working in the public sector when it comes to designing and evaluating creativity-supporting initiatives. The relevance of this work for IS research is twofold: First, the importance of creativity in designing smart cities is elaborated, and second, creativity-supporting initiatives are designed that – in turn – support the design of digital services, processes, and products in the context of both smart cities and participation. Research benefits from designed artifacts (i.e. guidelines, LLs, and the DT format) that can be further developed and transferred to other contexts. Practice also benefits from creativity-supporting interventions as well as from recommendations for action (i.e. the DT format, LLs, and guidelines) when designing digital services, processes, and products in the context of smart cities and participation.

> *Ad RQ 3: How can creativity support systems be designed within architectural design?*

With respect to Research Question 3, the present work contributes in three ways: First, two papers (Paper 3: Oschinsky *et al.,* 2019; Paper 7: Klein, 2020) provide a basis for understanding architects' work in practice and offer frameworks in relation to a theory of practice. Paper 3 (Paper 3: Oschinsky *et al.,* 2019) specifically addresses the SQB perspective and thus provides foundational knowledge for CSSs in architectural design that must be considered. Situations in practice are pointed out in which potentially irrational decisions can occur. Paper 7 (Paper 7: Klein, 2020) provides a further basis for understanding how architects work in practice and design and thus enables possible design variables for CSSs in architectural design to be derived.

Second, in two further papers (Paper 10: Klein, Weber, *et al.*, 2022; Paper 12: Klein, Weber, Niehaves., 2022), CSSs for architectural design are designed and evaluated. While the first work is conceptual in nature, the second work provides a system that is tested in situ. The work demonstrates a potential CSS for architectural design and evaluates it, thereby revealing a further possibility for designing a CSS within architectural design (i.e. GANs and AI). The technology of GANs is demonstrated as an opportunity to support architectural design in the form of an AI-based CSS.

Third, one study (Paper 13: Klein, Stelter, *et al.*, 2022) provides insights into the use of BIM. The study highlights the importance of previously identified irrational decisions and thus provides further knowledge related to the design of CSSs. At the same time, the identified biases and the designed and evaluated taxonomy serve as a design opportunity to develop CSSs in architectural design.

In summary, AI and – in particular – generative technologies such as GANs provide a way to support architects in architectural design. Furthermore, the SQB perspective aids in designing CSSs in the application area, and individual biases need to be considered when designing CSSs. Research benefits both from empirical results from AI-driven CSSs in the field of architectural design that have been designed and evaluated and from results regarding the SQB perspective when it comes to the use of CSSs. The investigation into and further development of this and other application areas provides a foundation for future research in IS. The practice can (1) benefit from the identified possibilities for design, (2) consider the SQB perspective, and (3) utilize the developed AI-driven CSSs, which provide a basis as a concrete possibility for designing CSSs within architectural design.

Overall, this dissertation contributes to a new understanding of information-system-driven creativity. One possibility for using such creativity is to design technical solutions in a way that maximises performance in terms of technical creativity. Thus, it is important to develop new approaches and to provide solutions in a deterministic domain in which performance in terms of effectiveness and efficiency is the independent variable for human effort. Another option is to support human creativity with existing and established systems and solutions while exploring how human creativity is influenced. As human creativity is multifaceted and not fully understood, it is also critical to view these opportunities in terms of human decision-making and creativity in the realm of heuristics and beyond rational decision-making processes.

However, this work proposes examining the two aspects of human creativity and technical creativity in combination and viewing them as two sides of the same coin. In so doing, a special contribution is made to DSR, which has always examined both the technical and behavioural aspects of design. The work goes beyond the current state of research by examining hybrid creativity in the context of professional applications, where creativity is indispensable and forms part of the way that professionals think and act. Thus, the work builds a new interdisciplinary bridge and opens possibilities for exploring and designing hybrid forms of AI. Furthermore, this approach enables us not only to understand AI as a interchangeable element in human–technology interaction, but also to foster emergent phenomena in the collaboration between human creativity and technical creativity and thus to allow more than merely the sum of both types of creativity to emerge in the collaboration.

In the work, I examine specific domains and illustrate both that there are no standard solutions and that information-system creativity must thus be analysed individually in each context. The different design approaches, design processes, and design methods play just as important a role as the technology that is used to support them. Existing solutions are not simply transferable to other domains; rather, they must be re-designed again and again depending on the context. For domains in which creativity and design activities are dominant, it is particularly important to consider these activities separately since principles from deterministic working methods cannot simply be transferred from one to the other. As a result, the design of information-system-driven creativity is a highly interesting and promising field within IS research.

5.2 Limitations and Future Research

Several limitations are mentioned in each paper in this thesis. For a more detailed presentation of the limitations, the papers can be found in Chapters 7–20. The present section focuses on the general limitation of the thesis. Three main limitations are described below.

First, technological solutions can only be captured contemporarily during the period in which the papers were developed and published. For example, AI, ML, KGs, and GANs are important technological developments that are considered in this thesis. However, these techniques and approaches were developed quickly, and new versions are frequently being found. Therefore, the thesis can only grasp recent developments. Further research could build on the developments we have derived in this thesis and design new artifacts that are inspired by the thesis or further design these artifacts iteratively.

Second, due to the design-oriented approach of the thesis, the empirical investigation into specific constructs and theoretical underpinnings is limited. While the conceptual development of solutions that can be further tested represents an important part of the work, some papers are only research-in-progress papers and thus lack an evaluation of the developed solutions. Therefore, an empirical evaluation of the designed artifacts would be an interesting path for further research, especially in connection with the iterative development of the artifacts and solutions.

Third, creativity is important in several fields. We applied our design-oriented approach in only two areas of application (i.e. the public sector and architectural design). Further research could thus apply our findings to more areas of application.

5.3 Conclusion

Due to the importance of creative work, information-system-driven creativity is becoming increasingly critical in modern societies. Accordingly, the insights gained in this thesis serve as important starting points for future research and for designing both CSSs and creativity-supporting initiatives.

The structured approach of the thesis allows us to identify, design, and evaluate opportunities for designing future creativity support initiatives and systems both systematically and in relation to (1) general individual CSSs, (2) creativity-support initiatives in the public sector, and (3) CSSs in the field of architectural design. Through the design-oriented approach of DSR, the work not only presents identified opportunities, but also designs and evaluates them. Track 1 of the thesis provides the theoretical foundations and knowledge needed to design context-related stimuli in CSSs and thus contributes to the current research on AI-based CSSs and the use of KGs. Track 2 of the thesis derives insights regarding creative work and the implementation of innovation strategies in the public sector for designing digital services, processes, and products in the context of smart cities and participation. The thesis thus reveals opportunities for further designing digital services, processes, and products. In so doing, the work highlights the importance of and opportunities for the innovation approach to DT. Track 3 of the thesis identifies opportunities for AI to support architectural design, and it designs and evaluates CSSs for the application area of architects. Irrational decision-making in relation to the use of technological support is considered.

In summary, this thesis provides rich insights that strengthen human creativity with the help of technological support. It contributes to research by identifying new phenomena and elaborating design options (e.g. identifying context-related stimuli and designing AI-based CSSs). The work contributes to practice by identifying and exploring design opportunities for CSSs and creativity-supporting initiatives in concrete application examples (e.g. a DT format for the public sector and AI-based CSSs for architects). Future work could build on these contributions and transfer the findings to other domains, investigate ethical implications, or iteratively develop the artifacts further.

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Part B

7 Paper 1: Towards an Explanatory Design Theory for Context-dependent Learning in Immersive Virtual Reality

Titel	Towards an Explanatory Design Theory for Context-dependent Learning in Immersive Virtual Reality
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Table 8. Fact Sheet Paper 1

[1] the stated affilations of the co-authors refer in this dissertation to the time of the publications

Towards an Explanatory Design Theory for Context-dependent Learning in Immersive Virtual Reality

Abstract. *Immersive virtual reality (IVR) is increasingly used for learning. However, research on specific designs for IVRs which can be used to enhance individual learning performance is still at an early stage. In this research-in-progress paper, we build upon theories on context-dependent learning to develop an explanatory design theory. We hypothesize that if the user learns in a virtual environment that represents the recall environment (environmental congruence), recall is facilitated. Additionally, if the IVR is designed with a high degree of sensory immersion, the effect of environmental congruence on learning is further increased through enhanced cognitive absorption in the technology. In contrast, cognitive absorption in the task should have a reversed effect. To test the explanatory design theory, we plan to conduct a 2 (learning environment: Room A vs. Room B) x 2 (sensory immersion: low vs. high) x 2 (recall environment: Room A vs. Room B) between-subjects laboratory experiment.*

Keywords. *immersive virtual reality, cognitive absorption, context-dependent learning, place-dependent learning, explanatory design theory, design science, laboratory experiment*

7.1 Introduction

Forms of immersive virtual reality (IVR), a technology in which the user is completely absorbed into by the use of head-mounted displays, are increasingly used for learning in different contexts. There are IVR applications used for learning in schools, universities and in health care (Martín-Gutiérrez et al. 2017). Additionally, organizations such as VW started to use IVR for letting their employees learn new organizational processes (Hayden 2018).

IVR has not only the advantage that learning can be designed highly engaging by involving the learner deeply into what they are doing, but also that it can be used to re-create places that are not available to the learner. For learning, the latter can be especially beneficial because of environmental context-dependent memory. According to research on environmental context-dependent memories (Isarida and Isarida, 2014), learning and recalling in the same place is more beneficial for individual learning performance than learning and recalling in different places. However, to the best of our knowledge, there is no research on how environmental context-dependent memory effects can be recreated.

With the research-in-progress paper at hand, we want to address the following research question (RQ).

> *RQ: How can IVR be designed to enhance context-dependent learning when it is not possible to learn in the environment where recall takes place?*

Explanatory design theories (Baskerville and Pries-Heje 2010; Gregor 2009; Kuechler and Vaishnavi 2012; Niehaves and Ortbach 2016) can answer this research question by not only stating how to design an artifact, but also explain why specific design options have specific effects (Gregor 2009; Kuechler and Vaishnavi 2012) through the use of structural equation modeling terminology (Niehaves and Ortbach 2016). In this research-in-progress paper, we draw upon theories on environmental context-dependent memory and cognitive absorption (CA) to develop an explanatory design theory for context-dependent learning that answers our research question (see Figure 10). We propose that environmental congruence enhances individual learning performance and that this effect is further increased by a high degree of sensory immersion which increases CA in the technology through heightened presence. We plan to conduct a 2 (learning environment: Room A vs. Room B) x 2 (sensory immersion: low vs. high) x 2 (recall environment: Room A vs. Room B) between-subjects experiment to test the explanatory design theory.

7.2 Theoretical Background and Model Development

Environmental Context-Dependent Learning

Theories about context-dependent memory (Isarida and Isarida 2014; Smith and Vela 2001) state that different contextual cues can affect recall of target information. Whereas target information is defined as the information that should be remembered, contextual cues represent information that is not the target information but was present (physically or mentally) during encoding. If the context is encoded with the target information, the context can be used as retrieval cue for remembering (Isarida and Isarida 2014). Therefore, the learning performance of individuals (individual learning performance, ILP) can be enhanced through the use of context-dependent learning.

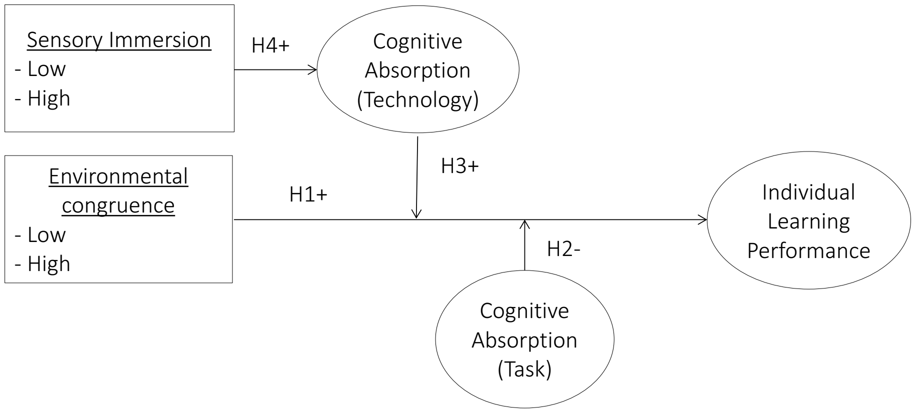

Figure 10. Explanatory Design Theory for Context-dependent Learning

Theories about environmental context-dependent memory specify this effect for aspects related to the environment in which the target information was learned (Isarida and Isarida 2014). Environmental context can consist of the larger environment, such as place (Smith and Vela 2001) or specific aspects of the environment, such as odor (Isarida et al. 2014), background color (Isarida and Isarin 2007), or background music (Isarida et al. 2017). For example, when an employee learns how to use a machine, new to the organization in an office, different elements of the learning environment (e.g. lightning, desktop computer, background music) can be encoded with the target information during learning. Therefore, recall of the target information might be hindered, when the employee tries to remember it in a different learning environment, such as a production hall, which consists of different environmental elements.

With physical reinstatement of the environment in which the learning took place, recall is facilitated (Godden and Baddeley 1975; Isarida and Isarida 2014; Smith et al. 1978). In the case of the employee, if they return to the office, the physical reinstatement of the environmental context could enhance recall, because the elements of the environmental context were encoded together with the target information. However, physical reinstatement is often difficult in practice. Returning to the office for recall every time the machine gives an error message which the employee learned at the office would be time-consuming. Additionally, returning to the office might not be a helpful solution if the employee has to remember the information in the production hall while using the machine and not in the office. Therefore, an alternative to physical reinstatement would be mental reinstatement – the mental visualization of the environmental learning context. However, mental reinstatement can be too difficult in some circumstances (Canas and Nelson

1986) or needs to be requested explicitly in order to be used for some individuals (e.g. older adults, Fernández and Alonso 2001).

With the use of IVR, it is possible to simulate the context almost completely without being physically located in the initial learning environment. Thus, with the use of IVR in the learning situation, employees could benefit from the advantages of physical reinstatement without the costs of mental reinstatement. However, to the best of our knowledge, research on using IVR in the learning situation has not yet been done. Based on the described place-dependent memory effects in real learning and recall environments, we assume that learning and recall in a congruent environment is more beneficial to the user than learning und recall in an incongruent environment. Regarding the design, we therefore hypothesize that learning in a room that is congruent to the recall room is more beneficial for recall than learning in a room that is incongruent to the recall room.

> *H1: Environmental congruence leads to a higher ILP than environmental incongruence.*

Cognitive Absorption

In the field of learning, cognitive absorption (CA), also called flow, refers to a state in which an individual is completely involved with a task (CA_TASK, Csikszentmihalyi 1990). CA_TASK is usually identified to be a desirable state for learning (see Table 9 for an overview of construct definitions). However, some research on CA_TASK suggested that high levels can be detrimental because context effects are blocked out (Magni et al. 2013). Likewise, research on environmental context-dependent learning has indicated that a high involvement with the task, and therefore high CA_TASK, decreases ILP because the environment is blocked out (Smith and Vela 2001). We therefore hypothesize that CA_TASK moderates the effect of environmental congruence on ILP.

> *H2: CA_TASK moderates the relationship between environmental congruence and ILP. For individuals with a low level of CA_TASK, the relationship between environmental congruence and ILP will be higher than for individuals with a high level of CA_TASK.*

In the field of Information Systems, CA has been conceptualized as the state of being completely immersed in a technology (CA_TECH, Agarwal and Karahanna 2000; Burton-Jones and Straub 2006), letting the role of the context strongly depend on the technology referred to. For example, in the study of Agarwal and Karahanna (2000), the technology in which an individual was cognitively absorbed in was the web, whereas Burton-Jones and Straub (2006) referred to MS Excel. If these constructs initially developed in the context of technology acceptance are adapted in the field of learning, it is important to note the different implications a high CA_TECH might have in both cases. If an individual has to learn something in the web, a high CA in the web does not necessarily imply a high CA_TASK because the web can be used in a range of task-unrelated ways very easily. In contrast, MS Excel still can be used in task-unrelated ways while being highly cognitive absorbed (e.g. drawing pictures instead of calculation), but the affordance for these alternatives is probably much lower than in the case of the web.

In the context of IVR, CA_TECH leaves the user even more room for task-unrelated activities. By sealing the participants from the actual world through a head-mounted display and earphones, an almost completely immersing new virtual world is created. Therefore, context that would traditionally be neither part of the task nor part of the technology (e.g., a cupboard displayed in the IVR) becomes a part of the technology. Thus, the meaning of CA_TECH changes dramatically in IVR by covering a much broader range of the environment.

Construct	Definition	Source
Cognitive absorption in task (CA_TASK)	Cognitive absorption is defined as an enjoyable state of deep (cognitive) involvement in the performed task.	(Csikszentmihalyi 1990)
Cognitive absorption in technology (CA_TECH)	Cognitivie absorption is defined as an enjoyable state of deep (cognitive) involvement with the technology used.	Agarwal and Karahanna (2000)
Telepresence	Telepresence refers to perception of the user in contrast to the technology design. It is defined as the degree to which an individual perceives to be in a distant place.	(Schultze 2010, 2014)
Sensory Immersion	Sensory immersion describes the design of the technology in contrast to the perception of the user. It is defined as the degree to which a	(Schultze 2010, 2014; Slater and Wilbur 1997)

	technology can achieve convincing illusion of reality to the users' senses.	

Table 9. Construct Definitions

Whereas the described unspecificity of CA_TECH is not that important for studies of technology acceptance, it needs to be addressed in the area of learning because of the confusion with CA_TASK. Studies that have used items that resembled CA_TECH instead of CA_TASK in the learning context showed that CA_TECH might enhance learning through a motivational route by affecting learner satisfaction (Leong 2011) and continued use (Guo et al. 2016) as well as perceived learning (Reychav and Wu 2015). However, these studies did not vary cognitive absorption experimentally and used technologies such as computers, smartphones or tablets instead of IVR. For the relationship between CA_TECH and learning in an IVR, a qualitative research gives initial support for a relationship between CA_TECH and learning (Kampling 2018). Therefore, we want to address this research gap and investigate whether CA_TECH has an influence on actual (instead of perceived) learning outcomes for declarative knowledge.

In the field of context-dependent learning in an IVR, CA_TECH might influence the relationship between environmental congruence and learning. We assume that a higher CA_TECH before the learning task will lead to a stronger encoding of contextual information which can then strengthen the relationship between environmental congruence and learning.

> *H3: CA_TECH moderates the relationship between environmental congruence and ILP. For individuals with a high level of CA_TECH, the relationship between environmental congruence and ILP will be stronger than for individuals with a low level of CA_TECH.*

Immersive Virtual Realities and Cognitive Absorption

IVR can enhance the sense of "being there" – usually called telepresence – (Schultze 2010, 2014) by presenting a high degree of sensory immersion to the user. Whereas telepresence refers to the psychological perception of the user, sensory immersion refers to the objective criteria of the technology design. Sensory immersion is therefore defined as the degree to which a technology can achieve an inclusive, extensive, surrounding and vivid illusion of reality to the users' senses, matches of the user and matches the users' movements to the visualizations of the IVR, and presents a convincing plot to the senses of the user (Slater and Wilbur 1997).

Different factors of sensory immersion influence telepresence positively (Cummings and Bailenson 2016) which in turn is positively related to CA_TECH (Faiola et al. 2013). High sensory immersion should therefore lead to higher telepresence and CA_TECH than low immersion. We therefore hypothesize an interaction effect of sensory immersion and environmental congruence on ILP, which is mediated by CA_TECH for sensory immersion.

> *H4a: There is an interaction effect of sensory immersion and environmental congruence on ILP. High sensory immersion strengthens the effect of environmental congruence on ILP more than low sensory immersion.*
>
> *H4b: The interaction effect of environmental congruence and sensory immersion is mediated by CA_TECH for sensory immersion.*

7.3 Method

Participants and Design

We plan to recruit 200 students of Information Systems and Business for the experiment who receive a compensation of 5€ for their participation. We use a 2 (learning environment: Room A vs. Room B) x 2 (immersion: low vs. high) x 2 (recall environment: Room A vs. Room B) between subjects design. We use Information Systems and Business students as participants because with them, we can let them take the IVR experience at a physical location where they learn frequently (the IS department). For the recall setting, we can then use one place in which they have never been (the research center) and one place in which they are only occasionally (the main university). By doing this, we create a similarity to the situation in which the user wants to learn in an environment which they can visit only with difficulty and therefore does not necessarily visit it often.

Materials

Hardware and Software. The entire virtual environment is designed with the game engine Unity and the use of a 360° camera as well as the use of 3D laser scanning for the two rooms in which the learning takes place. The use of the 3D laser scanning makes sure that the participants can walk freely in the Room And sit on a chair and at a table that are modeled in accordance with the real ones in both contexts. The chair is tracked with a HTC Vive Tracker to allow participants to sit down without falling. All participants will wear a head-mounted display (HTC Vive) for viewing the IVR in the learning phase. In the front of the HTC Vive, the Leap Motion technology (similar to Schwind et al. 2017) is mounted for all participants, even though it will display the tracked hands, recognized by optical sensors, into the virtual scene in real-time only for participants in the high sensory immersion condition. These participants can then act and interact (touching, moving, manipulating etc.) with objects through a virtual model of their real hands in contrast to using the HTC-Vive controller of the low immersion condition. Additionally, we will let the participants in all conditions wear three HTC Vive trackers (two on each foot and one on the hip) for full-body tracking with Ikinema Orion which are also only functional for participants in the high immersion condition. For the audio aspects within the experiments, a noise cancelling headphone will be used. At the beginning, each participant will be fitted with the headphone and active noise canceling.

Learning Task. Comparable to similar studies used for context-dependent learning (e.g., Godden and Baddeley 1975; Smith et al. 1978), we will use a word list consisting of 40 common, four-letter words that the participants have to remember. The words will be presented via headphones and the space between words will be an interval of 3 seconds.

Sensory immersion. In the low sensory immersion condition, participants wear a head-mounted display and use controllers to interact with the virtual environment and wear headphone through which no sound is played. Instead of having a body, participants only see two controllers with which they interact in the virtual world. In the high sensory immersion condition, participants wear a head-mounted display and, using Leap Motion, they can interact with the virtual environment using their hands which are displayed through Leap Motion in the VR. Additionally, they can see a body when they look down which is tracked through the HTC Vive trackers. Background music is played through the headphones, different for each context.

Contexts. Both contexts are presented virtually in the laboratory of the Information Systems department of the local university for the learning phase and are later visited physically for the recall phase. The contexts differ in how the two rooms look and where they are located. Room A is located at the research center of the local university which is about 15 minutes by bus from the Information Systems department. Room A is designed similar to an office and participants sit at a table on which a desktop computer, a telephone and various office tools stand. They look at a flip chart and a cupboard filled with books. A specific background music is played in the room. Room B is located at a building in the main university which takes about 20 minutes by bus from the Information Systems department and about 10 minutes by bus from the research center. The room is associated with a specific background music consisting of different classical music pieces. Room B is similar to an office and participants sit at a table on which a desktop computer, a telephone and various office tools stand. They look at a flip chart and a cupboard filled with books. A different background music consisting of other classical music pieces is played for Room B with the same tonality and tempo (similar to Isarida et al. 2017).

Procedure

The experiment is divided in two sessions, the first one for the learning phase and the second one for recall. The first phase, were the exposition to the IVR-setting takes place, is located at the Information Systems department of the local university. Participants are tested individually. When they enter the laboratory, the experimenter tells them that the experiment is about experiences in VR and explains them how to put on the head mounted-display and the trackers. After participants have put on the head-mounted display, they see the outside of the building in which Room A or Room B is located in a 360° video. Then they see a virtual walk through the door of the building and enter it. In the building, they walk to the door of either Room A or Room B (depending on the building). Participants are then instructed by headphones to open the door either with the controllers in the low immersion condition or with their hands in the high immersion condition. They can then walk freely towards the chair to sit at the table. After they answer the presence and CA_TECH questionnaires, they are told that they will hear a word list and that they should try to remember the words. Participants then hear the 40-word word list. Afterwards, similar to the procedure of Smith et al. (1978) the word list is presented again and participants have ten seconds between each word to rate the affective value of each word on a continuum from “good” to “bad” using either the controllers (low body tracking) or their hands (high body tracking). We use this approach to induce a sense of closure for the session and prevent participants from rehearsing the list between sessions. Participants then answer the questionnaire for CA_TASK. Participants are told that they should come to either Room A or Room B on the next day at a specific time in order to answer a final questionnaire and to receive their compensation fee.

The second session takes place about 24 hours later and is located either at the research center of the university (Room A) or a building in the main university (Room B). When they arrive at the room, the experimenter explains to the participant that they should write down as many words as they can remember in a surprise free recall test. The experimenter then leaves the room for 10 minutes. Afterwards, subjects are asked whether they have rehearsed any words between sessions, fill out the questionnaire of perceived room similarity between learning and recall room, answer questions for perceived learning, receive their compensation fee and are thanked and debriefed.

Measures

Individual learning performance. Individual learning performance is measured by the number of items recalled and by a perceived learning questionnaire adopted from Magni et al (2013).

Cognitive absorption. We adapt the 5-item-measure of Burton-Jones and Straub (2006) for CA_TECH and CA_TASK. We frame the CA_TECH items towards the technology, similar to Burton-Jones and Straub, and the CA_TASK items towards the task, similar to Magni et al. (2013).

Manipulation checks. We use the Igroup Presence Questionnaire (Schubert et al. 2001) as manipulation check for Immersion and questions for perceived room similarity as manipulation checks for environmental congruence.

Data analysis

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

7.4 Discussion

With the experiment, we plan to show that environmental congruence can be designed in IVR and that is enhanced by sensory immersion through CA_TECH. By letting participants learn a word list, an approach that is often used in basic research on memory, we want to show that the proposed explanatory design theory can be used for a range of different tasks. Whereas the relevance for practice would have been more obvious with a task that focused on application in an organization, recall of a word list represents a basic function of memory in general. Therefore, the underlying mechanisms of the explanatory design theory should apply for most tasks in which recall of declarative knowledge is relevant. On the basis of our results, we expect that future research can extend our explanatory design theory to different types of knowledge (e.g. implicit knowledge), compare it with the effects in reality, and use it as basis for identifying additional design options to enhance ILP.

7.5 References

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8 Paper 2: Would you like to Participate? Stakeholder Involvement in the Development Process of Digital Strategies for Municipalities

Titel	Would you like to Participate? Stakeholder Involvement in the Development Process of Digital Strategies for Municipalities
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Outlet der Veröffentlichung	Proceedings the 9th International Conference on Advanced Collaborative Networks, Systems and Applications (COLLA 2019)
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Table 10. Fact Sheet Paper 2

Would you like to Participate? – Stakeholder Involvement in the Development Process of Digital Strategies for Municipalities

Abstract. *Today there is a high pressure on municipalities to adapt to the digital demands of their citizens and to involve them in decision-making processes. One way to achieve this transformation is with the instrument of digital strategies to guide municipalities' way and to get them involved right at the start. In our case study, we analyzed strategic documents of 22 national and international smart cities regarding participation in the age of digitization. We conducted semi-structured interviews with seven of those cities asking about chances and challenges they had while developing their digital strategies using participatory elements. We also conducted expert interviews and a survey based on our findings from the interviews. One of the key aspects we looked at was the process of involving different stakeholders in the development process of digital strategies. As the development of a digital strategy, as guideline for the digital transformation process of municipalities, we look at the starting point of participatory processes when we look at the development of a digital city. Our results show, that the aim of cities is high to involve different stakeholders. However, it is often hard to encourage stakeholder to participate. We therefore propose important guidelines, which need to be taken care of for participatory processes regarding the development of digital strategies for municipalities.*

Keywords. *Digital strategy; digital transformation; participatory process; stakeholder involvement*

8.1 Introduction

When it comes to digitization municipalities are often said to be slow and far behind technological developments. Nevertheless, nowadays there are many federal state projects helping to face municipalities' digitization. Federal states try to help their municipalities with state subsidies. The result is that many municipalities use those state subsidies to do projects regarding digitization in different sectors. However, those projects often last only for their duration of funding. Afterwards, the projects cannot be carried on. This is a phenomenon often seen in the public sector. Nevertheless, what can help municipalities to set their projects long lasting? At this point, digital strategies and stakeholder involvement become more and more important.

Recent literature had a look at digital strategies, for example from the business perspective. Digital strategies, in the context of businesses can be defined as "organizational strategy formulated and executed by leveraging digital resources to create differential value", aligned with the existing Information Systems (IS) Literature [1].

Aligning with recent literature that has contributed to a deeper understanding of digital strategies in the IS ([1]-[4]) and digital strategies regarding smart cities [5], we want to aim to continue this tradition in light of current developments regarding stakeholder involvement. Specifically, we seek to shift the focus from previous conceptualizations, to a new form of conceptualization that also takes into account participatory elements of digital strategies, especially for municipalities, regarding stakeholder involvement.

Recognizing the need to get a better understanding of the construct of digital strategies with the focus on stakeholder involvement, the first goal of our study is to contribute to the exiting literature. We want to give clear information about the questions on "how to develop a digital strategy focusing on stakeholder involvement?" and "What kind of actors are important to involve in the process of developing a digital strategy?". Our objectives are motivated by the fact, that due to emerging consumer technologies, citizens of different stakeholder groups are more familiar with technological possibilities and have great ideas of how public services should be made available in the digital era.

The remainder of the paper is structured as follows. The second Section gives an overview of digital strategies and participation in the context of smart cities and municipalities. The third Section describes the research design of this study. In Section 4, the findings of the case studies and the survey are presented and in Section 5, we give rise to guidelines for stakeholder involvement. The Discussion is shown in Section 6. Section 7 points out limitations and aspects for future research.

8.2 Background and brief Theoretical Reviews

The construct of strategy has been discussed widely in existing literature (e.g., in the IS and management literature) [4]. As an example [3] conducted a comprehensive literature review on IS strategy starting with looking at strategies from the perspective of the management science literature [3]. In their study, IS Strategy was defined as "the organizational perspective on the investment in, deployment, use, and management of information systems" [3]. As a result of their literature review, [3] showed that a variation of expressions (e.g., Information technology (IT) strategy, IS strategy, IS/IT strategy or information strategy) have been introduced in literature to represent the same construct

[3]. However, looking at digital strategies shows, that they are understood to be even more, looking not only for examples on the investment and management of information systems but rather on the whole business [1]. Aligning with [1] and [6], such a digital business strategy could be defined as an "organizational strategy formulated and executed by leveraging digital resources to create differential value" [1] and "to support or shape an organization's competitive strategy, its plan for gaining and maintaining competitive advantage" ([6] and [15]).

Looking at participation, we notice that participation is widely used as construct for example in the management science literature but also in the smart city literature ([7]-[11],[21],[22]). Against this background and in the context of IS and management science literature, [11] defines participation as "allowing workers to have input regarding a proposed change" (p.134). When we looked at participation, we find that the adaption of the definition of [11] fits best our definition of participation. Aligned with [11], we define participation as allowing citizens to have input regarding a proposed change.

Existing theories have addressed contemporary developments regarding digital strategies or participation in various ways. As an example, Effing et al. [7] developed a Social Smart City framework, which includes a set of digital strategies (e.g., crowdsourcing strategy and open data strategy) for participatory governance in smart cities. Spil et al. [8] showed, using three cities (Hamburg, Berlin and Enschede) as case studies that a quadruple helix structure of citizens, companies, universities and government ensures effective participation. This phenomenon can be seen also by [9], who proposed suggestions regarding actions and projects in smart cities from the quadruple helix, thus creating a "360-degree" model for prioritizing smart city interventions in Greek cities. Ergazakis et al. [10] proposed a Digital City Concept and an integrated methodology for Digital City development in order to help regions and cities to adopt best practices from information technology. However, existing conceptualizations of digital strategies for municipalities and their process of development often did not look at the participatory process, explicitly the involvement of different stakeholders (e.g., politicians, companies, normal citizens, science) in the development process of a digital strategy for municipalities. In order to address our objective, this paper is guided by the following research question (RQ):

> *RQ: How can different stakeholder be involved in the development process of a digital strategy for municipalities?*

8.3 Research Methodology

In order to explore how participatory elements and different stakeholders get involved in the development process of digital strategies for municipalities, we conducted a mixed-method approach of qualitative and quantitative research [13]. The study at hand only shows the results regarding participation. Other elements of the study are published in other formats or conferences. First, we conducted a case study [14] consisting of qualitative and quantitative content analyses of digital strategy documents (aligned to the definition by [15]) in practice (we aligned our process on [15] who followed this methodological approach to conceptualize structural features of digital strategies for municipalities). We looked for criteria as for example, the development process and steps municipalities took to write their digital strategy. Moreover, we looked at how municipalities involved different stakeholders at different levels of their process. From the results of the content analysis, we conducted a qualitative process analysis combined with expert interviews (employees who developed the digital strategy). Afterwards, we reflected our results back to experts (e.g., chief digital officers, chief information officers, digital experts and mayors) in a workshop. Next, we conducted with the results from our case studies and based on existing literature a survey addressed towards the digital experts of the municipalities. Our mixed-method approach, aligned with [15] can be seen in Figure 11.

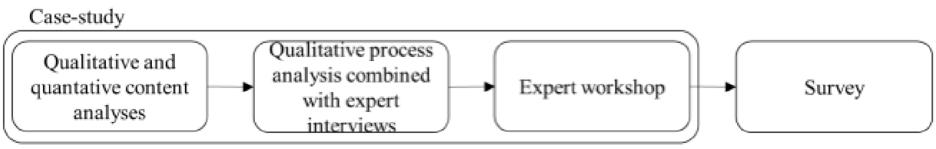

Figure 11. Research Design (aligned with [15])

We used case studies because they are a useful method while investing complex phenomena that have not been fully explored, and do not allow the analysis of causal relationships ([14] and [16]). Furthermore, aligning with [17], case studies allow us an in-depth analysis of phenomena that are related to the context where those phenomena occur [17]. Since our mentioned aspects are relevant to our objective and study, case study research is a well-suited method for the first part of our endeavor [15]. Especially, it is supposed that the strength of case studies lies in their internal validity whilst their weakness is often to be the external validity [15]. In order to increase the external validity of our case study, we introduced two forms of measures: First, our study was conducted in a team. This means, that at least three researchers conducted all phases, which are described in the following. With the use of multiple investigators, we were able to implement triangulation (investigator triangulation ([15] and [16])). As second measure, we included multiple cases to reduce case- specific findings ([14] and [18]). We selected our cases using content-related validity ([15] and [19]). We carefully choose the following 22 cities as cases: Birmingham, Brussels, Cape Town, Copenhagen, Den Haag, Dubai, Duesseldorf, Edmonton, Eindhoven, Gothenburg, Hamburg, Leipzig, London, Manchester, New Orleans, New York City, Oldenburg, Sonderborg, Stavanger, Sydney, Tallinn and Vienna.

With the findings of our case study, we started to develop a survey. Therefore, the survey is comprised out of the findings from different stages of the case studies. In detail, the survey consists out of elements and items, which we hypothesize having an effect on the involvement of stakeholders during the development process of a digital strategy for municipalities. These elements and items are direct findings out of existing digital strategies reflected into the existing literature. For example in our study, we focused on participation as an important dimension evolving out of the qualitative and quantitative analysis of the strategic documents. Participation as possible dimension was confirmed through the expert interviews and later on in the expert workshop. We found a construct fitting our understanding of participation in existing literature. We adapted the construct of participation from [11], e.g., "Which aspects regarding digital strategies play a role regarding participation of citizens? Citizens are able to take part in decision-making processes." Aligned with [11] every item of the survey was asked using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). In a next step, we cumulated the answers 1 and 2 from the Likert scale to one new scale called "fully disagree" and 4 and 5 to "fully agree". Aligned with [15] number 3 of the Likert scale stayed as "neither". Using relative frequencies [15], we were able to show how often and strong individuals of the municipalities agreed or disagreed with the proposed participatory elements in the development process of digital strategies for municipalities, where each participatory element stayed for itself.

We have to note that our study shows only a small part of a more comprehensive study we conducted regarding digital strategies for municipalities. Therefore, when rolling out our survey, we first run a pretest on 300 municipalities in Germany. We choose municipalities regarding their number of inhabitants in relation to the overall population of the state the municipality is located in. We calculated the number of municipalities taken for a state in relation to the number of municipalities in general [15]. As the survey was going to be run in the federal state of North-Rhine Westphalia (NRW) in Germany, the pre-test was conducted in every state in Germany leaving NRW out of the scope [15].

Afterwards, we adapted our survey regarding the results of the pre-test we conducted. We conducted our final survey in the state of NRW. Aligning with [15], we asked all 396 NRW-municipalities and 31 districts to participate in our study. With a response rate of 34%, 133 municipalities and 12 districts took part in our study.

8.4 Findings

Our first findings included findings from the analysis of the strategic documents of 22 smart cities. Those findings from our qualitative and quantitative document analysis showed that in 43% of our analyzed strategic documents of municipalities citizens got involved in developing the digital strategy. In 29% stakeholder from economy and in 52% science got involved. The interviews corroborate this aspect. Developing a digital strategy means setting the direction for the digital transformation. However, a small group of people cannot choose this direction. Different stakeholders need to be involved. Learnings from the interviews showed us that for each smart city it was hard to associate with different stakeholders and to motivate them to get involved in the development of a digital strategy as guideline for the digital transformation of their city.

Findings from our survey show that when we asked for responsibilities while developing and implementing a digital strategy we found that mayors take a big part of involvement at this stage. For example, when we asked for "who is responsible for the development of a digital strategy in your municipality?", we found that 82% of the municipalities filled in that the mayor is responsible. In 75% the city counselor, in 84% the head of department, in 42% an employee and in 72% a work group is responsible for the development. When we asked for "who is responsible for the implementation of a digital strategy in your municipality?", we found that 66% of the municipalities filled in that the mayor is responsible. In 64% the city counselor, in 84% the head of department, in 64% an employee and in 60% a work group is responsible for the development. Our findings show that the development stage is one of the responsibilities of the mayor. However, when it comes to the stage of implementing a digital strategy the head of department is responsible for further processes. With this finding, we get to know responsibilities at each stage of the development process of a digital strategy helping us to better understand, who the person in charge is for stakeholder involvement at each step.

Third, we also asked for important aspects regarding citizen participation ("Which aspects regarding citizen participation are important for digital strategies?). We found that in 88% of the municipalities citizens can ask questions. 62% of the municipalities involve citizens in decision- making processes and 51% are getting involved in the implementation of digital strategies. We found that even more than half of the municipalities who took part in our survey are given the possibility to get involved in the process of the development of a digital strategy.

As we concentrated in our study on the involvement of different stakeholders in the development process of a digital strategy for municipalities, we also asked for the involvement of different stakeholders beside citizens. We asked "To which information do you refer to while developing your digital strategy?" and "At your public administration expert knowledge is present." We found that 87% of the municipalities involve external experts in their development of a digital strategy. 50% refer to information from science or involve expert knowledge. 39% involve city- owned companies in the development of a digital strategy.

Aligning with [15], we wanted to control for the employees answering our survey. For this reason, we put a question in the survey, asking for the name and position of the employee. In our study, employees or mayors, who are concentrating on the topic of digitalization in their municipalities, answered each conducted survey.

8.5 Guideline Development

With our findings, we were able to give rise to four guidelines for the involvement of different stakeholders in the development process of digital strategies for municipalities. We found, that first, digitalization is a matter of executives, second digitalization needs participatory processes, third digital strategies need competences and fourth digitalization is a joint task.

Digitalization is a matter of executives. The findings show that talking about the development and implementation of digital strategies the person in charge are mayors and the head of the departments. This distribution of responsibility shows that digitalization is a matter of executives who lead the way to digital transformation.

Digitalization needs participatory processes. When we look at the way of how citizens get involved in the development of a digital strategy for their municipality we clearly see that digitalization needs participatory processes. Citizens are often able to ask questions. Nevertheless, when we look at the process of decision-making and implementation, we see that there are still more possibilities to get citizens involved. Municipalities need to work on these possibilities and on ways to get more citizens involved and to make it easier for them to take part in the different processes.

Digital strategies need competences. Looking at the involvement of different experts, science and city-owned companies, we see that the development of a digital strategy needs different competences and different perspectives from a variety of fields of action. Municipalities can still work on the references of information from science and city-owned companies. Different perspectives help municipalities to set their goals long lasting, taking into account different possibilities digitalization can have to help municipalities in their daily life.

Digitalization is a joint task. As last guideline, we see digitalization as a joint task of different stakeholders. Our findings showed us how important it is to get different stakeholders involved. We also could see on which stages of the development process different personas are in charge. Nevertheless, it is important that these different stakeholders involved are working together to develop a digital strategy for their municipality.

8.6 Discussion

Implications for theory. Aligning with references [7]-[11], we were able to look at participation in the development process of digital strategies. Especially we looked at digital strategies in the public sector for municipalities. Participation in the public sector involves many different stakeholders. Based on our case study we referred to different types of stakeholders extending recent literature ([7]-[9]). Our types of stakeholders involved citizens, economy, and science, functional roles of the public administration, external experts and city-owned companies. We were able to extend the construct of participation from [11] and to adapt it in the public sector.

Implications for practice. With our findings, we were able to give rise to guidelines for municipalities developing a digital strategy. Aligning with the guidelines should help municipalities to define participation their own way and to get different types of stakeholders involved in the development process of a digital strategy.

8.7 Conclusion

Regardless of the theoretical and practical relevance of our study, it is pointed with difficulties and shortcomings that leave room for future research. Aligning with [15] we have to note, besides the regular limitations of case studies (e.g., its weak internal validations), that our study is of an explorative nature. Its intention is to extend current perspectives on the development process of digital strategies, especially for municipalities regarding the involvement of different stakeholders. Our research can therefore be used to further develop the way different stakeholders can get involved in the development process of digital strategies, but is somewhat weak in its theoretical contribution. Second, in our study the unit of analysis is the municipality. As we asked for the development process of digital strategies for municipalities focusing on stakeholder involvement, only one of the employees of the municipal administration answered our survey representing the whole municipality. We were relying on those employees who answered our survey. Third, as we looked at digital strategies from an IS and management perspective, we defined participation in our study aligning with the results from our case study and aligning with our context of our study. Nevertheless, when we look at participation, this is a construct, which can be seen in a variety of ways. We aligned with the definition of [11], but there are many different possibilities to define participation. We also looked at participation only at the level of the development process of a digital strategy. However, looking at a smart city and their participation processes there is much more which need to be considered as [7] and [8] shows.

In order to overcome these limitations, future research might ask, aligning with [15], more than one employee per municipality and make sure the employees answer the survey by themselves. Future research should also consider a variety of definitions for participation and not only stuck on definitions used in the area of development of digital strategies for municipalities from an IS and management science perspectives. There are more possibilities to define participation. Moreover, looking not only at the development process of digital strategies for municipalities but looking at a smart city gives a wider range of how participation can be defined and realized.

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9 Paper 3: Working in the Digital Age: Merging a Status Quo Bias Perspective and Reflective Practice

Titel	Working in the Digital Age: Merging a Status Quo Bias Perspective and Reflective Practice
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Table 11. Fact Sheet Paper 3

WORKING IN THE DIGITAL AGE: MERGING A STATUS QUO BIAS PERSPECTIVE AND REFLECTIVE PRATICE

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

Keywords. *Digitalization, digital work, rational choice, reflective practitioner, cognitive bias, status quo bias perspective.*

9.1 Introduction

Digitization is changing the way we work and organize. The use of information technologies (IT) makes it possible to fulfil tasks more effectively and to maintain or even increase the quality of service and data security. At the same time, IT use can save time, reduce errors and streamline internal processes. Nevertheless, digital change is accompanied by new roles and modified needs for (IT) competence (e.g., Hill, 2014; Malsbender et al., 2014; Ogonek et al., 2018, 2016), as well as a changing attitude towards digital solutions (e.g., Ogonek et al., 2018). This triad has been intensively studied and provides the basis for our investigation.

In order to explain decision-making of employees in the digital age, we consider the fundamental work in decision research. Nobel prize winner Herbert A. Simon (e.g., Simon, 1944, 1946, 1997; see also Sherwood, 1990) has stated that employees do not have access to all the necessary information and cannot process all facts correctly. Rationality is 'bounded'. His work is more prominent than ever in the digital age. Despite the high value of using technologies, many benefit from them only to a limited extent and encounter IT with skepticism or even fear. They insist on learned procedures and known solutions, although this perseverance objectively entails disadvantages (e.g., temporal, financial and emotional costs). This behavior is known as 'status quo bias' (Kim and Kankanhalli, 2009; Polites and Karahanna, 2012; Lee and Joshi, 2017; Li et al., 2016).

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

9.2 Related Work

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

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

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

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

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

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

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

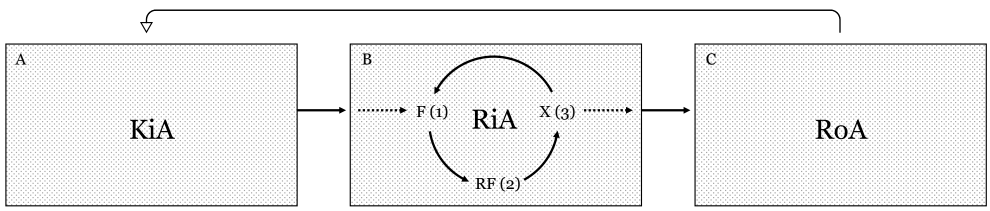

Figure 12. Reflection in Practice

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

Undesirable outcomes are what we often observe when someone sticks only to a habitual decision making and behavior, even when better alternatives exist (e.g., the department head does not consider IT solutions, although digital workspaces require digital components (Fleischmann et al., 2014)). Samuelson & Zeckhauser (1988) were at the forefront to distinguish between three main constructs that influence the so called 'status quo bias': rational decision-making, cognitive misperception, and psychological commitment. In IS research, Lee & Joshi (2017) supplement the perspective and offer the constructs. In particular, the authors adopted the categories and subdivided them even further. The dimensions are briefly summarized in the following.

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

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

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

9.3 Framework

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

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

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

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

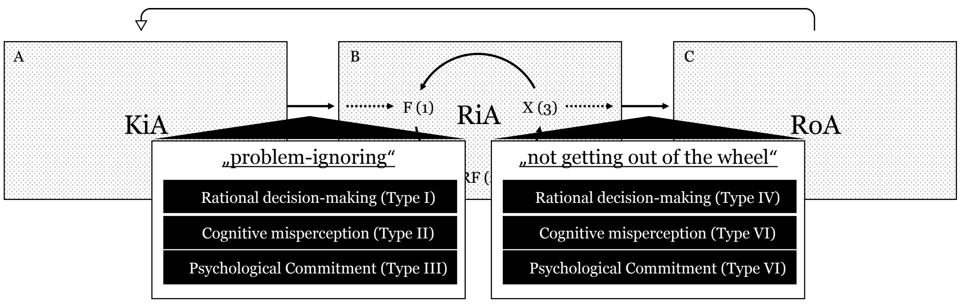

Figure 13. "Bounded" Reflection in Practice

9.4 Research Agenda and Concluding Remarks

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

Qualitative preliminary study. Focus group with public administration managers to develop an activity scenario that includes innovative technologies (e.g., artificial intelligence). Moreover, we present the status quo bias perspective and the reflection in action approach. Thereupon, we identify missing variables.

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

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

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

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10 Paper 4: MUSE - Towards a Concept of Inspiring Ambient Technology Driven by Artificial Intelligence

Titel	MUSE - Towards a Concept of Inspiring Ambient Technology Driven by Artificial Intelligence
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Table 12. Fact Sheet Paper 4

MUSE - Towards a Concept of Inspiring Ambient Technology Driven by Artificial Intelligence

Abstract. *Creativity is of increasing importance to all kind of organizations. Moreover, Creativity Support Systems (CSS) have a long history in Information Systems (IS) research. However, findings are various and not overwhelming. In this research-in-progress paper, we want to contribute to existing literature by using a design-oriented approach to start the route towards a concept of a CSS with inspiring ambient technology driven by AI and to propose further steps on how to evaluate the derived design variants (i.e., restrictive and expansive examples, texts and pictures). The justification knowledge is based on the Cognitive Network Model (CNM) and the Dual Pathway Approach to Creativity. Our work shows how to build the AI-driven CSS and how to evaluate the system in a two-step approach. The first part of the evaluation will be a qualitative ex ante evaluation in order to inform the subsequent post ante laboratory experiment.*

Keywords. *Creativity Support System, Creativity, Artificial Intelligence, Dual Pathway to Creativity, Cognitive Network Model of Creativity*

10.1 Introduction

Creativity is of increasing importance to all kind of organizations; be it a large traditional mechanical engineering group that has to rethink its product range; be it a medium-sized family business after a change of management with the will to re-organize work processes; be it a small start-up that puts its employees at the center of its business, but at the same time wants to build up a reputation for its innovative ability. Innovation often succeeds after creativity helped solve wicked problems, which are more and more obvious in today's complex business environment (Schmiedgen et al. 2016). Against this background, creative capacity can help companies that strive for sustainability and future viability to tackle pressing challenges. Creative settings (e.g., design thinking workshops) are necessary and surpass individually occurring ideation, because team creativity by far beats the individual (Buchanan 1992; Nijstad and Stroebe 2006; Paulus and Brown 2007; Santanen et al. 2004). For designing such creative settings, we have to understand the various situational and dispositional variables that can affect the quantity and quality of the creative output (Nijstad et al. 2010).

Artificial intelligence (AI) is increasingly present as more and more organizations use it for decision making and optimization. Thereby, AI tremendously affects the way we work

(Fink et al., 2010). In this respect, literature identified two different paradigms about the relation between humans and AI. Either, AI can be human-level (McCarthy 2007), or work symbiotically with humans to enhance their inherent abilities (Licklider 1960). The second paradigm points to the fact that AI assists, guides, challenges, supports and inspires human (e.g., artist and designers; see Künstliche Intelligenz Als Kreative Muse | Roman Lipski & Florian Dohmann | UBX18 2018), which will be the focal point of our analyses.

Inspiration stands as the opposite of fixation, which is one of the five different pillars of neuro-creativity (among priming, associations, inhibition, and incubation). To apply neurobiological principles to the complex and multifaceted concept of creativity is considered as promising (Onarheim and Friis-Olivarius 2013), as preventing fixation was shown to be doable when we "use clues or hints in the environment" (Smith and Linsey 2011). One specification of this approach is the exposure of examples as stimuli (Agogu et al. 2011), which was also shown in neuroimaging studies (Fink et al. 2010). As research revealed which examples can encourage fixation or inspiration (Agogu et al., 2011; Howard, Maier, Ponarheim and Friis-Olivarius, 2013), we expect an IT artefact that presents inspirational examples can help groups in creative workshops to become or to stay inspired (i.e., preventing fixation), which will, among other things, create better outcome, encourages the participants and saves time.

Summing up, the aim of this research-in-progress paper is to start from a design-oriented approach to start the route towards a concept of an inspiring ambient technology (communication media (i.e. screens) that are integrated into the architecture or furniture in the according rooms (e.g. workshop rooms) in order to assist with the task (i.e. inspire)) driven by AI and to propose further steps on how we will evaluate the derived design variants in a laboratory experimental setting. With our research, we seek to answer the following two research questions:

> *(RQ1) Do inspiring examples provided by an AI as visual stimuli help be more creative – and if so, how?*
>
> *(RQ2) Based on our findings, how can we design inspirational AI-driven creativity support systems (CSS) to help designers to produce more creative ideas through adaptive ambient technology?*

By answering these research questions, we seek to contribute both to theory, practice and design.

10.2 Theoretical Background

Creativity in the light of the Cognitive Network Model. The Cognitive Network Model (CNM) is a theoretical model that seeks to explain ideation episodes in a creative process on the basis of classic cognitive science research. The model differentiates two modes in memory (Baddeley 1997): the working memory (WM) and the long-term memory (LTM). The first has the capacity to store information for a limited time, whereas the second stores experiences and knowledge on a long-term basis (Nijstad and Stroebe 2006; Santanen et al. 2004). Bringing forth knowledge from the LTM is resource-consuming, so 'rules of thumb' are organized in different groups to make them easier to access. These groups are called 'frames' (Nijstad and Stroebe 2006; Santanen et al. 2004). One feature of frames is that they are directly linked to each other and oftentimes automatically activate linked ones, when being activated themselves (ibid.). Moreover, the content of the frames (i.e., its items) can be part of more than one frame (Collins and Loftus 1975), which results in the fact that the links and the strengths of those links can vary across frames.

Similar to the modes in memory, the cognitive process of ideation can be differentiated in two steps (Nijstad and Stroebe 2006): the activation knowledge and the combination of knowledge. Idea generation relies on the two modes in memory (i.e., WM, LTM) by (step 1) loading information from the LTM, activating it in the WM, and (step 2) by processing various frames in the WM to generate new ideas (Nijstad and Stroebe 2006). The combination of unrelated frames is considered a promising pillar for generating more creative output (Mednick 1962). During this process, the creative thinker iteratively makes new connections between items and applies existing frames to new domains. Because it is not easy to discover different frames, and to combine them in a meaningful way (Santanen et al. 2004), supporting this process by technological means may offer great advantages.

Technology can help humans in the creative process by providing context-specific stimuli on how to combine two unrelated frames (Santanen et al. 2004). As literature tells us, this can be achieved by activating unrelated frames in the LTM and by making them accessible in the WM. The provision of context-specific external stimuli via technology is possible to happen in a way, the individual cannot influence (Santanen et al. 2004) and thus automatically and free instead of deliberately and constrained. As a consequence, creative processes supported by information systems can on the one hand avoid ‘fixation’ and on the other hand assist switching between frames, which in the end inhibits inertia (Santanen et al. 2004). We would like to pursue this insight further and concentrate on CSS in the following.

CSS are information systems that support individuals or groups in being creative (Seidel et al. 2010). On the one hand, CSS have been a part of IS research for a long period of time (Couger et al. 1993; Nevo et al. 2009). On the other hand, they are currently under discourse (Althuizen and Reichel 2016; Minas and Dennis 2019; Sassenberg et al. 2017). Literature shows that there are three ways to support creativity by CSS (Müller and Ulrich 2013; Müller-Wienbergen et al. 2011). The most common approach is to provide task-specific information as stimuli (i.e., CSS as stimuli provider) (Müller-Wienbergen et al. 2011). The second approach is to provide help to structure the creative process (i.e., CSS as process guide) (Couger et al. 1993). The third approach is to use the system to prime individuals (i.e., CSS as priming instrument) (Minas and Dennis 2019). To the best of our knowledge, there is no CSS that is designed to support a group of people in ideation phase by ambient technology (AI).

Creativity in the light of the Dual Pathway Model. When studying creativity, it is important to note that there are two different ways to come up with new ideas, namely flexibility and persistence (De Dreu et al. 2008; Nijstad et al. 2010; Paulus and Brown 2007). The flexibility pathway can be seen as generating a great number of different ideas. Producing many original responses stand for a creative search process in the breath of various categories. On the contrary, persistence can be viewed as generating multiple ideas within a single category and as search process in depth in one category. Following Nijstad et al. (2010) we define the two pathways: Cognitive flexibility is “the ease with which people can switch to a different approach or consider a different perspective” and cognitive persistence is “the degree of sustained and focused task-directed cognitive effort”. The number of categories can be looked at as an indicator for the used pathway (De Dreu et al. 2008). Interestingly, the choice of the pathway can be influenced (Minas and Dennis 2019).

Looking closer at flexibility, we see that creative insights, ideas or problem solutions are achieved through “flexible switching among categories, approaches and sets” (Nijstad et al. 2010). People find remote associations as a source of inspiration and a “broad attentional focus and switch flexible between approaches” (Nijstad et al. 2010). New connections between distant frames can help to generate new ideas (Simonton 2018), however, resulting in the probable production of a lot of unusual and also useless ideas. Being persist then means to spend hard work, cognitive control and effort into creative ideas, insights or problem solutions. Only few categories are explored. The process does not directly lead to original ideas, but needs many resources to prevent irrelevant thoughts (Dreisbach and Goschke 2004). Thus, cognitive psychology emphasizes that flexibility and persistence are a tradeoff (Dreisbach and Goschke 2004; Nijstad et al. 2010). Both pathways seem to be negatively related, however, people are able to switch between the two (Leber et al. 2008). In the case of creative problem solving and ideation, people may use both modes (Nijstad et al. 2010), so in sum, both pathways can lead to inspiration, while preventing fixation. Both pathways will lead to more creative ideas. Depending on personality traits or the task one pathway is easier to activate than the other. However, in order to prevent fixation it does not matter which pathway is activated. Both pathways, although or because the can be negatively related, do lead to creative ideas.

10.3 Research Design and Methodology

Towards an integrated research model. The core component of our model is the integrated information system architecture for an AI-driven CSS. As our research is intended for design, it seeks to derive design implications that help construct and build the technological artifact (e.g., methods, techniques, and principles of form and function) (Gregor 2006). We focus on the design principles of form and function of an AI-driven CSS to foster inspiration and prevent fixation. For reaching our aim, we will consider two main perspectives on the artifact, namely to 'theorize prescriptively for artifact construction' (i.e., interior mode) and 'theorize about artifacts in use' (i.e., exterior mode) (Gregor 2009). By doing so, our research is a first step towards providing "theory-driven design guidelines and prescriptions for IS design, and the generation of hypotheses that are testable" (Walls et al. 2004, p. 54). At this stage, our research is of an explanatory fashion, because it "prescribes principles that relate requirements to an incomplete description of an object" (Baskerville and Pries-Heje 2010, p. 273).

Research design. Looking at the process of our research, we have to focus on two core activities, namely theory and artifact building (step 1) and evaluation (step 2) (Peffers et al. 2007; Simon 1967). Building implies that we need a framework for our research, which is built on theoretical work and does deliver a set of distinct theory components

(Baskerville and Pries-Heje 2010). In our case, it is the Cognitive Network Model and the Dual Pathway Model. This theoretical background delivers the kernel theory (Walls et al. 1992) and our justification knowledge (Gregor and Jones 2007) (Outcome A, see 'Theoretical Background'). As a consequence, we defined general requirements (Baskerville and Pries-Heje 2010) that a system needs to replicate and support creativity (Outcome B). In the next step, we defined initial principles of our design. They are "command variables" (Voigt 2014), which help create or change objects for a desired future situation (Simon 1967) (Outcome C). Based on these components, we then presented our inspiring AI-driven CSS as an expository instantiation (Gregor and Jones 2007) (Outcome D). Coming to evaluation, design science's core element is the evaluation of design artifact and theory (Hevner et al. 2004). We see our inspiring AI-driven CSS as a fruitful way to evaluate the given theories. Using prototype instantiation as artifacts in order to evaluate theories is common approach in verification and refinement (Ngai et al. 2009). Thus, and to be more precise, we differentiate two steps in our evaluation, namely the ex ante evaluation (Outcome E) and ex post evaluation (Outcome F). The first means receiving qualitative feedback (e.g., Becker et al. 2011), where "the artifact is evaluated on the basis of its design specifications alone" (Pries-Heje and Baskerville 2008, p.2) to thereupon implement improvements. The second is meant to conduct a quantitative evaluation, e.g. an experiment.

10.4 Initial Findings and Further Research

General Requirements (Outcome B). Based on related work (i.e. the kernel theory/justification knowledge (Gregor and Jones 2007; Walls et al. 1992)) we derive general requirements for an AI-driven CSS.

(1) support connections between the LTM and the WM: "This suggests that external stimuli provided to problem solvers may act as fresh entry points into one's cognitive network" (Santanen et al. 1999). Although the LTM contains a huge potential for creative solutions, people often rely on habitual ideas and narrow solution space and do not connect unrelated frames after loading them into their WM.

(2) support iterations: Whichever pathway (i.e., flexibility or persistent) is activated, an iterative approach will lead to more ideas, as new ideas will activate new associations and thus lead to more ideas and so forth (Santanen et al. 1999). In other words,

“activation of successive frames spreads through our memory causing the activation of yet other frames (Collins and Loftus 1975)”.

(3) activate unrelated frames: CNM “indicates the creativity of a solution is a function of the degree to which frames that were previously distant from one another become saliently associated in the context of problem solving” (Santanen et al. 1999).

Design Principles (Outcome C). To avoid fixation or “functional fixedness” (Howard et al. 2013; see for examples Duncker 1945; Maier 1931) in the form of unconscious blocking, which is quite familiar in disciplines like design (Jansson and Smith 1991), we have to encourage the exploration of the solution space during creative tasks. Studies have shown that examples can help to enhance creativity (Fink et al. 2010), because they can function as cognitive stimulation (see also Agogu et al. 2011; Howard et al. 2013).

One way to approach the integration of examples is the C-K-theory, because it helps to differentiate the examples between restrictive examples and expansive examples. Moreover, it delivers a useful framework to explain how designers create concepts. As designing itself can be described as an exploration of different spaces, namely the knowledge space and concept space, the idea of having a knowledge space can be transferred to our related work about the LTM, which we know as important for saving knowledge and experience. Moreover, the concept space can be seen as an image of the WM, where different mental content is processed and combined. Of course, this is only an initial approach, and not an exhaustive or problem-free comparison, but it helps to connect the theoretical flows. A figurative example has been given by Hatchuel et al. (2011). The Figure 14 below shows the concept space. The exploration of the concept space is like spinning a web of variations and alternative concepts, which differ from another in different ways. The basic concept is an exemplary shopping cart and the following example illustrates the concept space exploration.

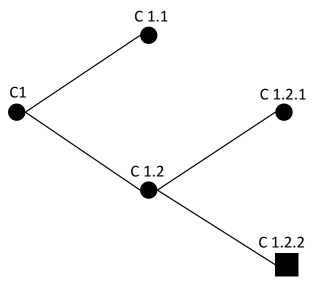

Figure 14. Expansive and Restrictive Examples

(1) C1 is a shopping cart

(2) C1.1 is a four wheeled shopping cart

(3) C1.2 is a three wheeled shopping cart

(4) C1.2.1 is a three wheeled shopping cart with advertising panel

(5) C1.2.2 is three wheeled shopping cart with display panel not provided by supermarkets yet

To deepen the understanding of how restrictive and expansive examples differ, the given figure also illustrates what is specified and termed as partition in the literature. As every dot or rectangle is a different partition, we see three restrictive partitions illustrated as dots being "propositions that further specify a concept in a routine or already known way" (Howard et al. 2013). In addition, we see one expansive partition being "propositions that further specify a concept or the product by adding an original element" (Howard et al. 2013). Empirical evidence showed that restrictive examples can cause fixation, while expansive examples can help to explore the concept space (Agogu et al. 2011; Hatchuel et al. 2011; Howard et al. 2013). Based on these insights, we can derive several design principles:

(1) DP 1: The system must present content build on what the participants talk about.

(2) DP 2: The system must create/present expansive examples or "original elements" (Howard et al. 2013) as inspiring stimuli.

(3) DP 3: The system must visualize examples and show different sets of examples without causing too much mental effort for the users.

Instantiation (Outcome D). We develop an initial information systems architecture in order to provide a first step into an ambient technology system, which is able to implement the design principles. It consists of three general principles (i.e. Information Input, Information Processing, and Information Output). Figure 15 summarizes the functionality and architecture of the ambient technology.

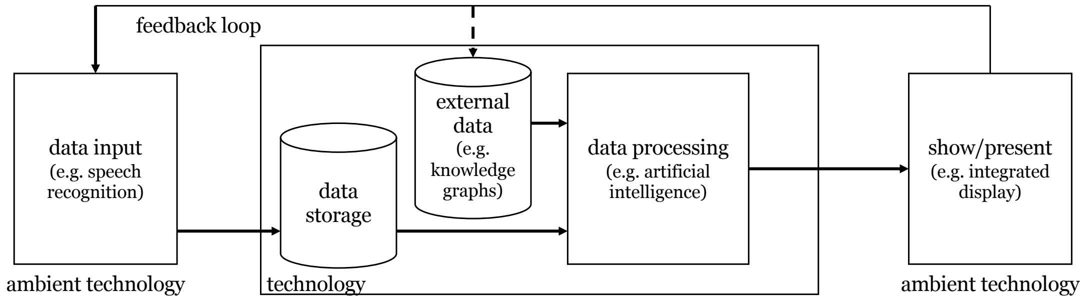

Figure 15. Ambient Technology AI-Driven CSS

Evaluation (Outcome E,F). As mentioned above, we evaluate our artifact in two ways. First, we will conduct interviews with design thinking experts on the derived design specifications of the prototype to specify them further (ex ante evaluation; Outcome E). The interviews will be semi-structured and last approximately 30 minutes. Participants will be invited from a pool of interested people by our department and will be rewarded with an expense of 25 Euro per interview. Second, after we have updated the prototype accordingly, we plan to conduct an experiment to test our inspiring AI-driven ambient technology (ex post evaluation; Outcome F). To do so, we generate four prototypes. Hence, the between-subject design will be 2 (example type: restrictive examples vs. expansive examples) x 2 (output type: picture output vs. text output). Again, the participants will be invited by our department and will be rewarded with an expense of 25 Euro. They will be randomly assigned to the conditions. Beforehand, our sample size will be calculated with G*Power. The exact procedure of the experiments is currently being coordinated with experts and is to be pre-tested twice before execution.

The creative output of the participants is measured with the variables 'quantity of ideas' and 'quantity of ideas'. Quantity of ideas is measured in line with previous research (Minas and Dennis 2019), as number of unique ideas without assessing quality. A list of ideas of all participants will be created by one rater. Based on this list, the rater and a second rater count the ideas independently. Subsequently, inter-rater-reliability will be calculated by the number of ideas on which both raters agree, divided by the total number of ideas. The final score will be calculated by the mean of both raters. Quantity of ideas will be measured by counting the number of ideas using the procedure of Dean et al. (2006) and Minas and Dennis (2019). Two independent raters will evaluate novelty, workability, and relevance. Whereas novelty consists of the subdimensions originality and paradigm relatedness, workability consists of acceptability and implementability, and relevance of applicability and effectiveness. Each subdimension is rated on a four-point scale, with higher values reflecting higher fit to the subdimension. Cronbach's alpha will be calculated as measure of inter-rater reliability in line with previous research (Minas and Dennis 2019). Finally, overall flexibility will be calculated by the number of topic categories (De Dreu et al. 2008). Using the aforementioned list, which includes all unique ideas (see above), categories will be counted using the same procedure as for quantity, only with the raters identifying unique categories instead of counting ideas. Persistence will be calculated by dividing the quantity of ideas of one individual by the number of categories that an individual used.

To assess whether our derived design principles hold, we will use independent samples t-tests using the afex package in R. Additionally, to assess occurring mediation effects, we will use the mediation package.

Figure 16 summarizes our research model. We expect that the exposure of expansive or restrictive examples will influence the pathway to creativity (i.e. cognitive flexibility, cognitive persistence) and thus will have an effect on creative output, which is measured with 'quantity of ideas' and 'quantity of ideas'. We also expect that the way of visualization (text or picture, see also DP 3) will also have an effect on the pathway to creativity and thus these two design variants are considered.

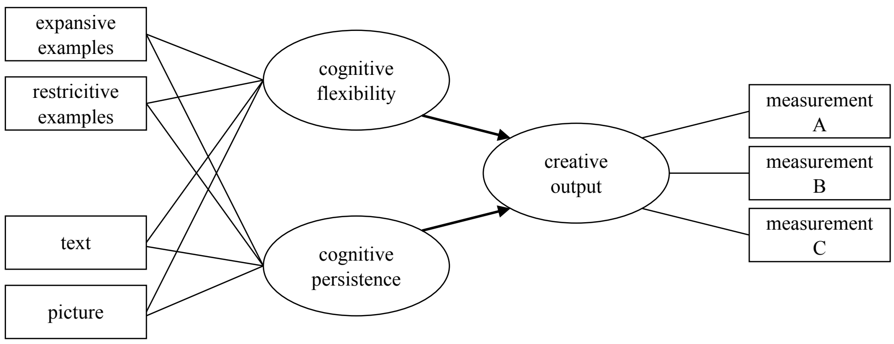

Figure 16. Research Model

Outlook. With our research, we plan to show how examples can enhance creative output by the use of ambient technology in form of an AI-driven CSS. We want to illustrate how expansive and restrictive examples (provided as text and picture) will influence the pathway to creativity and the final creative output to further develop theory. Likewise, the relevance for practice will be to develop a system which is capable to enhance individuals' and groups' creative output in creative settings and the workplace. Research will benefit from our findings by getting insights from the interaction of humans and machines concerning the phenomenon of creativity and by further clarifying the various results in research on CSS which showed discrepancies of theory and latest experimental findings (Wang and Nickerson 2019).

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11 Paper 5: Beyond the Obvious – Towards a Creativity Support System using AI-driven Inspiration

Titel	Beyond the Obvious – Towards a Creativity Support System using AI-driven Inspiration
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Table 13. Fact Sheet Paper 5

Beyond the Obvious – Towards a Creativity Support System using AI-driven Inspiration

Abstract. *In our digital age creativity is important to all kind of organizations. In Information Systems (IS) research Creativity Support Systems (CSS) have a long history. However, findings are various and not overwhelming. In this emergent research forum-paper, we want to contribute to existing literature of CSS and cognitive science by using a design-oriented approach to develop a roadmap to a concept of a CSS using AI and different design variants and propose further steps on how to evaluate the derived design variants (i.e., continuum from highly realistic representations to abstract representation of visual stimuli). The kernel theory is based on the Cognitive Network Model (CNM) and the fixation literature. Our work shows how to build the CSS and how to evaluate the system in a two-step approach. The first part of the evaluation will be a qualitative ex ante evaluation in order to inform the subsequent post ante laboratory experiment.*

Keywords. *Creativity Support System, Creativity, Artificial Intelligence, Cognitive Network Model, Fixation.*

11.1 Introduction

In our digital age, in which creative output and forward-looking innovations are increasingly important, the generation of ideas is becoming more and more relevant for management. Creativity is important for business, because it helps in problem solving and decision making (Seidel, Müller-Wienbergen and Becker, 2010; Perry-Smith and Mannucci, 2017; Seeber, Vreede, Maier and Weber, 2017) to create competitive advantage in complex business environments (Schmiedgen, Rhinow and Köppen, 2016). If individuals are mentally blocked and the creation of new or useful ideas does not work, literature speaks of fixation or functional fixedness (Cardoso and Badke-Schaub, 2011). Fixation is problematic for creative capacity (Cardoso and Badke-Schaub, 2011) on all levels of an organization (Stempfle, 2011). We define fixation as “the inability to overcome a bias in the representation of a situation by transferring knowledge from prior experience in an inappropriate manner” (Dong and Sarkar, 2011). According to Dong and Sarkar (2011) the source of fixation can be the individuals’ meta-representation. Humans develop three different abilities to represent the real world (primary representation, secondary representation, and meta-representation) (Perner, 1991). This ability can help people to see solutions that are beyond the mere semantic meanings of a given situation. One approach to prevent fixation is to “use clues or hints in the environment” (stimuli) as inspiration or source for new ideas (Smith and Linsey, 2011). We want to contribute to this understanding from a theoretical perspective on technology-supported creative processes in IS research and from a practical perspective on how to design creativity support systems (CSS) for making tomorrow's businesses more competitive. An innovative approach to design technology is the implementation of artificial intelligence (AI). This new technology becomes omnipresent and tremendously affects the way we work and decide (Fink et al., 2010). When it comes to how AI can be designed in interrelation with us human-beings, two different paradigms are depicted in literature. The first paradigm assumes that AI is developed on a human level (McCarthy, 2007). The second paradigm understands the relation to be a man-computer symbiosis designed to enhance human intelligence by offering assistance and guidance (Licklider, 1960). In this respect, AI as tool for individualizing stimuli can help to challenge, support, and inspire employees during ideation episodes. In our work, we want to understand how inspiring stimuli provided by an AI can help employees to be more creative. In specific, our concept of an inspirational AI is based on the principle of abstracting. In this context, we ask the following research question: Can an inspirational AI-driven approach be conceptualized with implementing stimuli based on the principles of meta-representations – and if so, how? For reaching our objective, we follow an explanatory design-oriented research approach, which allows us to then propose further research on how to evaluate design variants of AI-driven CSS.

11.2 Related Work and Theory

Creativity Support Systems

CSS are information systems that help individuals or groups being creative (Seidel et al., 2010). The discussion about this group of systems in IS research has both a long history (Elam and Mead, 1990; MacCrimmon and Wagner, 1991; Couger, Higgins and McIntyre, 1993; Nevo, Nevo and Ein-Dor, 2009) and is under current debate (Althuizen and Reichel, 2016; Sassenberg, Moskowitz, Fetterman and Kessler, 2017; Minas and Dennis, 2019). Considering current studies, we see that there are three ways to support creativity with technology which are well understood (Müller-Wienbergen, Müller, Seidel and Becker, 2011; Müller and Ulrich, 2013). First, the system can offer task-specific information as stimuli and act as a stimuli provider (Müller-Wienbergen et al., 2011). Second, the system can structure the creative process and act as a process guide (Elam and Mead, 1990;

Couger et al., 1993). Third, the system can offer stimuli and act as priming tool (Minas and Dennis, 2019). Note, however, there is yet no CSS, which is able to support creativity and decrease fixation with using AI.

Theoretical Background

The Cognitive Network Model (CNM) is a theoretical model to explain ideation episodes during a creative process. It is based on classic cognitive science research and differentiates two modes for storing memory (Baddeley, 1997). On the one hand, the WM stores information for a limited amount of time, but makes them directly accessible. On the other hand, the LTM stores experiences and knowledge for a vast amount of time (Santanen, Briggs and Vreede, 2004; Nijstad and Stroebe, 2006) and organizes them into different 'groups' (i.e., frames) to make them easily accessible, if needed (Collins and Loftus, 1975). By doing this, the content of the frames (i.e., the item) is not directly accessible, but has to be loaded in the WM to be processed. The frames are directly linked, so that an activated frame often automatically activates connected ones (Santanen et al., 2004; Nijstad and Stroebe, 2006). Moreover, the frames' items can be part of more than one frame. Keeping in mind the CNM, ideation episodes can be considered a fitting example of close connection between the WM and the LTM (Nijstad and Stroebe, 2006). Ideas cannot be generated without loading knowledge into the WM. Moreover, in the ideation episode, it is necessary to iteratively combine existing frames and to make new connections between stored frames and new ones (Nijstad and Stroebe, 2006). Combining unrelated frames can be an initial starting point for new ideas (Mednick, 1962), because it increases the likelihood that a new idea is produced (Santanen et al., 2004).

Perner's model discusses the different representational abilities of humans by linking them with the cognitive development of representational abilities (Perner, 1991): i.e., primary representation, secondary representation, and meta-representation. Primary representation means a direct semantic relation to the world, where individuals only represent what they see. Secondary representation stands for individuals being able to represent the real world in another way as they see (Dong and Sarkar, 2011), e.g., a playing child taking a banana as a mobile phone. Finally, meta-representation is the capacity to represent a representation or in other words "a representation of the representational relation between a referent (the represented) and its model (that which represents) (Perner, 1991)" (Dong and Sarkar, 2011, p. 150). People tend to interpret someone's thought about something and link someone's thoughts and believes to the person, but not to anything they see in the real world. They understand that representation they have in their minds have an interpretation (Perner, 1991). Abstract art is a fitting example of meta-representation, because it symbolizes an individual thinker thinking about someone else's representation of something and because it is an abstract conceptual way of visualizing. In order to visualize the different representational abilities, we present an example of Maier's study on functional fixation (Maier, 1931). In this study, subjects are placed in a room with two cords hanging from the ceiling. The task is to reach both cords at the same time and to tie them together, however, the cords are placed in a way that it is not possible to outstretch arms and reach both without help. Thus, several object such as pliers are also placed in the room. One possible solution is to use the pliers as weight for a pendulum and to complete the task this way. Nevertheless, most subjects are not able to come up with this solution. In this context, primary representation was found when the subjects see the pliers as pliers with the typical purpose and thus is not able to tie the cords. Secondary representation helps the subject to see cords as weight. Finally, meta-representation helps understand the phenomenon of inspiration and fixation and to tie the cords together. In summary, Maier's study shows the potential of meta-representations as inspiration source. Connecting the approaches by Fink et al. (2010) and Perner (1991), we recall the insight that the source of fixation can be the individuals' meta-representation (Dong and Sarkar, 2011), namely, that certain individuals are not able to build or easily build secondary representations in their minds. As the underlying relations between the representations are only based on the purpose (Dong and Sarkar, 2011), external stimuli can cause fixation instead of inspiration, because the individuals might overlook what the object could possibly be instead of only considering it real-world purpose. Thus, they only focus on its given properties and benefits instead of interpreting. This challenge grows even more significant when the represented properties of the object are highly realistic instead of generic (DeLoache, 2000; Uttal et al., 2009). We want to take up these findings and understand the different levels of representation in order to derive design implications.

11.3 Research Design and Outlook

As this research is intended for design, in the end, we aim at constructing an artifact and give prescriptions how to design an AI-driven CSS (e.g. methods, techniques, principles of form and function) (Gregor, 2006). By doing this, we will consider two main perspectives on IT artifact: first, the interior mode to "theorize prescriptively for artifact construction"; and second, the exterior mode to "theorize about artifacts in use" (Gregor, 2009). Our research seeks to help "provide theory-driven design guidelines and prescriptions for IS design, and the generation of hypotheses that are testable" (Walls, Widermeyer and El Sawy, 2004) p. 54. In this respect, it focusses on the explanatory design principles of form and function (Niehaves and Ortbach, 2016) of an AI-driven CSS to foster inspiration and prevent fixation. The design decisions of our inspiring AI-driven CSS should continuously be informed by evaluation, but in the first phase, it will be explanatory, because it "prescribes principles that relate requirements to an incomplete description of an object" (Baskerville and Pries-Heje, 2010) p. 273). Looking of the process of our research, it will consist of two core activities, namely theory and artifact building and evaluation (Peffers, Tuunanen, Rothenberger and Chatterjee, 2007) and following the procedure according to Becker et al. (2011).

The solid theoretical background delivers kernel theory and acts as a justification for our knowledge (Gregor and Jones, 2007) (Outcome A, see 'Theoretical Background'). Based on 'Related Work and Theory' (i.e. the kernel theory and justification knowledge (Gregor and Jones 2007) we derive the following general requirements and design principles (Baskerville and Pries-Heje, 2010) that the CSS needs to replicate and support. General Requirements (Outcome B): (1) The system must support iterative combination of frames. (2) The system must activate secondary representation and meta-representation. (3) Overall Requirement: The system must help the participants to interpret the given stimuli and objects (e.g., by asking "What else could the object be?"). Based on this insight, we define the core principles of our design, or in other word, the "command variables"(Voigt, 2014). These variables will help create objects for developing a desired future situation. General Components and Design Principles (Outcome C): Design Principle 1; the system must deliver stimuli, which are more generic rather than detailed and realistic. Design Principle 2; the system must deliver stimuli, which make relations between different objects visible. Based on the components, we present our inspiring AI-driven CSS as an expository instantiation (Gregor and Jones, 2007). Instantiation (Outcome D): According to Andolina et al. (2015) our system uses speech recognition in order to identify keywords (microphone, google implementation of the HTML5 Web Speech API) and delivers keywords on a display, which are related to the identified concept. In our case we visualize the keywords with a real-time google picture search. The images are revised with different design of AI algorithms (e.g., DeepDream, ArtBreeder or DeepArt).

After the preliminary building phase, the evaluation phase begins. As a core element is the evaluation of artifact and theory (Hevner, March, Park and Ram, 2004), using prototype instantiations as artifacts in order to evaluate design theories is common approach to verification and refinement (Brohman et al., 2009; Ngai, Poon, Suk and Ng, 2009). In our case, it means to differentiate two steps in evaluation phase: the ex-ante evaluation (Outcome E) and ex-post evaluation (Outcome F). The ex-ante evaluation means to receive qualitative feedback (e.g. see (Becker, Heide, Breuker and Voigt, 2011), where "the artifact is evaluated on the basis of its design specifications alone" (Pries-Heje and Baskerville, 2008) p.2. Based on this evaluation, it will be possible to implement improvements and to change attributes of the artifact and go back to any point of the building phase. In this first step (ex ante) we will follow the explorative focus group approach according to Mueller et al. (2019). The empirical data generation procedure presents a five-step approach (i.e. ideation, focused exploration, synopsis, design extraction, theory construction). We utilize this data to inform next steps in our iterative procedure. The ex-post evaluation stands for a quantitative evaluation (e.g., a laboratory experiment), which enables us to test hypothesis. When using different levels of abstraction in an AI-driven CSS, this evaluation will encourage us and future researchers to further think about the relations between the objects of the artifacts (e.g., whether they randomly appear or not). We generate different prototypes to test different AI algorithm designs (continuum from realistic to abstract) which will be tested in a 2x2 setting. Participants will get instructed to a creative problem-solving task. Creative output will be measured according to Dean et al. (2006).

With our research, we plan to show how the type of representation in a CSS can be used to make secondary representation and thus inspiration possible. Practical relevance lies in the insights of how to design a CSS. Research will benefit by creating insights of sources in fixation and inspiration. Through a machine learning-approach it would be able to learn which algorithms to decrease fixation and foster inspiration.

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12 Paper 6: Does one Creative Tool Fit All? Initial Evidence on Creativity Support Systems and Wikipedia-based Stimuli

Titel	Does one Creative Tool Fit All? Initial Evidence on Creativity Support Systems and Wikipedia-based Stimuli
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Table 14. Fact Sheet Paper 6

Does one Creative Tool Fit All? Initial Evidence on Creativity Support Systems and Wikipedia-based Stimuli

Abstract. *Creativity is important to all kind of organizations, because creative capacity can help tackle complex challenges and navigate through the ambiguity of wicked problems. In Information Systems (IS) research, this topic is addressed by studies on creativity support systems (CSS). One promising approach is to provide (context related-) stimuli to individuals in order to inspire new and useful ideas. The relatedness of a stimuli, which means the degree to which a stimulus is related to a topic (i.e., to the creative task), is a vital characteristic. We investigated in the relationship between Wikipedia-based searching results (computational relatedness) and individual cognition (individual relatedness). Our initial findings show that there can be differences between individuals based on demographic variables. We further suggest a laboratory experiment in order to contribute to a CSS that takes individual relatedness and thus custom-fit stimuli into account.*

Keywords. *Creativity Support Systems, Creativity, Relatedness, Wikipedia*

12.1 Introduction

Creativity is vital in today's digital world, because creative capacity can help organizations and companies tackle complex challenges and navigate through the ambiguity of wicked problems (Müller-Wienbergen, Müller, Seidel and Becker, 2011). Creative advantages are sustainable in the sense that they cannot easily be copied by competitors and help exploit new business options. In that line, it is argued that creativity is one of the most important human capabilities of the future (IBM, 2010; Powers, 2018).

In Information Systems (IS) research, this topic is addressed by studies on creativity support systems (CSS), which are tools that are able to enhance creative output of individuals or groups (Müller-Wienbergen et al., 2011; Althuizen and Reichel, 2016). There are several approaches to enhance creativity (Elam and Mead, 1990; Minas and Dennis, 2019; Wang and Nickerson, 2019) and a promising one is to provide (context related-) stimuli to individuals in order to inspire new and useful ideas (Wang and Nickerson, 2019).

The relatedness of stimuli, which means the degree to which a stimulus is related to a topic (i.e., to the creative task), is a vital characteristic (Santanen, Briggs and Vreede, 2004; Wang and Nickerson, 2019). Based on findings related to the Cognitive Network Model (CNM), the Adaptive Control of Thought theory (ACT) and the Search of

Associative Memory theory (SAM), we derive that remote stimuli indeed help enhance creativity, because "creativity typically emerges from discovering new associations between previously disparate things" (Müller-Wienbergen et al., 2011, p. 719). Current empirical findings show that exposure to closely related stimuli leads to more ideas and more useful ideas. In specific, "(…) stimulus relatedness is positively related to idea quantity and idea usefulness" (Wang and Nickerson, 2019, p. 2). So, based on literature and empirical evidence, we expect that the relatedness of stimuli affects creative output.

Previous literature already has emphasized personal characteristics (e.g., experience or knowledge) and their link to creative output (e.g., Briggs and Reinig, 2010). One aspect is that cognition is highly individual. For instance, the concept of *CSS* might be connected to the discipline of *information systems* for someone who has domain knowledge. The concept *iPhone* might be connected to *steve jobs* for someone who knows the company *apple*. People who have an *iPhone*, but do not have information about the company *apple*, will have probably experience a greater non-relatedness between the two concepts. However, in a lot of recent studies, *individual relatedness* is mainly neglected. Against this background, we define *individual relatedness* as an inherent cognitive structure of concepts by an individual and expect custom-fit stimuli to enhance creative output more than stimuli ignoring the aspect of *individual relatedness*. With our research, we want to make a first step towards addressing this research gap. To reach our aim, we will investigate the relationship between Wikipedia-based searching results (*computational relatedness)* and individual cognition (*individual relatedness*). We define *computational relatedness* as computational extracted concept structure. While both structures draw on human memory, *computational relatedness* builds on the relatedness, which is often cumulatively defined by several people who share their knowledge about a concept and relate it to other concepts. In turn, as highlighted by the previous examples, *individual relatedness* builds on one's own experiences. In the following, we give an overview of related work. Afterwards, we propose a research model to understand the implications of the relatedness of stimuli. We further illustrate the first results of our preliminary investigation (pre-study). The paper closes with a research agenda and outlook.

12.2 Related Work

Cognitive Processes of Creativity

Based on classical cognitive science research, the cognitive network model (CNM) seeks to explain ideation. There are two modes in human memory (Baddeley, 1997), which are the working memory (WM) and the long term memory (LTM). The WM only has the capacity to store information for a limited amount of time, while the LTM stores individuals' experiences and knowledge in the long run (Santanen et al., 2004; Nijstad and Stroebe, 2006). For the sake of better access to knowledge stored in LTM, knowledge is organized in groups, which we call frames (Minsky, 1975). Frames and entities of frames are linked to each other. The CNM refers "to these bundles as frames and assume[s] that the frame, rather than the discrete items within each frame, is the basic unit of knowledge that we store and manipulate in our memory“ (E. Santanen, Briggs and de Vreede, 1999, p. 490). Once activated, frames often automatically activate linked frames (Santanen et al., 2004; Nijstad and Stroebe, 2006), which then builds a network of frames, representing our knowledge and experience (Santanen et al., 1999). According to Collins and Loftus (1975), frames can be part of more than one entity. The links and the strength of the links between them are variable. Thus, not all information stored in LTM is equally well accessible.

The cognitive process of ideation in a creative process is a two-step process (Nijstad and Stroebe, 2006). First, knowledge is activated in the WM and loaded from the LTM. Second, we find a combination or a processing of different frames in the WM to generate new ideas (Nijstad and Stroebe, 2006). This two-step process is iterative. For example, new ideas can influence knowledge activation. Looking at the characteristics of new ideas, Mednick (1962) said that the combination of two unrelated frames leads to new ideas. Thus, a greater variation and the combinations of frames may increase the likelihood that a new idea is produced (Santanen et al., 2004). Notably, people often fail to explore the solution space and only activate bounded or familiar frames (Santanen et al., 2004). However, „the creativity of a solution is a function of the degree to which frames that were previously distant from one another become saliently associated in the context of problem solving“ (Santanen et al. 1999, p. 491).

Additionally, there are two other well-cited theories, which can help to understand the implication of stimuli: the SAM theory (Raaijmakers and Shiffrin, 1981) and the ACT theory

(Anderson et al., 2004). The SAM theory states that once the WM contains a task-related frame (e.g., hotel promotion) and once a stimulus word (e.g., cooking) is presented, this frame will be loaded from the LTM to the WM. Both frames (i.e., the task and stimuli frame) are used as search cues in LTM to identify useful other frames. The search is likely to identify closely related and highly connected frames. In the next phase, the identified frames are evaluated. If they seem to be useful for ideation, they will be progressed in the WM. If they do not seem appropriate, the cues will be used for the next search. According to ACT theory, the second useful theory, a steady level of activation ensures searching for fitting frames. External stimuli can enhance this process. A stimuli word will automatically activate other frames based on the strength of their relatedness. The automatic activation of frames based on the strength of their relatedness is the main aspect of the ACT theory (Wang and Nickerson, 2019).

Relatedness and Effects of Stimuli

Remote stimuli have a positive effect on creativity (Chan et al., 2011; Chiu and Shu, 2012). For example, they decrease a narrow focus and fixation during the ideation session (Wang and Nickerson, 2019). Likewise, literature shows that people who are exposed to novel or paradigm-modifying ideas tend to create highly creative ideas themselves (Wang and Nickerson, 2019). However, there are many studies that challenge these findings. For instance, also moderately distant stimuli can help create useful ideas (Fu et al., 2013). So, based on theory we can derive that a stimulus can be close, moderately close, remote, or unrelated to an initial ideation task. Relatedness can affect creative outcome (Wang and Nickerson, 2019).

We relate to Wang and Nickerson (2019), by noticing three limitations which also lead the way for our research. The first limitation is that relatedness has different definitions (e.g., in one study, remote stimuli are closely related, while in another study, they are moderately related). This causes inconsistency. Second, the differentiation between unrelated and remote stimuli is infrequent. This results in different empirical results. Third, the selection and collection of stimuli for experimental studies is usually done ‘by hand’ and is very vulnerable to biases and errors. This is not beneficial for any scientific setting and also not beneficial for further research in the sense that it is not replicable.

Besides these gaps, which are addressed in our research, to the best of our knowledge, there is no study that considered individual factors such as experience/age, domain knowledge, gender, etc., in conjunction with computational use/search of stimuli. The gap is particularly important to investigate as the use of computers offers enormous potential (e.g., artificial intelligence and knowledge graphs).

12.3 Research Model

Adopting related work, the relatedness of stimuli has to consider the individual cognition (Briggs and Reinig, 2010). Because knowledge and experience are so individual, we have to consider that also the link between a stimulus and the activated knowledge of a person is highly individual. That means that the definition of relatedness defined on the base of semantic structures such as a knowledge graph (1^{st}, 2^{nd}, 3^{rd}, etc. order) can be different from a highly individual cognitive network.

Also, the strength of the relatedness has to consider the individual level (Raaijmakers and Shiffrin, 1981; Anderson et al., 2004). For instance, a variation in strength can be how often links are used and activated. If someone is used to a certain link, it is highly likely that this link will automatically be activated in ideation sessions. Another example is the time when a link was activated. If it was a long time ago, it would not be likely to be activated. The boundary between the WM and the LTM plays a key role in this context. If links are not used for a long period, they are not only far away with regard to its content; they can become remote or quite unrelated although they might have been related before because of timing.

Both dimensions of individual relatedness (i.e., relatedness itself, strength of relatedness) do moderate the effect of stimuli on cognitive persistence and cognitive flexibility through cognitive load and WM capacity (WMC) (Wang and Nickerson, 2019). WMC moderates the effect between stimuli and cognitive flexibility and cognitive persistence. Cognitive flexibility is defined as "the ease with which people can switch to a different approach or consider a different perspective" and cognitive persistence as "the possibility of achieving creative ideas, insights, and problem solutions through hard work, the systematic and effortful exploration of possibilities, and in-depth exploration of only a few categories or perspectives" (Nijstad et al., 2010). It is noteworthy that especially cognitive persistence is affected by the WMC, because cognitive persistence (i.e., the systematic and effortful approach to creativity) needs cognitive effort (Baas et al., 2013). In turn, WMC is affected by cognitive load (Nijstad, De Dreu, Rietzschel and Baas, 2010). Thus, reducing the cognitive load by designing an optimal fit between the computational relatedness (i.e., close, moderately close, remote, or unrelated; Wang and Nickerson, 2019) and the actual cognitive relatedness (*individual relatedness*), can enhance the effect of stimuli on creative output. In sum, we expect that considering individual factors (e.g., age, gender, experience/knowledge) when implementing stimuli in a CSS can achieve a better fit between the *computational relatedness* and *individual relatedness*. This can reduce cognitive load and finally enhance the WMC for the creative task, which in turn leads to a higher creative output. illustrates the overall research model.

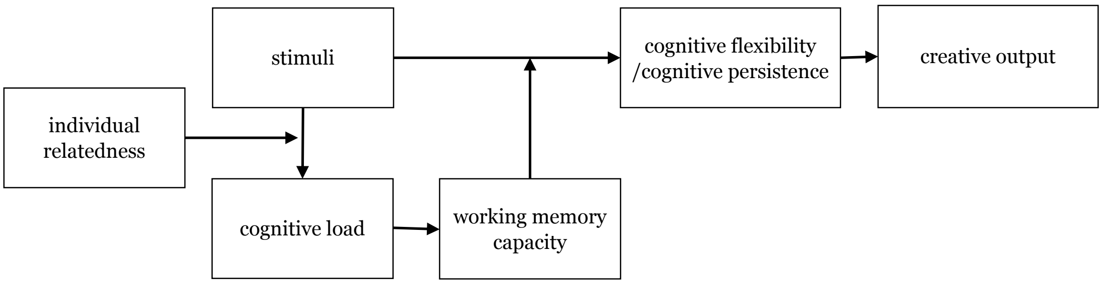

Figure 17. Overall Research Model

12.4 Pre-Study

Wang and Nickerson (2019) validated the use of a Wikipedia-based approach for automatically finding stimuli (*computational approach*), which opened the door for further developing CSS. While literature on CSS in IS research is rich and various (Wang and Nickerson, 2017), the understanding of the relation between cognitive structures and computational searching approaches (e.g., Wikipedia or other knowledge graphs) is not sufficiently understood for deriving design items, which could be validated. A better understanding of this relationship will inform future research.

In order to make a first step towards an individualized CSS, we want to investigate and understand the differences between the relatedness in Wikipedia and the rated relatedness on an individual cognitive level. A first attempt towards that direction is to examine three concepts where we expected to be different between groups. (1) The concept *iPhone*, because we expect differences on the basis of experience with technology. (2) The concept *breastfeeding*, because we expect differences on the basis of gender. (3) The concept *tree*, as a concept that is more universally valid.

Experimental Pre-Study

We followed the data collection approach proposed by Wang and Nickerson (2019), who suggested finding concepts that are spreading out from an initial concept through hypertext linkages. These are labeled as 1st, 2nd, and 3rd degree concepts. Returning to the previously mentioned example *iPhone*, we would receive iPad as a 1st degree concept as it is a hyperlink and in the text of Wikipedia page of iPhone. Similarly, Bluetooth (as a hyperlink and in the text of Wikipedia page of iPad) would be a 2nd degree concept and packet switching a 3rd degree concept (as a hyperlink and in the text of Wikipedia page of Bluetooth). We wrote a Node.js web scraping script to recursively identify the terms. While collecting, the script counted every term's respective hyperlinks on their Wikipedia page in order to rank them. As Wang and Nickerson (2019) suggest, we only included the 30 top-ranked concepts for every iteration to reduce the runtime and receive more well-known concepts. All duplicates were removed. Figure 2 illustrates the resulting structure.

Additionally, we implemented a function to search for random Wikipedia books (http://en.wikipedia.org/wiki/Special:Random/Book) in order to collect a totally unrelated concept for every combination. Overall, we selected three basic terms: *tree, iPhone*, and *breastfeeding*. We expect that *tree* could represent a concept well known to everyone, while *iPhone* and *breastfeeding* could result in different ratings across demographic variables. To evaluate the relatedness between a concept and its related concepts, we adopted the relatedness measurement by Wang and Nickerson (2019). Relatedness is measured on a scale ranging from 1 to 7 (1 being totally unrelated, 7 being highly related). For each of the basic concepts, we then randomly selected two combinations from our resulting structure.

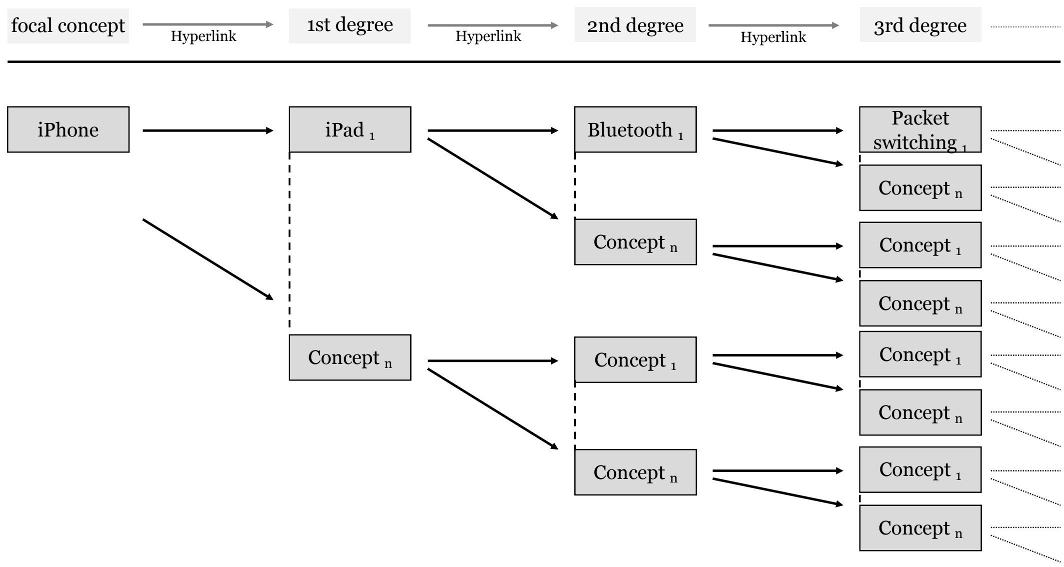

Figure 18. Structure of Scraping Results

To investigate the relatedness of the crawled Wikipedia concepts, we conducted an online questionnaire. We acquired 167 subjects from Amazon Mechanical Turk to evaluate the relatedness. The maximum time on task was set to 10 minutes. Each worker was offered and paid one US dollar for completing the task. On average, these participants were 35.9 years old (SD = 11.7 years) and spent 240 seconds on the survey (SD = 108 seconds). 29.3 percent of the participants were female, 67.7 percent were male, and the remaining 3 percent did not specify their gender.

First of all, our results confirm the findings of Wang and Nickerson (2019). Regarding the concepts *iPhone*, *breastfeeding*, and *tree*, all participants generally validated the order of concepts of Wikipedia. Exemplary, 1st degree concepts are closer related to *iPhone* (Mean = 4.89 SD = 1.8) while 2nd, 3rd degree, and random concepts are less and less related (in this order, Mean = 4.26, SD = 2.02; Mean = 3.81 SD = 1.9; Mean = 3.76 SD = 1.96). Based on a one-way analysis of variance (ANOVA), the relatedness differs significantly across groups ($F(3,980) = 18.29$, $p < 0.001$). Due to the statistically significant results, we carried out post hoc comparison analyses using Tukey's honestly significant difference (HSD) test to further scrutinize the differences between the groups. The post hoc Tukey tests show that the 1st degree concepts, 2nd degree concepts, and 3rd degree concepts differ significantly at $p < .001$; 3rd degree concepts and random concepts were not significantly different. We also carried out these procedures for the other concepts.

However, we expected varying results for particular demographic groups. For example, it is assumable that women have another relationship to the concept of *breastfeeding*. To evaluate this expectation, a two-way ANOVA was carried out on relatedness by gender and order. There was a statistically significant interaction between the effects of gender and order on relatedness [$F(3, 3721)=5.037$, $p = 0.002$]. Tukey's HSD post hoc tests were carried out. While females and males do not differ in the rating of relatedness of the 1st degree and 3rd degree concept, they differ significantly at $p=0.004$ in the rating of the 2nd degree concept and at $p=0.04$ in the rating of the random concept. Furthermore, when considering the term *iPhone*, it is assumable that IT users who rate themselves as competent are more likely to better evaluate the relatedness of concepts regarding the concept *iPhone*. To evaluate, a two-way ANOVA was carried out on relatedness by IT skills (ordinal scale: beginner, competent user, expert) and order. However, there was no statistically significant interaction between the effects of IT skills and order on relatedness [$F(6, 3484)=1.235$, $p = 0.277$]. Finally, we expected that there would not be a difference for a general term like *tree* across demographic variables. Exemplarily, we tested whether there are differences based on gender. To do so, a two-way ANOVA was carried out on relatedness by gender and order. There was a statistically significant interaction between the effects of gender and order on relatedness [$F(3, 3630)=6.251$, $p < 0.001$]. Further, Tukey's HSD post hoc tests showed that females and males do not differ in the rating of relatedness of the 1st, 2nd, and 3rd degree concept, but they differ significantly at $p<0.001$ at the random concept. Figure 19 shows the results of the posthoc comparisons.

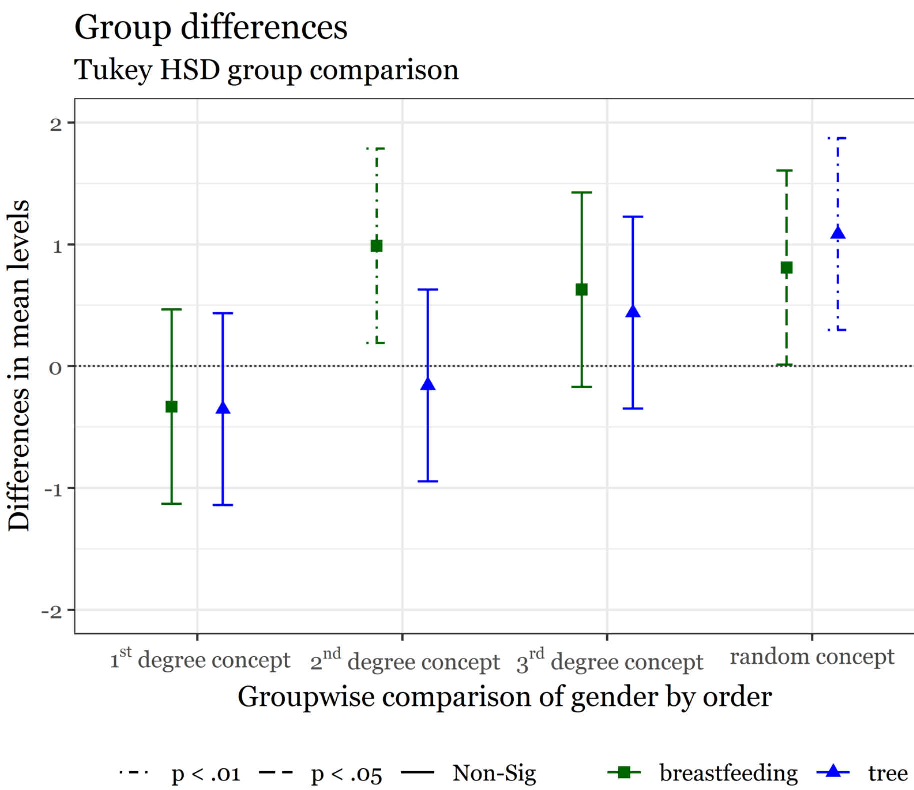

Figure 19. Groupwise Differences

Findings and Discussion of the Pre-Study

First of all, our findings highlight that future research can consider the limitations of previous research. In fact, it is important to view relatedness as a continuum and that people generally recognize the difference between remote and unrelated stimuli. Furthermore, our research shows that the relatedness of Wikipedia concepts generally applies to the results of Wang and Nickerson (2019). However, taking into account demographic variables, our results show that the relatedness of concepts can vary across different groups. Specifically, we demonstrate that not only specific concepts like *breastfeeding* (and their related concepts) but also general concepts like *tree* (and their related concepts) differ in their rating of relatedness across demographic variables. This suggests that the linked structure of Wikipedia concepts does not always reflect the individuals' cognitive networks.

12.5 Research Agenda and Outlook

As our research is intended for design, it seeks to derive design implications that help construct a CSS in the long run (Gregor, 2006; Niehaves and Ortbach, 2016). Our research is a step towards providing "theory-driven design guidelines and prescriptions for IS design, and the generation of hypotheses that are testable” (Walls, Widermeyer and El Sawy, 2004, p. 54). When it comes to the kernel theory, we follow Nijstad et al. (2010), who defined cognitive flexibility and persistence and said that creative insights, ideas or solutions are achieved through “flexible switching among categories, approaches and sets” (Nijstad et al., 2010).

Keeping our initial findings in mind, we plan to conduct an experiment to gain further insights. We will assign 80 participants to two conditions in a within-subjects design: stimuli text (Wikipedia-based), individualized stimuli text (validated stimuli). Based on our initial findings, we will validate the stimuli before the laboratory experiment. Foundation for the validation will be a similar procedure to the pre-study. This way, we ensure that the custom-fit stimuli achieve the desired effect. IS students from our local university will be recruited for the study in exchange for course credit. During the experiment, we use creative tasks that have been used in previous IS literature (Dennis, Minas and Bhagwatwar, 2013; Bhagwatwar, Massey and Dennis, 2017; Minas and Dennis, 2019). Each participant will work on each task, for 15 minutes each on three consecutive days. The order of the tasks is set at random. The first one (“tourism task”) is phrased as “Please generate as many ideas as you can to increase the number of tourists that visit the state of <State Anonymized for Peer Review>. Please consider tourists from inside the state who visit other parts of the state, as well as tourists from other parts of <Country Anonymized for Peer Review> and those from other countries”. The second task (“pollution task”) is phrased as “Please generate as many ideas as you can that will reduce pollution. Please consider ideas to reduce air pollution, water pollution, and ground pollution (e.g., garbage and landfills)”. As a third task, the participants read: “Please generate as many ideas as you can that will allow elderly people to stay in their homes. Please consider elderly people in need of physical, mental, and monetary assistance”. After each task, they read: “Try to generate as many ideas as possible. All ideas are welcome, no matter how silly or unusual they seem.” Participants will be tested in a laboratory with twenty computer workplaces in groups of ten to twenty persons. Necessary additional features due to the Corona pandemic will be taken into account, and distances will be kept at all times. The participants will obtain informed consent in which we explain that we are interested in their ideas for different areas over the course of the study. Afterward, we ask them to read the instructions on the computer screen and to provide sociodemographic information (e.g., age, gender, whether they have a job in the mentioned area). Next, whiteboards will open and participants receive an explanation of how the software works. After they have pressed the “Start“-button, the first task begins. After they have completed the first task, the experiment for day one ends. At the next day, the experiment continues with the respective following task. At the last day, participants fill out the last task, are thanked, debriefed, and receive course credit. *Creative output* is measured with the variables quantity of ideas and quantity of creative ideas. *Quantity of ideas* is measured in line with previous research (Minas and Dennis, 2019), as the number of unique ideas, without assessing quality. A master list of unique ideas of all participants will be created by one rater. Based on this list, this rater and a second rater will count the ideas independently. Subsequently, inter-rater-reliability will be calculated by the number of ideas on which both raters agreed divided by the total number of ideas and the final score will be calculated by the mean of both raters. *Quantity of creative ideas* will be measured by counting the number of creative ideas using the procedure of Dean et al. (2006) and Minas and Dennis (2019). For this, two independent raters will rate the ideas regarding novelty, workability, and relevance. Each is rated on a four-point scale, with higher values reflecting higher fit to the subdimension. Cronbach’s alpha will be calculated as a measure of inter-rater reliability (Minas and Dennis, 2019). We will use one-way repeated measures ANOVAs using the afex package in R (Singmann, Bolker, Westfall and Aust, 2015), followed up by planned contrasts. If necessary, to assess mediation effects, we will use the mediation package.

It is our goal to contribute to the development of an efficient CSS in the long run. Our ultimate vision is an ontology-based system that analyzes the user and task as automatically as possible and provides appropriate stimuli. After the proposed experiment, we try to investigate not only other stimuli, but also stimuli based on more established sources, such as a knowledge graphs based on an ontology.

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13 Paper 7: Reflective Practice in the Digital Age

Titel	Reflective Practice in the Digital Age
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Table 15. Fact Sheet Paper 7

REFLECTIVE PRACTICE IN A DIGITAL AGE

Abstract. The digital transformation, in the form of rapid changes, increasing uncertainties and unique situations, poses new challenges to all industries. As a result, there is tremendous use of new techniques and methodologies in order to enable "non-designer" to design. However, professionals of the "non-designers"-fields do not have the same requirements as designers have to do design thinking. With this short paper we aim to set out a preliminary conceptual framework of reflective practice in design context. To answer the question we go back to the roots of the actual design thinking discourse and set out a preliminary conceptual framework on basis of "Reflective Practitioner – How professionals think in action" as common denominator.

13.1 Introduction

The digital transformation, in the form of rapid changes, increasing uncertainties and unique situations, poses new challenges to all industries. One challenge is the demand of permanent innovation, which is not based on standard transactional business processes but on creating and designing new products, services and strategies which are based on creativity (Müller-Wienbergen et al., 2011; Matt et al., 2015; Hess et al., 2016).

As a result, there is tremendous use of new techniques and methodologies in order to enable "non-designer" to design (Brown, 2008; Brown and Katz, 2011). E.g. the "design thinking-methodology". The paradigm helps to create user-oriented services and products. There is also a stream on how to apply design thinking principles on strategies and organizations "design strategy" (Ignatius, 2015) and "change by design" (Brown and Katz, 2011), which is in line with the ideas of "managing as designing" (Boland and Collopy, 2004) and the idea of "science of the artificial" (Simon, 1967).

So, in order to progress we need to understand the commonalities and the differences in the underlying mechanisms of "how professionals think in action". This can be beneficial, because one critique is the practical orientation of common design thinking-approaches and that there is no explicit theory underlying in common design thinking-approaches (Schmiedgen et al., 2016). Is there a conceptual framework, which explains how professionals think in action? Such a framework can be helpful in order to identify possible connections and tailor-made applications of the design thinking method for different professions in practice.

To answer the question in further research, we go back to the roots of the actual design thinking discourse and set out a preliminary conceptual framework as common denominator. According to Johansson-Sköldberg et al. (2013) there is a discourse stream which is concerned with pragmatism epistemology what can help to gain insights for action, intervention and constructive knowledge (Goldkuhl, 2012). So Donald Schön – *Reflective Practitioner, How Professionals think in action* - is a first attempt of design discourse of designerly thinking in pragmatism paradigm (Johansson-Sköldberg et al., 2013).

With this short paper we aim to set out a preliminary conceptual framework of reflective practice in design context. Research question (RQ): *What is the framework of reflective practice in design context?* We want to derive the framework for ease of better understanding and ease of intervention in further research. To do so, we fist give an overview of Donald A. Schön's work *Reflective Practitioner - How Professionals Think in Action*. Secondly, we show the main dimensions of Reflection-in-Action in the case of an architect as an example for design context. Thirdly, we develop a framework. Fourthly, we make a proposal for further research.

13.2 Reflective Practice and the Ingredients

In order to understand the mechanism, we talk about Design Thinking – "the study of the cognitive processes that are manifested in design action" (Cross et al., 1992). With "Reflective Practitioner - How Professionals Think in Action", Schön has delivered a concept that describes situational thinking and action by practitioners (including architects). The concept consists of three parts (1) Knowing-in-Action (KiA), (2) Reflection-in-Action (RiA), (3) Reflection-on-Action (RoA). This serves as a basis for our framework of considerations.(Schön, 1983)[2]

Knowledge-in-Action

Knowledge – knowing-in-action – is of particular importance in practice for the following reasons. Professional practice has an element of repetition. The practitioner is often faced with repetitive tasks. The repetitions make his knowledge more and more specialized. This is accompanied by spontaneity, implicitness and automation. This helps to improve

[2] The following sources are listed as page numbers in the text for ease of reading.

"processing economics" [ibid, p.60]. It also results in negative effects of knowing-in-action (described by Schön as knowing-in-practice), the so-called "overlearning" [ibid, p.60-61]. This manifest itself in an ever-increasing specialization, which can be avoided with the help of reflection-in-action in the following cases of overlearning: Blind spots: The high degree of specialization can result in a narrow view. This leads to the practitioner no longer perceiving problems outside his view as a problem. The practitioner no longer relates some phenomena to his area of responsibility. The practitioner loses sight of new phenomena that do not fit into his knowledge and ignores them. Fragmentation: Through specialization and "subcategorization", the big picture of a domain and its implicit knowledge can be lost. This relates to a specific knowledge about a problem, but interrelationship of phenomena (e.g. interdisciplinary problems) are ignored.

Reflection-in-Action

Although the practitioner in part consciously falls back on theories in everyday work, he is still dependent on his implicit perceptions, his ability to judge, and his skill [ibid, p.50]. His actions are often only unconsciously influenced by his "knowledge". In other places, however, his actions are shaped or enriched by conscious thinking and reflection. While he is acting, situations arise – sometimes ad hoc – in which he accesses his knowledge in the middle of the action [ibid, p.50]. This is expressed exemplarily in questions such as: "What features do I notice when I recognize this thing? What are the criteria by which I make this judgment? What procedures am I enacting when I perform this skill? How am I framing the problem that I am trying to solve?"

This is the central process of reflection-in-action, the way in which practitioners deal with situations of uncertainty, instability, uniqueness, and value conflicts [ibid, p.50]. It is not conscious thinking but a kind of heuristic through which the knowledge of the practitioner (knowledge-in-action) is applied. Schön describes this process as reflective conversation with a unique and uncertain situation. Below, we introduce two aspects that have a direct impact on the phenomenon of reflection-in-action (Timing, Modes). Timing: Reflection-in-action is generally limited in time. There is only a certain amount of time during which you can make a difference by making a decision about the action. This has something to do with timing. The timing depends on the nature of the task and the situation at hand and is related to the speed of the activity. Speed and timing are a limiting element of the phenomenon. Different domains have found different ways to deal with it [ibid, p.62]. Modes: The goal of reflection is often completely different. Norms and expectations, behavioural patterns (influenced by implicit strategies and theories), impressions of the situation and/or his self-image are further factors influencing the way in which reflection-in-action manifests itself.

Process: (1) The problem space is defined. There is a kind of dead end in which one gets stuck and/or has an unsatisfactory result at hand. Every practitioner understands his task as unique and has to define the problem to be solved as the first step (framing – "F" in figure 1). It is not about replicating standard solutions [ibid, p.129]. (2) The problem space is then reset - the "reframing" ("RF" in figure 1). The focal point is shifted away from the problem to a different focus of the situation and its variables. This can result in new design possibilities. A practitioner succeeds in solving problems with a kind of craftsmanship. He succeeds in spontaneously and easily solving the difficulty and hopelessness posed by the complexity of a problem, which would unsettle a student or layperson [ibid, p.130]. (3) These will then be examined under the new problem space. It is a kind of experiment ("X" in figure 1) to enter into conversation with the situation. The practitioner succeeds in spontaneously comparing many solution variants and finding the best solution in his opinion without losing the flow [ibid, p.130].

Virtual Worlds: The experiments initially take place in a virtual world and serve as a context for the experiments [ibid, p.162]. The possibilities and abilities to influence virtual worlds are important characteristics of an architect and another facet of RiA [ibid, p.157]. Advantages of virtual worlds: The speed adjustment of RiA by means of drawing allows the architect to adjust the speed to his reflection. In this way, the architect can use it both ways in the design. On the one hand, he can draw a wall and test its effect on the ensemble much faster than in the real world. On the other hand, he can also pause to allow space for reflection-in-action in the flow of action [ibid, p.158]. Reversibility means that the practitioner can undo any "move". The quickly drawn idea of a wall can also be discarded just as quickly. This enables iterative loops and sequences of learning. And this without external restrictions, such as machine defects or similar environmental influences [ibid, p.158]. Restrictions: The repertoire of language makes it possible to study many phenomena. But it is also limited by the nature of graphic media. A good practitioner knows that drawings and representations cannot illustrate some things. This can only gain trust through experience [ibid, p.158]. The practitioner's experience influences the validity/reliability of virtual worlds. He must have wandered back and forth between building and drawing. An inexperienced architect therefore runs the risk of not incorporating valid considerations into his reflection-in-action [ibid, p.159].

Experiment: The reflective conversation is a kind of experiment. However, it differs from the scientific experiment as we know it from research [ibid, p.143-146]. The biggest difference is objectivity with respect to the experiment [ibid, p.163]. The practitioner wants to influence the situation and therefore evaluates the situation according to the three features (1) solvability (Solvability), (2) coherence and intelligibility of the situation (Talk-back), (3) potential for further development of the situation and the conversation (Openness) [ibid, p.136]. Below, we will give a short introduction to these three features. Solvability: Even if an experiment of the practitioner cannot be evaluated on the basis of effectiveness, the practitioner must keep feasibility in mind when re-setting for "Reframing". An experienced practitioner always sets the new problem space in such a way that he feels he can solve the problem [ibid, p.134]. Talk-back: Talk-back with the situation arises and the practitioner thinks about it. Then the conversation is assessed by evaluating the direction in which the conversation is going. This judgement is at least partly based on his perception of coherence and congruence potentials, which he can realise through further investigation [ibid, p.135]. Openness: The openness of the architect is another dimension in the evaluation of the experiments. Within the framework of the experiment, the practitioner changes the problematic situation at hand without fully understanding the situation. In this way, he leaves room for something new and for unintended effects. These are then evaluated and answered with questions as to whether he likes it or not. In this way, new possibilities are discovered through conversation with the situation [ibid, p.134].

Experience: As the practitioner tries to solve a problem in a unique and unfamiliar situation, the question is how he succeeds in incorporating previous experiences. According to Schön, the practitioner brings in his experience in the form of a repertoire of examples, images, understandings and actions. When he faces a new situation with a problem to be solved, he sees both the unique and the equal (same and different features). He perceives the new problem as a variation on an old problem. On the other hand, there will also be moments in which he consciously compares the new situation with old situations and thus compares them in a reflective way [ibid, p.138-139]. Capability - "see-as" & "do-as": Decisive for the feeling of solving new problems where existing rules do not apply is the ability to see at unfamiliar situations as familiar ones and then judge them as if they were a familiar one. This enables practitioners to apply their experiences to new and unfamiliar cases. The quality of this ability – to use existing experiences in new, unique, and unknown situations – is reflected in the breadth and diversity of the repertoire. Through a feedback loop, each new experience will enrich the practitioner's repertoire [ibid, p.140].

Rigour: The necessary environmental conditions for a controlled experiment are very difficult or impossible to achieve in practice. In practice, the experiments are therefore rather nested [ibid, p.143]. In this sense, RiA is not an experiment. But, if one understands experiments more generically – "What if?" –then in practice there are different experiments that appear mixed up [ibid, p.145-146]. While research is only about pure understanding, the practitioner's overriding goal is to change the situation so that he likes it better than before and understanding the situation is only a means to an end [ibid, p.147]. The practitioner uses the hypothesis as a kind of imperative. He makes it "come true" and he tries to change the phenomenon he examines in the situation [ibid, p.149]. He thus breaks with all the rules that constitute a controlled experiment – objectivity and distance. While in research all biases (e.g. Hawthorne effect) should be eliminated [ibid, p.149], in practice they are more likely to be of use [ibid, p.63]. Transactional: Hypothesis testing in conversation with the situation is neither self-fulfilling nor is it completely neutral. The practitioner's relationship with the situation is more transactional. He "manipulates" the situation but the situation, or rather the conversation with the situation, also influences him and his opinion and evaluation [ibid, p.150-151]. Stop: A crucial question is when to end the experiment. In research, the experiment is stopped as long as new theories can be introduced. In practice, it is about unintentionally finding something satisfying by (a) seeing something you like and (b) designing something that confers a new idea "as a whole" [ibid, p.150]. Appreciations: In practice, the primary goal is to generate an increase in value. Therefore, the practitioner will stop as soon as a situation has been created that achieves an increase in value. Since there are other questions/issues regarding hypothesis testing that remain open and much can be investigated, hypothesis testing remains subordinate in practice/function [ibid, p.152].

Openenss: Conversely, practical experiments also have something that research experiments do not. The overriding intention is to change the situation. But, if the practitioner ignores the resistance against his intention to change, it becomes more of a self-fulfilling prophecy. Reflection on the situation is the goal [ibid, p.152].

Attidude: Objectivity towards the experiment influences the attitude towards the solution. How and where does the practitioner draw the boundaries between himself and the object/situation under investigation [ibid, p.163]? In contrast to the understanding of technical rationality, the practitioner becomes part of the situation and acts as a kind of agent/discoverer – which in turn influences the practitioners attitude. Thus, the attitude of the reflective practitioner is also shaped by a kind of "double vision" (two-headedness) [ibid, p.164]. On the one hand, it is about changing and adapting the situation but on the other hand it is also about keeping an openness for criticism of the situation. This is of course difficult with increasing commitment and energy invested into altering the situation.

13.3 The Dimensions of Reflection in Action in Design - Architect

Design Domains

The design domains with which the architect works are names of elements, properties, relationships, actions, norms for assessing problems and solutions, consequences and effects [ibid, p.95-96]. Thus, all consequences that are evaluated by the architect from possible "traits" in the design thinking process come from the design domains that are available to the architect (repertoir). During the evaluation, the design domains fulfil a multitude of functions that can be divided into three areas. (1) descriptive functions, (2) constructive functions, and (3) normative functions. The effects and consequences often extend over several design domains, which only strengthens their significance [ibid, p. 98].

References: It is important for the architect to recognize references during the design thinking process and to understand their specific meaning in the new context. The references serve as a tool to use visions in all design domains. The importance of the design domains as a limiting framework is also evident when references are used. Repertoire of design domains, prioritization: Through prioritization, the repertoire of design domains experiences a further restriction. It is easy to imagine that the number of design domains the architect pays attention to has a strong influence on the design thinking process. The relative frequency of design domains serves as an indicator of the architect's attention and prioritization [ibid, p. 98].

Variation in priorities: How the architect prioritizes the individual design domains in design thinking is not static. Rather, it must be imagined that the architect "serves" different design domains depending on the status of the project (e.g. nothing at hand, first idea of cubatur, nearly fixed floorplan) [ibid, p.103]. The priorities in the different planning phases of the architect are normative. Depending on the planning phase, the priorities must be set differently. At the beginning of a project certain domains are more important than others (e.g. costs have to be estimated very roughly or cannot be considered at all, whereas the use of the property becomes a central question at an early stage) [ibid, p. 98]. Different styles and "schools" also result from the different prioritization of the design domains [ibid, p. 103].

The dimension of the design domains has an enormous influence on the proposals the architect develops in design thinking. The design domains have a quantative effect on the variety of possibilities and thus evaluated variants. Only what lies within the repertoire of the architect can be considered as a possible solution. In the end, however, this quantitative factor is reflected as a qualitative property of the architect.

"The practitioner has built up a repertoire of examples, images, understandings, and actions. Quist's repertoire ranges across the design domains. It includes sites he has seen, buildings he has known, design problems he has encountered, and solutions he has devised for them." [ibid, p. 138]

Implications

When you think about design thinking, you have to imagine the architect's thoughts as a whole network of possible "features". The consequences of each "move" have consequences for subsequent "moves". The web that the architect spins consists of further "features", consequences, effects, valuations. The effects can be partly expected from the architect and partly unexpected. From these unexpected effects, new possibilities arise for the overall idea [ibid, p. 94-95]. The design domains form the framework for action when the architect communicates the effects and their consequences in the form of words [ibid, p.95]. Communication often extends over several design domains [ibid, p.95]. The evaluation of the effects takes place three times. (1) With regard to expediency. (2) In relation to previous intentions. (3) Based on the expected impacts [ibid, p.101].

Impact on what: The architect evaluates the impact in a way that creates the opportunity for change. He always does this against the background of different "disciplines". In other words, in terms of the effects his "move" has on exposure. Or against the background of the building organisation and the walkways made possible by the current floor plan. In some cases, however, there are also effects on a larger scale, such as the effects of its "trains" on border distances or distances from other buildings. Perhaps, however, it is precisely the effects of changes in the floor plan (which entails an increase in the building volume) on the building alignment, i.e. the building cubator in relation to the surrounding buildings. On a smaller scale, however, the decisions also have an impact on hiding places or the accessibility of rooms, parts of buildings or entire complexes. Elsewhere, however, the architect also evaluates the effects of his "traits" on the handling of existing buildings (e.g. appreciative, ignoring, neutral) [ibid, p.101]. Complexity: Because the network of "trains" has many branches, it becomes a great challenge for the architect within the network to discover new ideas and good solutions for his problem. In addition, it is aggravating that one must not only consider and evaluate a decision for the moment, but also the consequences for possible later decisions with different meanings and effects [ibid, p.100]. The architect addresses the problem of complexity and uncertainty by fixing assumptions and variables from time to time, thus simplifying the growing system of variables and uncertainty. The architect must make a binding decision from time to time (initially) in order to allow further investigation and not allow the system to become too complicated [ibid, p.100].

Shifts in Stance

Another dimension that can be seen in the architect's RiA is the ability to change one's own attitude towards one's own design ideas several times (very simplified: good policeman, bad policeman).

Can/might or should/must happen: In some situation the architect can leave decisions open with a certain non-binding character. This is not possible elsewhere. Then things are more binding and the architect regards them as a necessary condition [ibid, p.101]. Some "moves" have to be implemented in order to create further possibilities. The cubature of a building is often bound to the site and the boundaries. Here some "moves" have to be made. If you build in an existing building, there are often "moves" that arise and must be made. For example, if you decide to maintain an old development (e.g. staircase). Then there are liabilities which have to be "worked out".

Focusing unit/whole: Another change in the attitude that the architect makes in design thinking is the change of perspective between the unit and the whole, i.e. the overall idea of the design. This is reflected in a change of attitude from participation on the one hand and demarcation on the other. Participation manifests itself in the form of active design of small elements of the design, while demarcation manifests itself in the form of observation of the overall situation [ibid, p.101-102].

Tentative adoption / eventual commitment: The complexity and uncertainty in the network of "trains" requires a further change of attitude on the part of the architect. That manifests itself on the one hand in a very hesitant assumption, which is quickly rejected again and questioned, and on the other hand in a final commitment towards a "train", which is binding for further investigation. Especially with a large number of iterations, this is extremely necessary to make the investigation manageable.

13.4 Framework

We can identify three dimensions that are critical to the way a practitioner works. Design domains decide the architect will include in his considerations. The Design Domains form the action framework for the solution attempts and have a "limiting" characteristic. Due to the repertoire of design domains with which the architect goes into conversation, the WHAT of the possible solution is decisive. The implications have an influence on HOW the architect deals with possible solutions in the decision tree. The Implications no longer ensure that something is taken into account or not, but much more in what quality the considerations are carried out.

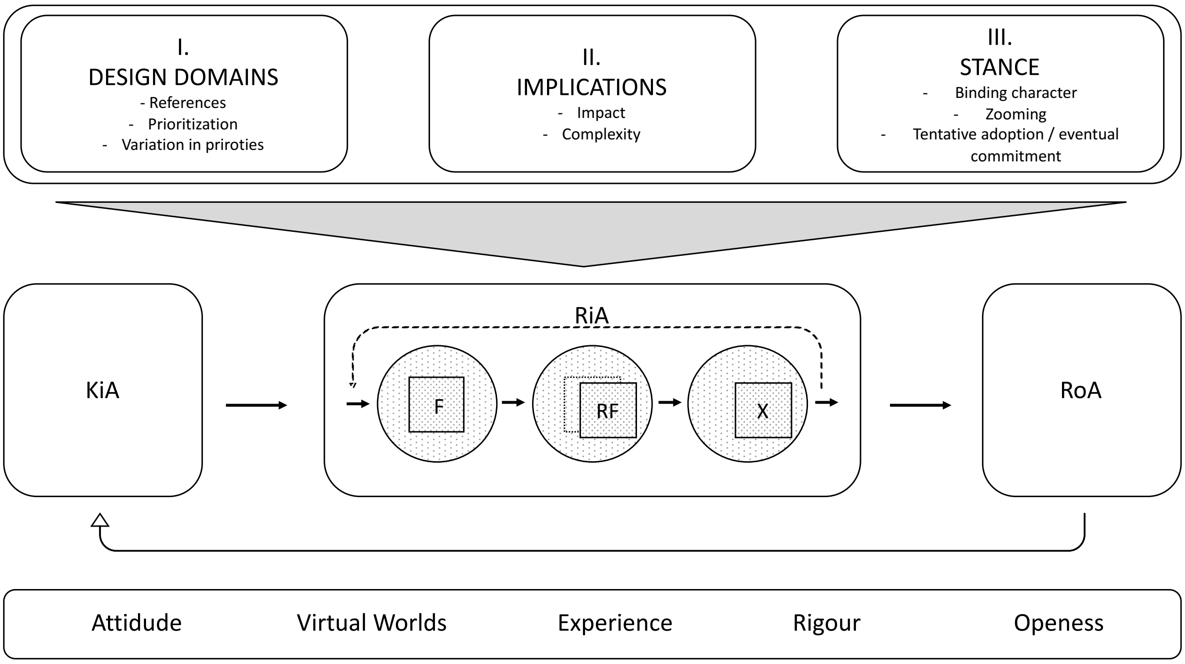

Figure 20. Framework of Reflective Practice

Stance towards the conversation with the situation is a kind of personal characteristic of the architect, HOW he is confronted with investigation. This is also a qualitative dimension. But more on the part of the architect and less easy to influence and implicit than the other two dimensions. New tools (VR, AR) make it easy to change perspective, both literally and figuratively. It can be possible to change the scale, but also to get away from the design.

13.5 Further Research

This purely conceptual framework shows possible starting points. However, the framework is only a preliminary orientation and a first attempt to better understand the creative problem-solving practices of practitioners.

As a next step, we propose to validate our framework. In order to do so, we will conduct design thinking-sessions (n=6). In three sessions the participants (n=8) are software-developers. The other sessions will be with participants (n=8) of the design-oriented practice (architects and industry designer (50%/50%). We suggest semi-structured interviews for further research to identify focal points within the framework at the beginning, in the middle and at the end of the session and validate the dimensions and process of framework.

With an iterative approach we will further develop our framework. So, after the first design thinking-sessions with designers and non-designers, we will revise the framework for next sessions.

The framework can help to understand which individuals' competencies and personal qualities do influence practical design thinking. That can help to gain insights on how to design systems that interact and collaborate between humans and robots (e.g. CSS) and how to adapt methodologies in order to make them more beneficial in the era of industry 5.0.

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14 Paper 8: Reflective Practice in the Digital Age

Titel	Cultivating Creativity: Insights from German Local Governments about the Drivers and Barriers of Change
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Table 16. Fact Sheet Paper 8

Cultivating Creativity: Insights from German Local Governments about the Drivers and Barriers of Change

Abstract. There is a tremendous need for creative problem solving and innovation. While creativity is considered as a crucial resource in the private sector and in start-ups, creative methods such as design thinking are rarely used as a systematic approach for public innovation. Thus, individual creative work practices with their drivers and barriers are not yet fully understood in public organizations. We start to fill this gap by giving an overview on related work as well as on the foundations of creativity. Next, we present best practices from German local governments. We conduct a focus group interview and illustrate preliminary results. By doing so, we identify four main themes that determine the drivers and barriers when cultivating creativity in the public sector (i.e., creativity and self-efficacy, complexity and application, clearance, mindset). As a conclusion, we discuss our results and show avenues for further research.

14.1 Introduction

In public sector, there is tremendous need for creative problem solving and innovation. For instance, evolving Smart Cities seek to answer questions about urbanization and globalization on all levels and with multiple stakeholders [16]. Public administrations are faced with the need to improve the economy, governance, mobility, environment and living in their cities [3, 9, 13]. They increasingly intend to solve their challenges and address the digital transformation with creative and agile methods, but they are often only at the beginning [22, 23].

New social challenges (e.g., pandemics like Covid-19) show that governments have to be resilient and agile in a way that they have to adapt to new situations more often and much faster than before [39]. These new challenges have to be tackled from all governments independently from their size, location and approach (techno centric or human centric) by implementing new technologies and innovations – in other words: ideas [18]. Also, digital services and multisector approaches for co-creation are under development in order to deliver promising services and thus increased value for citizens. Existing solutions fail and the need for new approaches and work practices is high [22].

Creativity is precedent for creative problem solving and innovation in organizations and cities. Thus, creative work practices offer a high chance for the public sector to tackle today's challenges and the need to innovate [5, 33]. We see the concept of creativity as broader as it is colloquially used, as we do not limit our understanding to haphazard Eureka-moments. Instead, we approach creativity from a psychological perspective and see it as cognitive process with an interplay between flexibility ("the ease with which people can switch to a different approach or consider a different perspective" [26]) and persistence ("the degree of sustained and focused task-directed cognitive effort" [26]). Individual creativity is the origin and starting point for innovation – also in collaborative settings. While the state of knowledge is rich about public innovation [36], the understanding of drivers and barriers of individual creativity in the public sector is rare.

Private sector and start-ups in particular use this two-fold understanding of creativity with its associated techniques and mindsets to develop innovation and solve problem with the power of creativity [15]. Their idea of creative work practices differs from the idea of optimized processes and incremental improvement by going new ways with the help of new methods like design thinking [5]. In the public sector, innovation is not driven by competition or profit motives [36], what makes it different from private sector innovation. There are different strategies to foster public sector innovation. Collaborative settings are described as most promising according to Torfing [2019]. However, as the individual creativity is the origin of public innovation, it will be a decisive need of collaboration to foster individual creativity. While these new methods are not clearly defined and allow for different interpretations, they are widely understood as (a) a clear description of a process, (b) a new mindset for evaluating and doing things, or (c) a toolbox to use different instruments and techniques [38]. There are different methods in use, which all have a three-step approach in common. Step 1, analyzing; Step 2, ideation; Step 3, testing [19]. Around these methods and steps, there are several techniques (e.g., brainstorming, prototyping, etc.) in order to enhance creativity on the individual, group and organizational level.

It is important to understand the drivers and barriers in German local governments, as the mechanisms in public sector are different due to the fact that *"…the absence of competition and profit motives creates different conditions for innovation in the public sector"* [36, p.4]. In order to understand the drivers and barriers of adopting and cultivating creativity in German local governments, it seems to be helpful to understand where these creative techniques and methods come from. Because it makes a difference if a work practice or method is rooted in a discipline or whether it is adopted to a domain, we will use an example of a popular creative problem-solving method. Using the example of design thinking illustrates that the idea of creative problem solving is a methodological approach that origins from product design and architecture [30]. Adopting design-oriented methods in the business sector went along with a human-centered approach where the user and user needs became focal points [38]. The third and the most current stream of adopting design thinking is about social innovation [20]. In this line of argument, creativity is seen as key to innovation.

Against the theoretical background and initial practical work, a few questions remain unanswered: Which drivers and barriers determine the governmental use of creative methods like design thinking? What are the drivers and barriers when cultivating creativity in German local governments? Answering these questions help understand and further shape the adoption of creativity in the public sector.

To answer our research question, this work is structured as follows: First, we present an overview on creativity and the current state in German local governments. Second, we give an overview on the methodological approach. Third, as our research is an initial step, we present preliminary findings of our pre-study. Finally, this paper ends with discussing our findings and by providing an outlook for future research.

14.2 Related Work

Creativity

Creativity is a multifaceted cognitive phenomenon and has been studied in various disciplines, including psychology, sociology, organizational behavior research, Information Systems (IS), and the humanities [32]. In IS research, authors have discussed this topic since the early 90s, however, Couger [6] stated that it is still under-researched in the respective domain [32]. Since then, the research of creativity is a permanent stream of interest [17]. The common characterization of creativity is to create or produces something new, that had not existed before, or in other words, "creativity typically emerges from discovering new associations between previously disparate things" [24]. We define individual creativity as a necessary prerequisite for innovation and want to contribute to existing knowledge by examining the individual conditions of creativity and ideation.

One model to understand the complexity of creativity is proposed by Rhodes [29] and it is called 4-Ps model. The model proposes different perspectives on creativity, namely the *process*, the *person*, the *product*, and the *press* or *environment* behind the phenomena of creativity. In contrast to other theories, the model provides a broad understanding and a holistic approach, that other theories such as the Cognitive Network Model (CNM), the Adaptive Control of Thought theory (ACT) and the Search of Associative Memory theory (SAM) did not offer at this point. After presenting the initial work by Rhodes, we will transfer these perspectives to the public sector, because this opens areas for action. We identify public sector specific features concerning the 4-Ps.

The perspective on the creative *person* shows that there are differences on the individual level [29]. It is important that the creative abilities on that level can be trained and learned and are not only determined by gens – which is a widely known mindset [6, 28]. This perspective opens opportunities for IS research by enhancing creativity through the use of technology or software [6]. Looking at public sector specific features, the employees in this sector are traditionally not trained in creative techniques. Whilst creative methods already reached the business world, employees in the public sector are not seen as designers or agile thinkers, because there was no need for that before. However, governments reach out for creative problem solving and innovation. Thus, there is a huge potential of enhancing creativity on the individual level by using software or stimulating creativity by public management.

The creative *process* is omnipresent in contemporary creative techniques like design thinking. It is about the process which can be taught, learned, and thus communicated [29]. In IS research, this perspective can value the opportunity to implement skill-enhancing support systems incorporating strategies and software tools [24]. Again, looking at this perspective from the public sector's point of view, skill-enhancing techniques, which are supported by strategies and software tools, seem to be worthwhile. Governments in the digital age are highly interconnected. Co-creation is one example of multi-sectoral and cross-juristical networks of collaboration [7]. Thus, people with different backgrounds are increasingly working together. Understanding common grounds and processes can help both individual with different background and diverse teams to collaborate. Moreover, at the organizational level, a shared understanding facilitates work routines. Because administrations have become diverse, interdisciplinary and open-minded work settings need to be designed in order to enhance creative output.

The creative *product* is the outcome of the creative process, which leads to a novel and original idea. Thus, the idea can be seen as a created artefact, which can be a product, service, business-model, or even a strategy [4]. The outcome can be evaluated and tested, which is a good point of departure for IS research to evaluate and measure the creative *product*. Transferring this perspective to the public sector shows that the development of new services is a corner stone of e-government and digital government value creation [2, 22, 23]. Against this background, there are creative methods like service design thinking, which were adopted to and applied in the public sector [7, 34]. Another example are digital service teams, which were implemented in order to enhance the development of new services [22]. In addition, we can find different streams where *products* are present. For example, on the website https://open.gov.sg/ Singapore presents its work under the slogan “Build Technology for the Public Good” [40]. In other countries, such as Germany, this perspective manifests itself in policies, which implement the user- and customer-orientation as well as new public management approaches, and at the same time adopt perspectives from the private sector [31].

Business-models in the sense of public sector *products* also play a role. Through the development of smart cities and the co-creation between different sectors, there can emerge different opportunities concerning creativity towards business-models. One is the opportunity for public sector spin-offs or new public sector agency, where the understanding and creation of new business models takes place [11]. Another one is the need for understanding business models in order to shape policies and strategies that foster innovation and new business models in order to stimulate new industries as value for society [14]. Also strategies do play a major role in public sector, e.g., smart city strategies. From traditional urban planning- and spatial strategies we know that the development of smart cities requires strategic work [25]. The transformation of governmental organizations needs these strategies in order to transform purposefully [12].

Finally, the creative *press* or *environment* describes the organizational influence of values and norms, which can support or suppress creativity in organizations [6]. Opportunities and challenges for IS research are various in this respect, because of the disperse use of technologies and related organizational policies. In the case of the public sector, creativity and the related norms and values of an open-minded work culture do differ from what a lot of traditional professions learned and what traditional skills such as optimization built on [37]. One example is how to deal with failure. While it is important not to make mistakes in core-processes in traditional environments, it is absolutely worthful to make mistakes and learn from them in a creative culture. The ability of ambidexterity is another important aspect to handle both core-processes and new ways of work. Because of the digital transformation, it is important to be efficient in core-processes and to frequently find new ways and solutions. The influence of the *press* or *environment* does also play a major role [1] by giving creative abilities space.

Exploring German Local Governments

In Germany, there are many municipalities and city administrations that run creativity projects and use creative methods. Now, we present some examples from German local governments, which are regarded as best practice examples, and have served as pioneers for other large projects. They might have a special appeal due to the size of the city or its regional character.

Office for unsolvable tasks. The Office for Unsolvable Tasks (German: "Amt für unlösbare Aufgaben") is an interdisciplinary team consisting of a theatre-maker, an architect, a music producer and an urban developer, which came together during the PHASE XI project that has been initiated by the Cultural and Creative Industries Initiative of the German Federal Government and the Federal Competence Centre for Cultural and Creative Industries. The office develops creative solutions for bureaucratic processes. Topics from business, politics and society are examined from the perspective of eleven creative industries in a total of eight labs throughout Germany. Leonie Pichler, theatre director and member of the Office for Unresolvable Tasks, summarizes the central aim in providing answers on how to get humanity, an appealing language, appreciation, design, humor and identification into bureaucracy [101].

GovLab Arnsberg. A similar approach is the governance laboratory (GovLab) in Arnsberg. The initiative was founded in April 2018 in the district government of Arnsberg, which is a central authority in the state of North Rhine-Westphalia. The principles of the innovation lab will be transferred to the administration and agile methods will be used to make life easier for citizens, communities and employees. The aim is to make administration as simple as possible. Some projects are submitted by core administration staff; others are the result of events organized by the lab. The projects always include diverse project teams. They have a workshop room as well as templates, method descriptions, prototyping software, and even chatbots [102, 103].

Dinslaken. The metropolitan region Rhine-Ruhr is one of the largest conurbations in Europe. Because the cities are becoming crowded as the population grows, questions of the reorganization and restructuring of areas and spaces in cities need to be tackled. Space as a resource plays a major role as one of five core themes of CREATIVE.NRW (Cluster of Cultural and Creative Industries in North Rhine-Westphalia). In 2005, the Lohberg mine was closed. In the following years, a design workshop entitled 'Perspectives for Dinslaken-Lohberg' was set up to collect the concerns, criticism and wishes of citizens and local actors. The project was about restructuring, reorganizing and reusing space. Subsequently, several event-related citizens' workshops on structural planning were held. The results were incorporated into a structural plan. In 2009 and 2010, a framework was developed, which divides the area into a residential area, the core area 'Creative Quarter Lohberg' and a commercial area. A park and a foot and cycle path, the serve as a connection. These goals were achieved with multiple forms of citizen participation. In workshops with international experts and creative companies, a mission statement was developed. Furthermore, there is a debating platform for debating future topics. There are discussions on fundamental tasks of location development, aimed at experts as well as citizens. In addition, creative people from Dinslaken and the surrounding areas visit the event 'Idea meets market' organized in the form of a world café and used as an opportunity to exchange ideas. It dealt with questions like "How do young companies manage to successfully position themselves on the market?".

Munich. In 2018, representatives got involved in a three-day Design Sprint. The participating departments were the E-/Open-Government & Smart City unit, the Department of Social Affairs and the Department of Urban Planning and Building Regulations of the City of Munich. All of them brought questions to the table, which were then addressed with the help of moderators. A design sprint is about generating and validating ideas and solutions as quickly as possible. Approaches such as Design Thinking, Service Design or agile product development are used. A major advantage is that measurable and user-centered results are obtained within a very short time. Through a mixture of group and individual work and the deliberate use of time pressure as a creativity technique, Design Sprint teams are extremely productive. The administration in Munich used the Design Sprint as an inspiration to shorten lengthy processes with "comparatively little resources and time, to deal with questions openly and across departments, and to develop concrete, user-oriented solutions" [104]. The participants looked at questions from different perspectives and put themselves in the position of their users (citizens or colleagues). First insights were derived and solution spaces were defined. Finally, prototypes were created and tested on users. The feedback enabled the participants to revise their solution approaches and to plan the next steps.

Heidelberg. The municipal administration of the city of Heidelberg is considered a best practice example for administrations in Germany when it comes to creative techniques. The city does a lot to make communication as transparent and simple as possible. There are committees, a staff newspaper, information events and one-on-one meetings with employees [105]. The resource of space is also put to new uses: The "office of the future was designed as a place of mutual appreciation" [106]. For example, the is an armchair with an integrated table. Raised rotary chairs are intended to enable conversations literally at eye level. This room concept has been tested by citizens and said to be a good idea during the long night of bureaucracy, another idea from Heidelberg. Since 2017, the administration opens from 8 to 11 pm to reach people who have to work during normal opening hours [107]. Somehow, Heidelberg resembles an up-to-date company. Citizens are regarded as customers to think and act in a solution-oriented manner and to be able to offer the best possible service. In areas such as design and digitization, the administration works with experts from the private sector, who are hired on a part-time or as freelancers. In this way, the administration becomes open to modern topics, methods and working methods. Some of the methods are team boards, the development of personas and design thinking. In addition, there is further training, a flexible pension program, and great efforts to be family-friendly. Home office can be negotiated individually. Feedback discussions are held with all employees several times a year.

14.3 Methodological Approach

Research Design

Case study research. Since our research is intended to gain insights into government and its digital transformation, our study is highly explorative and specified to the governmental context. As the situation in public sector organizations is dynamic, because of e-government legislation and internal change and smart city transformation an explorative case study approach seemed promising [8].

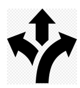
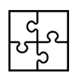
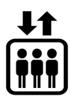
Focus group approach. Doing focus groups as qualitative method is underestimated and its potential is not fully exhausted [27, 35]. In our case, interaction and the deep discussion on a topic based on personal experience is considered as valuable. Thus, we decided to conduct a focus group interview. The discussion helped make social dynamics, consensus and conflicts observable. The participants empowered each other and brought broad insights to the table [35]. We were able to collect rich data in a short time period – "*attitudes, feelings, beliefs, experiences, and reactions in a way that is not feasible using other field methods*" [35].

Case description. The participants were part of a larger project in which the municipalities of a district reconvene on a regular basis with the goal to develop a shared digitization strategy. Their professional background and training is multidisciplinary. The topics of the overall project are *building competencies* (workshops which are offered to the mayors, administrative boards and executives are directed), *developing strategy* (developing a digitization strategy), *implementing projects* (develop concrete, joint projects to initiate and accompany digitization projects), and *supporting activities* (activities to promote the networking of the individual actors in the district and to provide opportunities for further training). Currently, the competencies had been completed and the strategy had been developed. Projects are being assembled and the project implementing is taking place.

Data and Analysis

We conducted a focus group interview with employees from four different public sector organizations (n=4, all male) to identify drivers and barriers of a creativity in their domain. The sample of organizations obtained three municipalities (population 104.000/25.000/7.000) and one district (280.000), which includes the municipalities. The sample covered the most common classes of municipalities in Germany (*Kleinstadt* – small city up to 20.000 inhabitants, *Mittelstadt* – medium city up to 100.000 inhabitants, *Großstadt* – large city from 100.000 inhabitants) and thus gives a good starting point. The participants had positions within their organization, which include aspects of smart city or digital transformation. The focus group interview was held virtually with the Webex platform by Cisco.

The workshop was divided into three phases. First, the moderator gave an overview about creativity and about common stimuli and psychological factors (creativity as something you can learn). There are two kind of enhancing individual creativity. Priming (unconscious) and stimuli (conscious) are hints to be more creative [26,32]. In order to understand the mechanisms, we used stimuli to introduce the concept in our study. Second, we conducted two ideation tasks. The first one happened without stimuli and the second one with stimuli. The visual stimulus (11 design heuristics/design principles – guidance for idea generation) was presented as text and icons (*see table 1*). The second one was designed in a similar fashion, but now the participants had the same understanding of ideation. We choose ideation because it is core of creative problem-solving tasks. In the third phase, we discussed whether and how creativity could be helpful not only for doing ideation tasks in public administrations, but for a 'real' design or problem-solving task for governmental products, services, processes, strategies or even business-models in daily live, i.e. authentical problem-solving tasks. By presenting and discussing the results of phase 2 and discussing the questions of phase 3, we achieved an ongoing discussion encouraging the experts to think and reflect about their everyday practices and beyond. We collected the data with audio recording and transcription, prepared by one of the authors. Based on this data, we identified different themes in Table 17. Analyzing the data was performed by two of the authors in several iterative steps.

Heuristic/ principles	Description	Icon
Add features from nature	The object mimics natural features or helps to mimic natural features	
Attach product to user	The object is attached to something or helps something to be attached	
Change flexibility	The object helps to change flexibility or is flexible	
Contextualize	The object fits within a specific context	
Elevate or lower	The object can be used to lift or lower something or can be lifted or lowered	

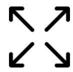
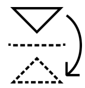
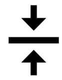
Extend surface	The object can be used to extend the assumed size of something or can be extended	
Fold	The object can be used to fold something or can be folded	
Mirror or array	The object can be used to something because it is mirrored or arrayed along a central axis or pattern	
Reorient	The object can be used by being flipped (vertical/ horizontal) or help to flip something	
Repeat	The object can be used by being repeated or help to repeat something	
Separate parts	The object can be used by being separated or help to separate	

Table 17. Design Heuristics

14.4 Findings

In this chapter, we present our findings structured in four emerged themes. The quotations were translated into English with minor adjustments.

Theme	*Definition (provided by the authors)*
T1: Creative self-efficacy	The belief of being capable of producing creative ideas.
T2: Complexity and application	The barrier to transfer the principles of creative work into every-day work.
T3: Organizational structure	The belief that creative work is possible.
T4: Mindset	The belief that creative work is allowed and desired.

Table 18. Theoretical Overview

Creativity and self-efficacy. These two concepts (T1) emerged when discussing the results of the two ideation tasks. The participants refined the common understanding of creativity as something which can be learned and practiced. Here, the participants reported what was helpful to produce more ideas and what was not helpful. *Complexity and application* as theme (T2) involved different aspects of the application of creativity and ideation in the setting of the public sector. This theme deals with aspects of transferring creativity in the context of public sector organizations. *Clearance* (T3) refers to aspects of the implementation in the respective organization and the daily business. This can be about resources (time, staff, etc.) or about constraints such as laws or rules. *Mindset* (T4) deals with cultural aspects in public sector organizations, such as openness towards new solutions, leadership or socio-cultural aspects and demographic variables.

Creative Self-efficacy

In the second phase we made the following core observations:

Self-efficacy. The presented visual stimuli of design heuristics enhanced the creative outcome (quantity of ideas) in three of four cases (quantity first task without stimuli / quantity second task with stimuli: 13/12, 15/17, 9/13, 7/12). One interviewee told us: "*I think it's basically already helpful. It was the external circumstances that maybe influenced it a little bit with me. But I think it's basically helpful."*

Creativity stimulation and support. The interviewees reported that the icons themselves were not sufficient for being creative and were only helpful in combination with the explanatory text. Dealing with the heuristics led to a higher cognitive load. One participant said: *"In addition, the heuristics were helpful, although they always give cause for reflection, which of course takes time and is not necessarily target-oriented."* And *"I honestly did not look at the icons at all, only at the text."*

Complexity and Application

Complexity. While the ideation task was abstract and restricted to a simple task, the context related aspects increased complexity. The complexity and the application of creative work method seems to be hard. One interviewee highlighted: *"However, I find it difficult ad hoc to link this to a concrete example."*

Application. However, the participants made some promising suggestions, where creative work methods could be applied. One idea was about designing processes. One employee told us: *"I believe that the topic of process management in general is not yet a major issue in many administrations. That's why there should be potential for creativity techniques in many areas, because I don't think that processes are really being tackled as much as they are with digital possibilities. How they could be repositioned now, and it depends on whether you are creative and look at your processes from a different perspective."* We know some examples of service design thinking and design thinking of processes. This has already been applied in some cases [22, 41] and seems to be interesting on a more general basis, too.

Organizational Structure

Organizational structure. The theme refers to the freedom of employees to try out new techniques and methods. In the public sector, we often face policies and alignments between state, province, district, and the municipalities. This leads to the view of a limited scope for design at the individual level. The theme *organizational structure* consists of three sub-themes: clear definitions, clear regulations, and perspective-taking.

Clear definitions. While the one participant reported one potential application of creative techniques in designing governmental processes, other participants reported some constraints. It was said that *"In my eyes, there are areas where this could take up more room and in others, processes are so clearly defined that this cannot offer so much help."*

Clear regulations. Regulations were reported as constraints. However, there is a potential fields of action where they see a potential application – culture and tourism. One of the participants concluded: *"So if you look at certain specialist applications, for example in the Citizens' Office, where the processes are digitally supported, but where the procedures are already clearly regulated, the scope is not quite as great as when you say that you are doing something completely new for the […] museum, where everything is still open as to how culture can be communicated digitally in the future. There is a lot of room for manoeuvre and in other areas, because there are so many specifications regarding the procedures, you would have to find niches where it might be possible to provide support." "I believe that the areas that are less regulated, culture but also tourism, are definitely areas where this can work better than in the real estate cadastre or the environmental office, i.e. where the processes are generally very strongly regulated."*

Perspective-taking. We could also identify a driver for using creative techniques in the public sector. As every employee is actually also a citizen, it is hard to change the perspective when it is about designing new services, processes, business models or even strategies. *"I believe that everything that has a perspective on citizens simply has an additional perspective from which to look at it, and that creativity techniques can work well in these areas. Because then it has a kind of application and an additional external perspective. That creates space for creativity."* Creative techniques are reported as promising when taking the perspective of citizens in order to enhance user-centricity.

Mindset

The theme *mindset* deals with the attitude and the culture in government. The context-specific circumstances in government lead to some special aspects. For example, creative work can be hindered by the fact that one organization is just one of hundreds with similar problems. Why should they start to question existing solutions? *"Situations often have to follow laws that dictate what to do, but the laws usually dictate what has to be done, but not how it has to be done. The question is how to build something like this, how can it look like at all, and the whole issue of intermunicipal cooperation is always involved to some extent, so that people from the same specialist offices in other municipalities think about such processes. You have more people and resources to think about creativity techniques."* On the other hand, the same aspect has a positive stance. The high amount of other municipalities that are open for cooperation and for the scaling of solutions, can be a driver.

Management in the sense of public value creation and public welfare is different to private sector with its commercial orientation. Employees in the public sector act in the role of a multi-stakeholder representative. This can be a hard fact when it comes to impede cultivating new work methods. *"We always have these resource problems. Budgetary security concept, lack of financial, time and personnel resources... You have to sell these free spaces very well and then you have to show how productive something is when we invest something. A start-up has a better chance of creating this kind of freedom, saying that we try something completely new and we go crazy and we do something and if it goes wrong, then it has gone wrong. That has to reach us first. But we are dealing with tax money. For us, we don't think it's like saying, come on, let's experiment and let it run into the wall and then we'll take a look and say oh yes, too bad."*

Drivers and Barrier

In our study, we identified several entry points for different drivers and barriers to cultivate individual creativity in public sector. In this chapter we show our results and categorize them *into process, person, product*, and *press or environment*.

Category	*Drivers and Barriers*
Process	Applying creative methods in problem solving is complex. A clear process could help. Methods like design thinking with a structured process can be a driver and help to foster individual creativity.

Person	Public sector employees are not trained to generate disruptive ideas or concepts. CSS or teaching strategies like design heuristics/principles can help foster individual creative self-efficacy.
Product	Public sector employees act in the sense of public value. The product (e.g., a new digital service) needs to be defined and the task has to be clearly articulated in order to foster individual creativity. Also, the user-centricity (of the user who will use the product) should be part of the task.
Press	In an environment, where innovation does occur rather by chance, than systematically, encouraging a mindset that fosters creativity helps to increase individual creativity.

Table 19. Drivers and Barriers

14.5 Discussion

Our research and the preliminary findings are just a small first step on the route of understanding drivers and barriers of creative techniques and methods in local governments. However, the represented findings serve several implications for both, theory and practice.

Our initial step contributes to theory by understanding what kind of stimuli can be helpful in order to support creativity. It thus contributes to the body of knowledge about Creativity Support Systems (CSS). Adapting the design heuristics to the context of the respective domain (i.e. the public sector) will help better apply them. Second, we seek to study the drivers and barriers of individuals when it comes to adopt new work methods. By understanding which drivers and barriers determine the adoption of creative problem-solving tasks, we contribute to the state of research in innovation management in public sector organizations. Based on the statements of the participants one can see that the employees in a government are in a dilemma situation. On the one hand, they manage tax money and have no task and only few opportunities to experiment. On the other hand, this does not lead to innovative solutions. It can be valuable for future research to see to find out to what extent the decisions of the employees regarding their working methods (e.g. willingness to experiment and take risks) are influenced by cognitive biases (e.g. projection bias: A projection bias or 'presentism' [10] occurs when a decision-maker projects the present into assumptions about the future [21]. This bias leads to decisions which neglect events that differ from the present, e.g., extreme events like pandemics). Moreover, uncertainty and complexity are not yet fully taken into account. Due to the complexity and uncertainty of social phenomena, it is not possible for employees to make purely rational decisions. Therefore, employees have to rely on heuristics and run the risk of not making optimal decisions due to cognitive distortions. If the public sector is not able to experiment, social innovations will fail to arise and then to materialize. This provides a point of reference for research on bounded rationality.

The implications for practice are various. Our results represent different links to the use of creative techniques in governments. Employees assume that creative techniques application can be beneficial in the fields of action of tourism and culture. While we also show implications that creative techniques can be used more general when it is about processes design and taking the perspective of citizens. All barriers we identified can be a starting point by asking how to determine them. For instance, cooperation is an implication with practical relevance, by working together on problems governments share. Another implication for practice is the aspect to question the regulations and definitions. Some findings suggest that not every regulation and definition is a barrier. Maybe there can be more space to design new processes by implementing clear rules. We also expect that the introduction to design heuristics (e.g., via webinar, podcast, etc.) will lead to a higher creative self-efficacy. Public sector employees will trust their ability to find creative solutions after understanding that creative skills can be learned.

Besides our preliminary findings, our research has some weakness. The explorative qualitative interview is just a first and initial step. The sample size (n=4) is sufficient as a starting point, however, the findings are not to be understood in generalizing fashion. The project the participants were part of and consequently the common goals and shared perspective of the participants might have also limited our insights. Furthermore, there are general limitations of focus groups such like biases due to group interaction and social desirability.

As our investigation is designed just as a first step, there are several possibilities for further research. A semi-structured interview seems to be promising to validate our findings from different perspectives. Second, quantitative data (e.g. a survey) can help to understand how to cultivate creativity in a broader context. Third, a laboratory experiment can help understand the drivers and barriers on the individual level in detail.

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15 Paper 9: Design Thinking als Werkzeug für Co-kreation und Co-design – Ein Erfahrungsbericht in 5 Thesen

Titel	Design Thinking als Werkzeug für Co-kreation und Co-design – Ein Erfahrungsbericht in 5 Thesen
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Table 20. Fact Sheet Paper 9

Design Thinking als Werkzeug für Co-kreation und Co-design – Ein Erfahrungsbericht in 5 Thesen

Zusammenfassung. Die digitale Transformation stellt deutsche Städte und Gemeinden vor große Herausforderungen. Dabei ist es wichtig, dass der Mensch mit seinen Bedürfnissen im Mittelpunkt der Gestaltung der zukünftigen Lebens- und Arbeitsräume steht. Im vorliegenden praxisorientierten Artikel wird aufgezeigt, wie der innovative Design Thinking-Ansatz zur digitalen Transformation öffentlicher Verwaltungen beitragen kann. Anhand des Fallbeispiels eines kommunalen Open Government Labors in Nordrhein-Westfalen, welches den „Kurort der Zukunft" gestalten möchte, können allgemeine Anregungen zur aktiven Teilhabe der Bürgerschaft und Stadtgesellschaft abgeleitet werden. Ferner werden spezielle Prinzipien für die Durchführung eines Ideen- Workshops diskutiert und mögliche Herausforderungen virtueller Formate beleuchtet. Der Beitrag schlussfolgert, dass der Design Thinking-Ansatz eine große Chance ist, den Wandel unserer Kommunen inklusiv, kollaborativ, agil zu gestalten und einen wertvollen Beitrag zu Stadtentwicklung zu liefern. Aufbauend auf unserem Anwendungsbeispiel wird insgesamt deutlich, wie und warum durch innovative Formate der Zusammenarbeit ein zusätzliches Potential der co-kreativen und co-produktiven Gestaltung der Städte und Gemeinden von morgen geschaffen werden kann. Das Gelernte kann schnell auf andere Fälle adaptiert und übertragen werden.

Schlüsselwörter. Smart City, Design Thinking, Verwaltungsinnovation, Co-Kreation, Co-Produktion, digitale Transformation

Abstract.The digital transformation is a major challenge for German cities and municipalities. It is becoming increasingly important to consider the citizens' needs and to account for their various interests when designing future living and working spaces. This practice-oriented article shows how the innovative design thinking approach can contribute to the digital transformation of public administrations. Based on the case study of a municipal Open Government Laboratory in North Rhine-Westphalia, which aims for designing the "health resort of the future" ["Kurort der Zukunft"], general suggestions for involving citizens and the urban society can be derived. Furthermore, distinct lessons learned for the implementation of an ideation workshop are discussed and possible challenges of virtual formats are highlighted. Our work concludes that the design thinking approach is a great opportunity to manage change in our municipalities more inclusive, collaborative, agile and to make a valuable contribution to urban as well as rural development. Building on our use case, it becomes clear how and why to use the potential for the co-creative and co-productive innovative formats of cooperation when designing the cities and communities of tomorrow. These insights can easily be adapted and transferred.

Keywords. Smart City, Design Thinking, Innovative Administration, Co-Creation, Co-Production, Digital Transformation

15.1 Einleitung

Bei der Gestaltung intelligenter, bürgernaher Städte und Gemeinden bieten kollaborative Innovationstrategien einen guten Ansatz für Inklusion und Partizipation (Torfing 2019). Sie versprechen, relevante Akteure mit unterschiedlichstem Hintergrund in Entscheidungs- und Entwicklungsprozesse einzubeziehen, um auf nutzerorientierte Weise Antworten auf komplexe Herausforderungen der öffentlichen Hand zu finden und mögliche Lösungsansätze frühzeitig zu legitimieren. Nicht zuletzt bieten die Formate eine Antwort auf die knappen Ressourcen in öffentlichen Verwaltungen (z.B. wegen schlechter Haushaltslagen, auf Grund von Nachwuchskräftemangel, wegen des demografischen Wandels) sowie die Möglichkeit, die Performanz und Transparenz der Dienstleistungen (Services) vor Ort zu erhöhen. Doch wie genau kann eine kollaborative Innovationsstrategie in Kommunen umgesetzt werden?

Der Ansatz des Design Thinking ist ein Werkzeug zur Gestaltung von innovativen Lösungen und dem Umgang mit komplexen Problemen (Brown 2008; Brown und Katz 2011), der zur Entwicklung neuer Ideen führen soll. Ziel sind Lösungen, die aus Anwendersicht (z.B. Perspektive der BürgerInnen) überzeugend sind. Seine Wurzeln hat das Design Thinking in der Produktentwicklung und Architektur. Heute wird es bei der Entwicklung von Produkten, Geschäftsmodellen, Strategien und – wie im vorliegenden Fall – Dienstleistungen angewendet (Brown 2008). Es ist eine vielschichtige Methode. Die leitenden Prinzipien, die die Haltung und Handlungen der Design Thinker formen, sind radikale Kollaboration, am Menschen orientiertes Handeln, sofortiges Demonstrieren, spielerisches Experimentieren, direkte Umsetzung, Klarheit und stetige Prozessorientierung. Diese Leitlinien helfen, schnell neue Perspektiven einzunehmen und nutzerorientierte Innovationen zu gestalten (Schmiedgen et al. 2016).Wie aber sieht Design Thinking konkret im öffentlichen Sektor aus?

In unserem Erfahrungsbericht möchten wir Ihnen Einblicke in unser Projekt „Open Government Lab: Designing Future – Kurorte der Zukunft“ (Bundesministeriums des Innern, für Bau und Heimat 2021) geben und darauf eingehen, wie die digitale Transformation gerade in ländlich geprägten Regionen gestaltet werden kann. In dem vom Bundesministerium des Inneren, für Bau und Heimat (BMI) geförderten Projekt nutzen wir die Ansätze des Design Thinking und das Prinzip eines Open Government in einem Verbund aus sieben Kurorten, diversen Klinikbetreibern und weiteren Partnern. Im Rahmen der Projektarbeit möchten wir die Potenziale des Design Thinking als Kollaborationsformat der Smart City von morgen verstehen. Dies tun wir im vorliegenden konzeptionellen Beitrag, indem wir fünf Thesen zum Thema Design Thinking als innovatives Kollaborationsformat der Smart City illustrieren:

1. *Design Thinking ist inklusiv: Wie mit Design Thinking ein Partizipationsformat für Kommunen entsteht*
2. *Design Thinking ist kollaborativ: Warum viele Perspektiven helfen, man dabei aber einiges beachten muss*
3. *Design Thinking verhilft agilem Arbeiten: Warum Design Thinking auf agilen Prinzipien beruht und wie man den spezifischen Anwenderkontext berücksichtigen kann*
4. *Design Thinking ist nicht nur Mittel zum Zweck: Warum Design Thinking auch ein gutes Change-Management-Werkzeug ist*
5. *Design Thinking kombiniert Planung und Freiheit: Warum Design Thinking zwar Offenheit für Überraschungen bieten muss, es aber keine ungewollten Überraschungen geben sollte*

In dem folgenden Kapitel gehen wir näher auf das Konzept der innovativen Kollaboration ein und beschreiben das Open Government Lab „Designing Future – Kurorte der Zukunft“. In Kapitel drei teilen wir die „Lessons Learned“ und schließen in Kapitel 4 mit einer Diskussion und einem Ausblick.

15.2 Bisherige Arbeiten und der Case

Innovative Kollaboration

Die digitale Transformation unserer Städte ist eine der wichtigsten Herausforderungen unserer Zeit (Portmann und Finger 2015; Gil et al. 2019). Auf der einen Seite stehen Themen wie Landflucht oder Urbanisierung. Auf der anderen Seite bieten der technologische Fortschritt und aufstrebende Innovationen neue Möglichkeiten diesen Herausforderungen zu begegnen. Während der digitale Transformationsprozess in großen Städten und Metropolen bereits seit Jahren auf der Agenda von Verwaltung und

Stadtgesellschaft steht, besteht gerade in ländlichen Regionen noch Handlungsbedarf (Ruhlandt 2018). Das lässt sich unter anderem durch kontextuelle Faktoren, wie unterschiedliche Autonomiegrade der Verwaltungsebenen oder die Verfügbarkeit von Wissen bei z.B. BürgernInnen (Ruhlandt 2018) erklären. Diese Faktoren sind bei Kommunen im ländlichen Raum geringer ausgeprägt als in großen Städten und Metropolen.

Informations- und Kommunikationstechnologien (IKT) sind der technologische Baustein von intelligenten Städten und Gemeinden (Smart Cities) (Andrushevich et al. 2015). Durch sie können sowohl die Qualität als auch Effizienz von städtischen Dienstleistungen verbessert werden. Gleichzeitig besteht bei zweckorientiertem Einsatz von IKT und bei einer gründlichen Risiko-Analyse die Möglichkeit, dass Kosten reduziert und Ungleichheit aufgehoben werden können (Yigitcanlar et al. 2018). Über die technologischen Neuerungen hinaus ist es wichtig, dass in Kommunen Formate für die kollaborative Zusammenarbeit zwischen Verwaltung, Bürgerschaft und Wirtschaft entstehen, um strategische Leitbilder zu erarbeiten und als greifbare Maßnahmen der Stadtentwicklung umzusetzen (Alawadhi et al. 2012).

Die Öffnung des Verwaltungshandeln spielt bei der Kollaboration von Smart Cities eine wichtige Rolle (Bickmann et al. 2020; Hennen et al. 2020). Governance-Formate rahmen die Zusammenarbeit unterschiedlicher Interessengruppen (engl. Stakeholder), die gemeinsam Verantwortung für die digitalen Angebote der öffentlichen Hand übernehmen. Diese haben bereits seit den 1980er Jahren Bestand und stehen für Transparenz, Effizienz und Legitimität (World Bank 1992). Mit den fortschreitenden technologischen Möglichkeiten, wie dem Internet und der Präsenz der sozialen Medien, hat sich dann das Konzept des e-Government entwickelt. Dabei werden neue Services für die BürgerInnen möglich und gleichzeitig gibt es neue, teils digitale Austauschformate zwischen der Verwaltung und den BürgerInnen. Durch Letzteres konnten neue Arten der Partizipation umgesetzt werden (e-Participation) (Guenduez et al. 2017). Allerdings zeigen sich nur geringe Beteiligungsquoten (Zepic et al. 2017). Eine persönliche Ansprache oder ansprechende Themen fördern jedoch die Beteiligungsquoten (Zepic et al. 2017).

Der nächste logische Schritt in der Öffnung des Verwaltungshandelns ist es, über bisherige Formen der Partizipation hinauszugehen und noch direktere Formen der Kollaboration zu ermöglichen (Crosby et al. 2016; Torfing 2019). Das bedeutet, dass

BürgerInnen nicht nur beteiligt werden, sondern diverse Stakeholder gemeinsam an komplexen kommunalen Fragstellungen arbeiten. Auf dieser radikalen Einbeziehung fußt die Idee des Open Government, welche aus den drei Bausteinen Transparenz, Beteiligung und Zusammenarbeit besteht (Lathrop und Ruma 2010). Der Baustein Transparenz kann beispielsweise mit der voranschreitenden Digitalisierung beschrieben werden. Dabei spielt die langfristige Stärkung ländlicher Regionen vor dem Hintergrund demografischer Herausforderungen, schlechter Erreichbarkeiten sowie der Wertschätzung dieser Regionen eine zentrolle Rolle. Der Baustein Beteiligung kann z.B. durch die Einbindung von unterschiedlichen Akteuren gestärkt werden. Durch den gemeinsamen Austausch und Diskussionen zwischen Lokalpolitik, Verwaltung und Zivilgesellschaft können die Vorteile und Möglichkeiten von Open Government genutzt werden, um dialogorientiertes Handeln im ländlichen Raum zu verankern. Der Baustein Zusammenarbeit kann z.B. durch den Aufbau eines gemeinsamen Netzwerks mit unterschiedlichen Akteuren, den Einsatz von Arbeitsgruppen, Barcamps, Digital Cafés gestaltet werden und soll mit Co-Kreation ein gemeinsames Verständnis schaffen (Schaper-Thoma 2021). Gerade der Baustein der Zusammenarbeit bietet großes Potenzial für die Stadtentwicklung, da es um die Gestaltung der zukünftigen Lebensrealitäten der BürgerInnen vor Ort geht (Poocharoen und Ting 2015; Lembcke et al. 2019). Oftmals müssen vielschichtige Probleme gelöst werden, bei denen es nicht nur die eine richtige Lösung gibt. Der traditionelle Führungsansatz (Top-Down) gerät an seine Grenzen, da diese Herausforderungen ohne Graswurzelbewegungen (Bottom-Up) nicht angemessen bearbeitet werden können.

Kollaborative Innovation ist ein strategischer Ansatz, der Antworten liefern kann und verspricht, den Baustein der Zusammenarbeit vor Ort mit Leben zu füllen. Pragmatisch und mit wenig Ressourcenaufwand entsteht die Chance, Themen zu bearbeiten, die ansonsten nicht hätten bearbeitet werden können (Torfing 2019). Austausch und Wissenstransfer werden erleichtert, wenn Lösungen für die Probleme vor Ort generiert werden und die Beteiligten gewillt sind, ihre Perspektiven und ihr Wissen zu teilen (Torfing 2019). Zusätzlich kann es gelingen, Empathie für unterschiedliche Stakeholder, Nutzergruppen oder BürgerInnen aufzubauen. Gerade in Zeiten, die von Wandel und Unsicherheiten geprägt sind, ist das ein großer Vorteil für eine nachhaltig befähigte Stadtgesellschaft, die aus ihrer Mitte heraus innovativ ist (Crosby et al. 2016).

Design Thinking im Open Government Labor

Design Thinking ist ein einschlägiges Instrument zur kundenorientierten Entwicklung von Lösungen (Cross 2001; Uebernickel et al. 2015; Liedtka et al. 2017; Lembcke et al. 2019). Lösungen sollen stärker an den Kundenproblemen orientiert sein als an der technischen Machbarkeit (Brown 2008). Es umfasst einen mehrschrittigen Prozess, der von der Problemdefinition, über die Zielgruppenanalyse, Lösungsentwicklung und Prototypengestaltungen hin zum Testen der Ideen reicht (Schmiedgen et al. 2016). Die elementaren Dimensionen des Ansatzes sind die involvierten Personen, der genutzte Raum und eben jener mehrstufige Prozess (Uebernickel et al. 2015). Aufgrund ihrer hohen Relevanz möchten wir auf diese Dimensionen nun genauer eingehen.

Personen

Design Thinker: Der Design Thinker übernimmt die inhaltliche Verantwortung eines Projekts und ist inhaltlich mit den Problemstellungen des Projektes vertraut (Kimbell 2009). Er oder sie übernimmt die Projektkoordination sowie die Workshop- und Projektadministration. Außerdem kennt er oder sie die wichtigsten Stakeholder und räumlich-sozialen Gegebenheiten und ist folglich HauptansprechpartnerIn für die Teilnehmenden.

Design Thinking-Coach: Der Design Thinking-Coach übernimmt die methodische Verantwortung eines Workshops und ist dafür ausgebildet, mit komplexen und vielschichtigen Problemstellungen umzugehen. Er oder sie übernimmt inhaltlich objektiv die Gruppenbetreuung sowie Vorbereitung und Moderation in den Workshops. Da das Design Thinking bestimmte Werte, Haltungen und Werkzeuge transportiert, ist er oder sie für die Methodik exzellent ausgebildet.

Workshop-Teilnehmende: Die Workshop-Teilnehmenden arbeiten gemeinsam unter Anleitung des Coaches an definierten Problemstellungen. Die Auswahl eines Themas kann je nach inhaltlicher Ausrichtung des Workshops gestaltet werden. Eine ausgewogene Mischung der Gruppen ist förderlich, da jede neue Perspektive ein großes Potenzial mit sich bringt.

Raum

Kreativraum: Da Räumlichkeiten einen großen Einfluss auf die Art und Weise haben, wie wir zusammenarbeiten, sollte der Design Thinking-Raum idealerweise die kreativen

Potenziale der Gruppe fördern. Er kann zur Abwicklung von Workshops dienen und sollte mit den notwendigen Möbeln ausgestatten sein (Uebernickel et al. 2015). Darüber hinaus ist es sinnvoll, dass dieser Raum an einem neutralen Ort ist, da es für die Workshops wichtig ist, alte Sachzwänge hinter sich zu lassen. So gelingt es einfacher, eine inspirierende Umgebung umzusetzen, die neue Ideen fördert.

Verstehensorte in Kommunen: Die Räume vor Ort sind von entscheidender Bedeutung. Das gilt insbesondere für die Phasen Verstehen und Beobachten (siehe **Fehler! Verweisquelle konnte nicht gefunden werden.**), in denen ethnographische Methoden und Interviews durchgeführt werden. Die Verstehensorte helfen, die darauffolgenden Phasen auf ein gutes Fundament zu stellen. Die Design Thinker müssen das Leben vor Ort schließlich verstehen und ein Gefühl für die jeweilige Kommune bekommen, um Fragestellungen nutzerorientiert bearbeiten zu können.

Prozess

Die Workshop-Struktur sieht sechs Phasen vor (siehe Table 21). Es handelt sich um einen dynamischen Zyklus mit teils iterativen Schleifen. Schwerpunkte werden je nach Bedarf gesetzt. Der Prozess lässt sich in zwei Hauptphasen unterteilen, die Problemphase und die Lösungsphase. Diese bestehen wiederum jeweils aus je drei Schritten. Die Problemphase umfasst das Verstehen, Beobachten und Synthetisieren. Die Lösungsphase beinhaltet die Ideengenerierung, das Prototyping und schließlich das Testen der Ergebnisse oder Lösungen.

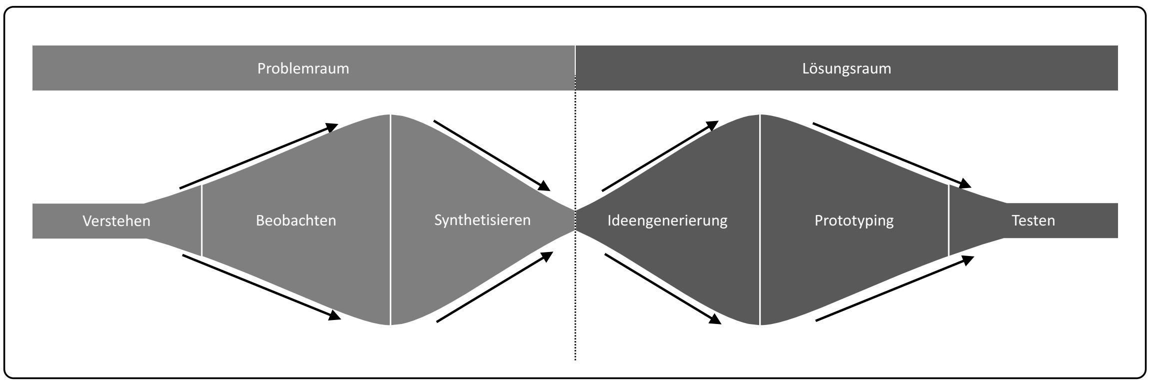

Table 21. Design Thinking-Prozess in Anlehnung an den Ansatz der Dark Horse Innovation GmbH (2019)

In allen Dimensionen spielen die bereits erwähnten Design Thinking-Prinzipien eine wichtige Rolle (Carlgren et al. 2016; Redlich et al. 2019). Die Art und Weise der Zusammenarbeit, während eines Design Thinking Workshops ist für viele, wenn auch nicht alle, MitarbeiterInnen in Verwaltungen neu und entspricht nicht dem, was die meisten VerwaltungsmitarbeiterInnen aus ihrem Alltag gewohnt sind.

15.3 Die fünf Thesen und unsere Erfahrungen im Use-Case

Open Government Lab "Designing Future – Kurorte der Zukunft"

Mit dem Projekt „Designing Future – Kurorte der Zukunft“ (Bundesministeriums des Innern, für Bau und Heimat 2021) entstehen deutschlandweit Open Government Labore, die die Öffnung der kommunalen Verwaltungen pilotieren. Dort will man gemeinsam an den Herausforderungen des digitalen Zeitalters und der Zukunftsfähigkeit der ländlich geprägten Kommunen arbeiten. Bürgernahe Anwendungen sollen erarbeitet werden und Co-Produktion und Co-Design in den Mittelpunkt rücken. Speziell in unserem Labor geht es um den „Kurort der Zukunft“. Der präventive Gesundheitstourismus bedient zum einen demografische Veränderungen und stellt zum anderen eine vielversprechende wirtschaftliche Erweiterung des kommunalen Portfolios dar. Neue Dienstleistungen und Angebote sollen die Lebens- und Arbeitsumgebung für BürgerInnen und BesucherInnen in Qualität und Quantität bedarfsgerecht und nachhaltig verbessern (siehe auch Geiger et al. 2020). In den Umgestaltungsprozess der Kurorte werden diverse Stakeholder einbezogen, etwa BürgerInnen, die Klinikbetreiber und deren Kooperationspartner, die heimischen ÄrztInnen, EinzelhändlerInnen, TourismuskoordinatorInnen und der Verwaltungsvorstand. Bisher haben wir zwei von sechs Workshops durchgeführt. Dabei diente uns der theoretische Rahmen (Personen, Raum und Prozess) immer wieder als Hilfe, um das Projekt in all seiner Komplexität und Offenheit zu strukturieren und unsere Erfahrungen zu reflektieren.

Es geht um die Frage, wie der Kurort der Zukunft konkret aussehen kann und der thematische Schwerpunkt ist die Gestaltung von neuen digitalen Services und individualisierten Dienstleistungsangeboten für Kurgäste auf Basis von mobil erhobenen Gesundheitsdaten. Dazu arbeiten VertreterInnen aus Forschung und Praxis gemeinsam an unterschiedlichen Leitfragen und nutzen die Design Thinking Methode. Sieben Kommunen und acht Organisationen aus dem Bereich der Gesundheitsversorgung und Tourismusbranche sind an dem Projekt beteiligt. Das Projekt wird dabei durchgehend von einer Universität begleitet. Darüber hinaus sind weitere Forschungseinrichtungen in einzelnen Workshops dabei.

Im Rahmen des Forschungsprojekts haben wir uns für eine gestaltungsorientierte Herangehensweise und Methode entschieden. Entsprechend der in der Wirtschaftsinformatik etablierten Methode Design Science Research (DSR) (Hevner et al. 2004) haben wir unser Vorgehen gestaltet, um die Zusammenarbeit vor Ort (als soziales Artefakt) (Lee et al. 2014) bestmöglich zu gestalten. Dabei haben wir uns an der Vorgehensweise nach Sonnenberg und vom Brocke (2012) orientiert, die eine wiederholte Evaluation nach jeder Entwurfsaktivität vorschlagen. Die Entwurfsaktivitäten erfolgten in vier Schritten: 1) Problemidentifikation, 2) Design, 3) Konstruktion und 4) Nutzung. Jede der Aktivitäten wurde durch eine Evaluation beendet. Die Problemidentifikation (die Fragestellung nach dem Kurort der Zukunft – Evaluation I) haben wir mittels Literaturrecherche evaluiert. Den ersten Entwurf für unsere Zusammenarbeit haben wir in Zusammenarbeit mit einem erfahrenen Design Thinking-Coach evaluiert (Experten-Interview – Evaluation II). Den konkreten Entwurf für die Zusammenarbeit (Projektmanagement und Workshop-design – Evaluation III) haben wir in einem gemeinsamen Workshop mit dem erfahrenen Design Thinking-Coach reflektiert. Die letzte Evaluation (Evaluation IV) haben wir durchgeführt, indem wir unsere Planung in dem Open Government Lab umgesetzt haben. Die folgenden Lessons Learned sind nach den vier Evaluationsstufen und auf Grundlage der gesammelten Daten in unserem Projektkonsortium entstanden.

Design Thinking ist inklusiv: Wie mit Design Thinking ein Partizipationsformat für Kommunen entsteht

Bürgerbeteiligung ist ein wichtiger Baustein bei der Öffnung unserer Verwaltungen im digitalen Transformationsprozess. Grundsätzlich kann das auf unterschiedliche Weise geschehen. Erstrebenswert sind die Zusammenarbeit und das gemeinsame kreative Problemlösen im Sinne von Co-Produktion und Co-Design. Der Design Thinking-Ansatz bietet hier einen guten Rahmen. Allerdings sind wir während der Vorbereitungen des ersten Workshops auf Herausforderungen gestoßen: In unserem Projekt geht es an einer Stelle konkret darum, neue digitale Services für Besucher in einem Kurort zu entwickeln. Eine potenzielle Nutzergruppe sind Kurgäste. An diesem Punkt wurde deutlich, wie schwierig die Beteiligung einiger Nutzergruppen ist, denn die Personen, die oft nach schweren Krankheitsverläufen psychischer oder physischer Natur zur Genesung in einem Kurort weilen, sind oft sehr belastet oder befangen. Während die aktive Mitarbeit dieser Nutzergruppe somit also herausfordernd ist, bietet der Design Thinking-Ansatz aber gleichzeitig eine große Chance, diese Personengruppe besser zu verstehen. Um ihre Bedürfnisse besser nachvollziehen zu können, haben wir explorative Interviews durchgeführt, die nicht direkt nach aktuellen Bedarfen fragen, sondern diese vielmehr durch empathisches, personenzentriertes Nachfragen aufdecken (Steller 2021). Im Anschluss hat es uns geholfen, die Interviews aufzuarbeiten, indem wir sowohl die Bedürfnisse der NutzerInnen, als auch die vorliegenden Hindernisse identifiziert haben, die der Erfüllung des Bedürfnisses bisher im Wege stehen.

> *Lessons Learned 1 (LL1): Eine direkte Beteiligung von betroffenen Gruppen kann zu Einschränkungen im Lösungsraum führen. Deshalb lohnt sich die eingehende Untersuchung der Bedarfe potenzieller NutzerInnen bereits vor den Partizipationsworkshops.*

Design Thinking ist kollaborativ: Warum viele Perspektiven helfen, man dabei aber einiges beachten muss

Offenheit und Transparenz sind notwendige Bedingungen der Open Government Labore und auf den ersten Blick scheint es, dass man daraus schlussfolgern sollte, möglichst viele und diverse Gruppen zusammenzustellen (Carlgren et al. 2016). Im Design Thinking lebt die Gruppe von der Dynamik und Diversität der Personen, die an einem Problem arbeiten. Allerdings lässt sich diese Annahme nicht ohne weiteres auf Kommunen übertragen. Die verschiedenen Stakeholder haben oft eine starke, normative Haltung und spezifisches, teils exklusives Wissen in Bezug auf ein zu lösendes Problem. In unserem Beispiel wird das anhand zweier Stakeholdergruppen deutlich. Zum einen gibt es die VerwaltungsmitarbeiterInnen, die einen Fachbereich vertreten. Mit ihrer Funktion sind Verantwortungen und eine gewissermaßen politische Perspektive verbunden. Zum anderen gibt es gesundheitswirtschaftliche Experten auf dem Gebiet. Wasserkuren und therapeutische Behandlungsverfahren in Kurorten fußen auf das Wissen ausgewiesener Experten, was dazu führen kann, dass mögliche Lösungsräume außer Acht gelassen werden. Deshalb schlagen wir vor, eine Differenzierung der potenziellen Stakeholder vorzunehmen. So wird ermöglicht, die Potenziale der Einbindung aller Stakeholder dezidiert zu nutzen. Dies ist uns gelungen, indem wir in den Workshops Inputs unterschiedlicher Stakeholder einplanen. Zum Beispiel haben beteiligte ProfessorInnen (als thematische Experten) aus den Fachrichtungen Informatik, Medizinische Informatik und Mikrosystementwurf sowie Tourismusmanagement und Marketing während der

Workshops inhaltliche Impulse geliefert. Die fünf unterschiedlichen Klassen haben wir in einem Workshop (Evaluation 3) gemeinsam mit einem Design Thinking-Coach identifiziert.

LL 2: Eine differenzierte Unterscheidung der beteiligten Stakeholder hilft die unterschiedlichen Perspektiven beteiligter AkteurInnen zu verstehen, wertzuschätzen und die Stakeholder entsprechend ihrer Hintergründe einzubinden. Wir unterscheiden zwischen Projektteam, inhaltlichen Stakeholdern, thematischen ExpertInnen, NutzerInnen/BürgerInnen und rahmengebenden Stakeholdern.

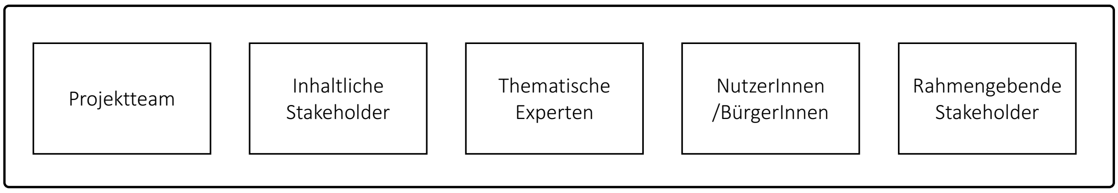

Figure 21. Unterscheidung der Stakeholder

Design Thinking verhilft agilem Arbeiten: Warum Design Thinking auf agilen Prinzipien beruht, man den Kontext aber immer berücksichtigen muss und wie man den spezifischen Anwenderkontext berücksichtigen kann

Kreative Problemlösungsstrategien erfordern es, in bestimmten Phasen verschiedene Denkmuster abzurufen (Steller 2017) und unterschiedliche Kreativitäts-Werkzeuge anzuwenden. Kreative Problemlösungsstrategien mit den dazugehörigen Arbeitsweisen gehören nicht zu dem grundlegenden Repertoire der meisten Berufsgruppen. Die ungeübte Auseinandersetzung und Anwendung von Design Thinking-Werkzeugen kann die Teilnehmenden eines Workshops überfordern. Idealerweise beginnt man zunächst mit Befähigungsworkshops. Da dies aufgrund zeitlicher und personeller Ressourcen häufig nicht als einzelner Termin möglich ist, planen wir in unseren Workshops keine klassischen Design Thinking-Dramaturgie bei der klassisch alle sechs Schritte auftauchen. Stattdessen können die inhaltlichen Phasen 1-3 im Vorfeld durch eine kleine Gruppe (z.B. Projektteam) bearbeitet werden. Der größere Beteiligungsworkshop aller Stakeholder ist dann als ein Ideation-Workshop konzipiert, bei dem es darum geht, eine möglichst große Zahl an Ideen und Lösungen zu generieren. Die Phasen 5 und 6 werden dann wieder durch eine kleinere Gruppe (z.B. Projektteam in Verbindung mit thematischen ExpertInnen und inhaltlichen Stakeholdern) abgebildet. Jede Phase wird durch Erklärungen und Ausprobierzeiten eingeleitet.

LL 3: Design Thinking kann ungeübte Stakeholder überfordern und den zeitlichen Rahmen für einen Workshop sprengen. Es lohnt sich deshalb, bestimmte Phasen des Design Thinking im Vorfeld oder im Nachgang in kleineren Gruppen durchzuführen.

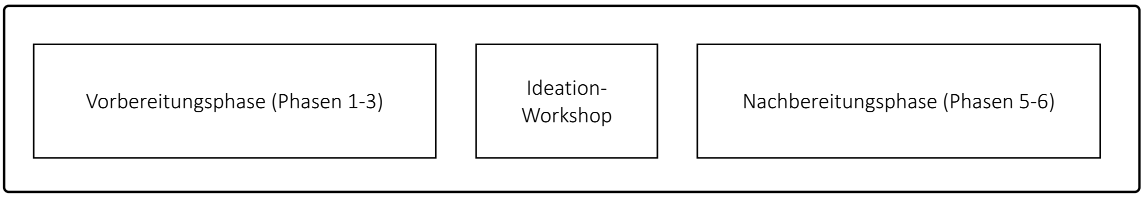

Figure 22. Gliederung der Phasen für die Durchführung eines kommunalen Befähigungsworkshops

Design Thinking ist nicht nur Mittel zum Zweck: Warum Design Thinking auch ein gutes Change-Management-Werkzeug ist

Design Thinking erscheint gegensätzlich zu gewohnten linearen Prozessen und den an Effektivität, Effizienz und Null-Fehler-Kultur orientierten Arbeitsweisen in Verwaltungen ohne Experimente und kreatives Problemlösen. So können wir gerade dort nicht einfach neue Arbeitsweisen etablieren und die alten Strukturen über Bord werfen. Trotzdem können die erlernten agilen Fähigkeiten und Denkweisen vorteilhaft sein. Aus unserer Sicht macht es deshalb Sinn, mit Bedacht Räume zur Befähigung und zum Experimentieren mit diesen neuen Arbeitsweisen in Kommunen zu schaffen. Neben dem Projekt der Open Government Labore selbst kann das Projekt „Experimentierräume in der agilen Verwaltung (AgilKom)“ dienen. Es zielt darauf ab, Veränderungsprozesse von öffentlichen Institutionen, die sich im Rahmen des digitalen Wandels der Arbeitswelt vollziehen, mit sozialen Innovationen zu verbinden. Es werden Labore eingerichtet, um innovative Lösungen im Handlungsfeld „Lernen und Arbeiten“ zu erproben. Für die öffentliche Verwaltung werden Methoden der agilen Organisation genutzt, adaptiert und ausgeweitet. Die Ergebnisse der Erprobung sollen Impulse und Best-Practice-Beispiele für Kommunen sowie für Bundes- und Landesbehörden liefern. Zuletzt werden jedoch nicht nur Projekte ins Leben gerufen, sondern auch anwendungsorientierte Räume geschaffen, so etwa der Dataport Experimentierraum in Hamburg. Er ist ein weiterer Ort zum Ausprobieren für die öffentliche Verwaltung und bietet eine Seminarfläche für Workshops, Vorträge oder andere Veranstaltungen. Der Experimentierraum entstand durch eine Kooperation mit dem Forschungs- und Transferzentrum Digital Reality der HAW Hamburg. Auch in anderen Anwendungsfeldern wurde Design Thinking neu eingeführt und die Bedeutung des entsprechenden Mindsets hervorgehoben. Auch in dem speziellen Fall von industrienahen Dienstleistungen für kleine und mittlere Unternehmen konnte der Design Thinking-Ansatz erfolgreich angepasst und genutzt werden, jedoch wurde das Mindset als wichtiger Aspekt identifiziert (Redlich et al. 2019). In unserem Projekt konnten wir feststellen, dass die Teilnehmenden in unseren Workshops sehr positiv auf neue Werte und Haltungen reagiert haben. Sie fördern die Offenheit für Veränderungen und begleiten den teilweise drastisch einschneidenden Prozess der Digitalisierung in öffentlichen Verwaltungen. Das bestätigen auch aktuelle Entwicklungen und Angebote führender Ausbildungsanbieter (siehe z.B. Hasso-Plattner-Institut Academy GmbH 2021). Die Arbeit mit Design Thinking kann tiefgreifende Effekte für eine Organisation haben und ihre Entwicklung positiv beeinflussen. Design Thinking kann beispielsweise neues Interesse an komplexen Herausforderungen wecken (Selbstwirksamkeit), die kreativen und sozialen Kompetenzen der Mitarbeitenden schulen (Empathie), die Arbeitskultur der mitwirkenden Teams verbessern (Wir-Gefühl) und einen Raum für menschliche Faktoren und Bedürfnisse schaffen (Vertrauen). Durch ein tiefes Verständnis der bevorstehenden Herausforderung und ein starkes Wir-Gefühl beim Lösen der damit einhergehenden Probleme, wird die Freude bei der Arbeit hochgehalten. Darüber hinaus bietet Design Thinking viele Ansätze und Methoden an, um gemeinsam Entscheidungen zu treffen, Verantwortung für Herausforderungen zu übernehmen und damit in eine moderne Führungsrolle zu wachsen.

> *LL 4: Neben der inhaltlichen Arbeit an komplexen und vielschichtigen Problemen ist Design Thinking ein vielversprechendes Change-Management-Werkzeug.*

Design Thinking kombiniert Planung und Freiheit: Warum Design Thinking zwar Offenheit für Überraschung bieten muss, es aber keine ungewollten Überraschungen geben sollte

Offenheit ist ein Muss, um die bestmöglichen Lösungen für neue Services im Kurort der Zukunft zu erarbeiten. Freiheit heißt hier allerdings nicht, dass wir keine Struktur verfolgen, an dem wir das Projekt ausrichten. Wir haben deshalb die Frage nach dem Kurort der Zukunft auf weitere Unterfragen hinunter gebrochen und arbeiten mit einem kontrollierten, wenn auch agilen Projektplan. Im Laufe des Projekts führen wir sechs Workshops durch. In jedem der Workshops wird eine Frage bearbeitet, die sich von der übergeordneten Frage nach dem Kurort der Zukunft ableitet. So zum Beispiel die Frage: „Wie können sich Akteure aus dem Gesundheits- und Tourismusbereich bei der Gestaltung des Kurorts der Zukunft gegenseitig unterstützen?" Die Erkenntnisse des Workshops werden anschließend von dem Projektteam in Bezug auf die Frage nach dem Kurort der Zukunft reflektiert. So erhalten wir uns zu jedem Zeitpunkt die Übersicht bei gleichzeitiger Entscheidungsfreiheit über folgende Themen. Wir bleiben offen gegenüber neuen Themen und Impulsen, haben aber gleichzeitig alle Fäden in der Hand, das Projekt zu organisieren und zu monitoren. Jede neue Unterfragestellung wird in einem einzelnen Workshop bearbeitet, womit wir gute Erfahrungen in Bezug auf unser Projekt gemacht haben. Dabei startet man bereits vor dem Workshop mit Interviews, tätigt Beobachtungen oder sichtet Dokumente. Im Anschluss an jeden Workshop folgt die Reflektionsphase in der die Ergebnisse hinsichtlich der übergeordneten Frage aufbereitet werden.

LL 5: Eine offene und agile Arbeitsweise benötigt eine kontrollierte Struktur, die ein geordnetes Projektmanagement ermöglicht.

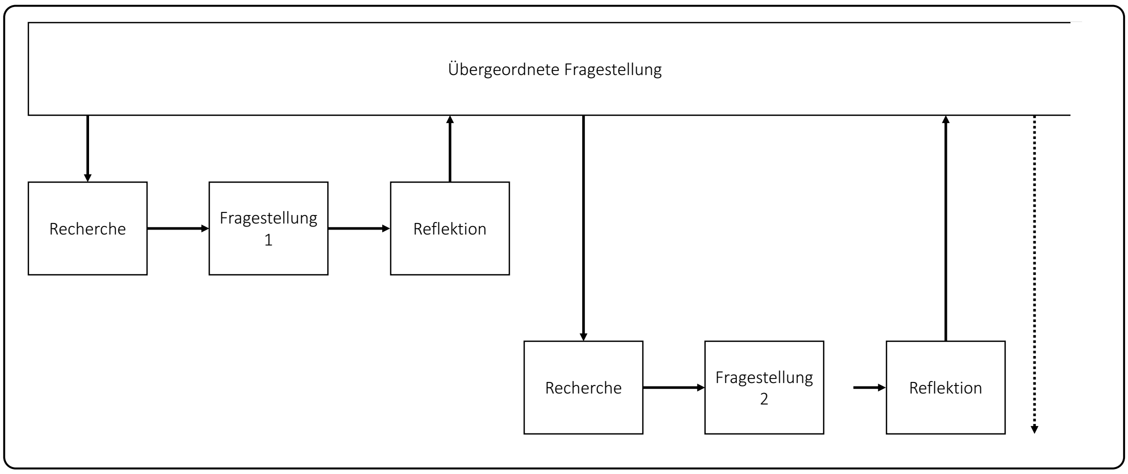

Figure 23. Übergeordnete und untergeordnete Fragestellungen zur Orientierung der Projektstruktur

15.4 Diskussion und Ausblick

Neue kollaborative Innovationsstrategien ermöglichen die Öffnung des Verwaltungshandelns eines Open Government. Sie unterstützen es auf der einen Seite, die geringen Ressourcen der öffentlichen Verwaltung bestmöglich einzusetzen, um inklusiv an den Fragen des digitalen Zeitalters zu arbeiten und gleichzeitig neuartige Partizipationsformate zu etablieren, um den konkreten Herausforderungen vor Ort zu begegnen.

Doch wie diese innovative Kollaborationsstrategien tatsächlich umzusetzen sind, um unsere Städte und Gemeinden in zukunftsfähige, intelligente Lebens- und Arbeitsorte zu verwandeln, blieb bislang im Dunkeln. Gerade klassische Beteiligungsformate stoßen schließlich an ihre Grenzen, wenn es darum geht, nutzerzentriert neue Dienstleitungen oder Angebote zu entwickeln. Komplexe und vielschichtige Fragestellungen lassen sich mit bekannten Beteiligungsformaten nur schwer lösen.

Design Thinking bietet hier einen vielversprechenden Ansatz. Gleichzeitig wirft er viele Fragen auf, auf die wir Antworten bieten möchten und teils auch neue Fragen identifizieren. In einem laufenden Forschungsprojekt konnten wir lernen, was es etwa bei der Übertragung von dem Privaten auf den öffentlichen Sektor zu beachten gilt und haben in diesem Beitrag folglich einen Versuch unternommen, unsere Lessons Learned praxisorientiert vorzustellen. Grundsätzlich haben wir die Erfahrung gemacht, dass es schwierig ist, das Konzept Design Thinking, wie es heute vermarktet und im privaten Sektor angewendet wird, eins zu eins auf den öffentlichen Sektor zu übertragen. Dabei können wir empfehlen, den Versuch zu starten, auf Grundlage der Design Thinking Prinzipien seinen eigenen Weg mit der Methode zu gestalten. Mit Design Thinking gibt es nicht den einen richtigen Weg zu innovativer Kollaboration. Für jede Organisation wird dieser anders aussehen.

Bisher konnten wir zwei von sechs Workshops durchführen. Während wir einige Iterationsschleifen bei der Gestaltung dieser beiden Workshops durchlaufen haben, gilt es in den verbleibenden Workshops die Erkenntnisse auf einer weiteren Ebene zu hinterfragen und iterieren. Außerdem stellen wir uns die Frage, inwiefern ein klassischer Design Thinking Workshop unterteilt werden und durch unterschiedliche Stakeholder bearbeitet werden kann, ohne, dass die Mehrwerte von Design Thinking noch erhalten bleiben. Das theoretische Rahmengerüst (Personen, Raum und Prozess) hat sich für uns als gutes Werkzeug erwiesen, unsere Arbeiten und Gestaltungsprinzipien zu erarbeiten und reflektieren. Diese Struktur kann bei weiteren Versuchen, Design Thinking in Verwaltung zu etablieren hilfreich sein. Aber auch diese Struktur gilt es in der weiteren Arbeit zu hinterfragen und eventuell weiterzuentwickeln.

Design Thinking hat sich in unserem Projekt als gutes Werkzeug erwiesen, um innovativ und kollaborativ an kommunalen Fragestellungen im Sinne von Open Government und mit Bezug auf die Gestaltung digitaler Services (individualisierte Dienstleistungsangebote für Kurgäste auf Basis von mobil erhobenen Gesundheitsdaten) zu arbeiten. Wir konnten einige theoretische Annahmen, die sich aus bisherigen Arbeiten und der Literatur ergeben hatten, überarbeiten, differenzieren oder erweitern. Gleichzeitig bestätigte sich unsere Erwartung, dass sich Design Thinking für die Umsetzung innovativer Kollaborationsstrategien in Kommunen eignet, sofern die Begebenheit des öffentlichen Sektors und die projektspezifischen Voraussetzungen einzelner Fragestellungen berücksichtigt werden. Allen Voran geht die Befähigung der Mitarbeitenden, die Offenheit gegenüber Fehlern und agilen Denkweisen und die kompetente Begleitung durch ausgewiesene Design Thinking Coaches. Diese Fertigkeiten und Fähigkeiten müssen, können und werden in den Verwaltungen der Zukunft etabliert werden. Und wie genau – das geschieht nutzerorientiert.

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16 Paper 10: Designing AI-driven Inspiration for Design Professions

Titel	Designing AI-driven Inspiration for Design Professions
Autoren	Hans Christian Klein[1] Sebastian Weber[1] Bjoern Niehaves[1] [1]University of Siegen, Siegen, Deutschland
Typ der Veröffentlichung	Conference Paper
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Status	Accepted
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Table 22. Fact Sheet Paper 10

Designing AI-driven Inspiration for Design Professions

Abstract. In design professions like architectural design, engineering, product design, urban design, or systems design, it is important for business to innovate and solve problems creatively. However, peoples' creativity is not naturally inexhaustible and personal traits, biological conditions and several other external influences determine human ability to solve problems creatively. That makes it hard for professions whose necessity to exist on the markets depends on creative problem solving. Artificial Intelligence (AI) offers new possibilities to design creativity support systems (CSS). We design an AI-based CSS for architects that delivers stimuli by using generative adversarial networks (GANs) trained with a high-quality dataset. The kernel theoretical assumptions are based on the concepts of fixation and mental representation abilities. Based on design principles, general requirements, and a trained GAN, we design instantiations to test our hypotheses. We further suggest an online experiment to evaluate our designs.

Keywords: Creativity, Design Science Research, Artificial Intelligence (AI).

16.1 Introduction

In today's world, we are often faced with wicked problems. Therefore, we need new digital solutions that allow for a better tomorrow. Creativity is a crucial pillar in this regard to tackle those problems and innovate [1]. From that practical point of view, the practice of design is based on creativity, and further competitive advantage calls out for creative problem solving. In the realm of design practice and design professions like architectural design, engineering, product design, urban design, or systems design, it is important for business to solve problems and make decisions creatively. However, peoples' creativity is not naturally inexhaustible. For example, personal traits, biological conditions, and several other external influences determine human ability to solve problems creatively [2]. Especially for design practice it is important to understand creativity as a resource that is never complete and perfect. According to Baskerville et al. [3], "bounded creativity (the amalgamation of Simon's bounded rationality in design and bounded creativity in engineering) means that humans are limited in their ability to make perfectly creative designs" [3]. An exemplary phenomenon is fixation, which is an undesirable condition for professionals who rely on creative problem solving and try to generate variations in their designs. Such an issue makes it hard for professions whose raison d'être depends on creative problem solving. We understand fixation as "the inability to overcome a bias in the representation of a situation by transferring knowledge from prior experience in an inappropriate manner" [4]. To prevent or solve the inability to generate new and useful ideas or concepts, stimuli can be a means to foster the idea generation [5]. Delivering technology-based stimuli to support creativity of individuals or groups and the exploration of the systems (i.e., creativity support systems; CSS) has a long history in information systems research (e.g., [6]). Technological progress is constantly creating new needs and opportunities to design these systems [7]. For example, AI offers new possibilities to design CSS. Especially adversarial learning, or more specifically GANs, are an exciting approach for the data-based generation of stimuli as they try to mimic cognitive capabilities. However, GANs rely on probabilistic instead of deterministic calculation. This implies that CSS building on this technology derive their results based on complex statistical models that incorporate many contextual factors without the knowledge of developers and users. Hence, outcomes are hard to comprehend and research on design is needed. We design an AI-based CSS for architects that delivers stimuli based on a high-quality dataset by using a GAN. Therefore, we build on the work of [7], who already suggested a general AI-based CSS, which we applied to the context of architectural design. In this work, we apply the general requirements and principles of AI-driven CSS to a specific context (i.e., architectural design). For this purpose, we apply them without exploring further requirements and principles to investigate their robustness in the research-in-progress status of our work. We will further iteratively deploy the prescriptive knowledge from the unspecific CSS and improve, adapt, and exploit the requirements and principles of AI-driven CSS, which is a relevant design contribution in DSR [8]. The kernel theoretical assumptions are based on the concepts of fixation and mental representation abilities. Based on the derived design principles [7] and a trained GAN, we design instantiations to test the design principles. We further suggest an online experiment to evaluate our designs.

16.2 Designing inspAIred

Designers' repertoire. While some cognitive explanations of creativity focus on phenomena like *eureka moments*, which explain creative problem solving that emerges from *nothing,* this explanation alone is not sufficient for the case of designers and the case of architects. Their personal experience is important to generate new designs [9]. In this case, experience does not mean that old solutions are simply reinvented and used for the new situation at hand. It is more about investigating the new situation by using previous procedures, forms, practices, and bodies of knowledge to create a new solution. The so-called repertoires of a designer are "[...] not rules, but thousands of examples, comparative, directly and intuitively based on experience[...]" [10, 11].

Representational abilities of humans. Representational abilities are important for creative problem solving to prevent fixation, and thereby deal with bounded creativity. There are three different representational abilities [12]: i.e., primary representation, secondary representation, and meta-representation. To better understand and to visualize the different representational abilities, we present Maier's [13] study. In a room two cords are hanging from the ceiling and subjects are placed in the room. The task is to tie the two cords together. However, the tow cords are placed too far away from each other to reach them with open arms. Additionally, there are several objects placed in the room (e.g., pliers) that can be used. Most subjects were not able to solve the problem. The solution is that the pliers can be used as weight and pendulum to reach one of the cords, while holding the other one. Primary representation led the subjects to see the pliers as what they semantically mean. Primary representation means a direct relation to the reality, where the individuals only see the actual meaning (i.e., pliers are pliers). The ability of secondary representation led the subjects see the pliers as weights. Individuals' ability of secondary representation helps to see the real world in another way [4]. Further, the third ability of representation, the meta-representation helps to solve the problem and understand the pliers/weights as inspiration and part of the solution. In summary, secondary representation and meta-representation can help to change the perspective and leave the problem space to enter the solution space, which is shown in Maier's study.

Training the GAN. While traditionally designers and in our particular case architects rely on heuristics, and we stressed out the problem of individual experience and overall the concept of bounded creativity (i.e., fixation), AI as a statistical and data-based concept seems to be promising [14, 15]. Machine Learning can help to enrich the individuals' repertoire and complement individuals' intuition based on countless previous solutions [16]. Neural networks are a new approach in the field of adversarial learning through which the algorithms mimic human capabilities. GANs are a special form of neural networks, which can generate data themselves [17]. A GAN consists of two competing neural networks: a generative model G that aims to create results of a certain distribution out of training data, and a discriminative model D that estimates the probability of whether these results came from G or from the training data. As such, G aims to maximize the errors of D to create realistic results that cannot be distinguished from real data. With this methodology, GANs are capable of, e.g., creating realistic images [18]. Particular fields of application have been face aging, image inpainting, and building footprint recognition and generation [14, 17]. Thus, the ability of GANs to recognise patterns and reproduce them opens new windows of opportunity for AI as an "expert system for design diagnosis and design synthesis" [16].

General Requirements and Design Principles. While GANs can generate realistic images, the illustration as stimuli has the potential to strengthen different representational abilities. Realistic images will tend to stimulate primary representation, more abstract representation in turn will tend to stimulate secondary and meta-representation and help the viewer to look beyond the obvious. Based on kernel theory and justification knowledge [19], we apply the general requirements and design principles [20] from Klein et al. [7]. The general requirements help to link the design principles with theoretical and conceptual underpinnings. According to Klein et al. [7], the general requirements are: "(1) The system must support iterative combination of frames. (2) The system must activate secondary representation and meta-representation. (3) Overall Requirement: The system must help the participants to interpret the given stimuli and objects (e.g., by asking "What else could the object be?")". We apply the "command variables" [20] as general Requirements (GRs) and: "Design Principle 1; the system must deliver stimuli, which are more generic rather than detailed and realistic. Design Principle 2; the system must deliver stimuli, which make relations between different objects visible." as design principles (DPs) [7].

Construction and Instantiation. According to the DPs and GRs, we present an expository instantiation [19] (Outcome D) to suggest an evaluation strategy [22]. The construction consists of three different activities: data acquisition, data annotation, and algorithm training. We collected site plans of already published competition-winning results. For data annotation, we considered the following elements of the site plans: surrounding buildings, existing buildings on the site, the site, the building, access to the building, and access to the site. We trained the algorithm with 460 images. Based on the trained GAN, we were able to generate stimuli for new architectural design tasks. In the following, we present two different representation variants that have different normative characteristics with respect to our requirements and thus allow a "systematic manipulation of artefact design variables" [23]. Figure 24 shows four different conditions to evaluate the instantiation. A: abstract and information high; B: detailed and information high; C: abstract and information low; D: detailed and information low.

Figure 24. Instantiations

16.3 Evaluation / Further Research

Approach. As this research is intended for design, we want to contribute to descriptive and prescriptive knowledge base. Accordingly, we aim at constructing an IT artifact and develop prescriptive knowledge on how to design the IT artefact (e.g., methods, techniques, principles of form and function) [24]. The two perspectives (i.e., interior mode and exterior mode) define our research: 1. interior mode, "theorize prescriptively for artifact construction"; 2. exterior mode, "theorize about artifacts in use" [25].We "provide theory-driven design guidelines and prescriptions for IS design, and the generation of hypotheses that are testable" [26], in order to contribute to the knowledge base in both, the rigor and the relevance cycle [27]. Against that background, our research activity will ensure to derive and implement explanatory design principles of form and function [28] of an AI-driven CSS to inspire design-oriented profession during creative problem solving. Our design decisions in this project are continuously informed by evaluation, and in this first phase, the evaluation will be explanatory, because it "prescribes principles that relate requirements to an incomplete description of an object" [20]. The process of our research activity will consist of two core activities: It consists of (a) building and (b) evaluation (i.e., (a) theory and artifact building and (b) evaluation of design principles and hypotheses) [29].

Model (Figure 25). According to kernel theory, it is important to enable secondary and meta-representation. The stimuli should enable interpretation of the shown stimulus. Thus, abstract illustration of the information will lead to a higher evaluation of the possible inspiration and a more detailed illustration will lead to a lower evaluation (DP1). Additionally, more information contextual and relational information regarding the design task, will lead to a higher evaluation and low degree of information will lead to a lower evaluation (DP2).

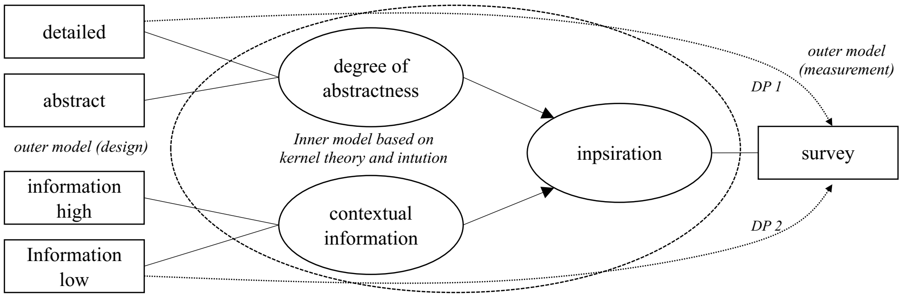

Figure 25. Design Theory for AI-driven Inspiration

Evaluation. We will conduct an online experiment following a two-step approach (i.e., ex-ante, ex-post). The design model will be tested in a 2x2 setting (ex-ante). Participants are architects with professional experience. Participants will get instructed to a fictive creative problem-solving task. After the instruction, the participants will get the stimuli. Then, participants will evaluate the usefulness of the shown stimuli regarding their potential inspiration. Additionally demographic variables and information about their professional context will be requested. In the ex-post evaluation, we will test the credibility of our GAN. Therefore, the participants will rate different designs (n=40) as to whether they are designed by a GAN or if they are contributions from architects. With our research we want to show, that AI-driven systems are potentially able to inspire professionals during creative problem-solving tasks and contribute by identifying explanatory variables, why they do inspire. The relevance for practice is high, as designers and architects' demand for unique solutions are high. The findings can be seen as a first step and the transfer for other professions would be beneficial. Our theoretical contribution is high, because we build theoretical elements and derive design principles, which are based on kernel theory.

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17 Paper 11: Invite everyone to the table, but not to every course – How Design Thinking Collaboration can be implemented in Smart Cities to Design Digital Urban Services

Titel	Invite everyone to the table, but not to every course – How Design Thinking Collaboration can be implemented in Smart Cities to Design Digital Urban Services
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Table 23. Fact Sheet Paper 11

Invite everyone to the table, but not to every course- How Design-Thinking collaboration can be implemented in smart cities to design digital services

Abstract. *Innovative-collaboration strategies are a promising tool for fostering the governance of smart cities while acknowledging citizen centricity. During implementation, however, determining the number and background of the involved actors is challenging. The Design-Thinking (DT) approach appears suitable for addressing this issue as it offers a concrete and adaptable course of action. The present contribution involves a study on implementing DT principles in a German health resort and identifies three critical components: (1) team, (2) process, and (3) workspace. Our use case is an adaptable project- and workshop plan that encourages the implementation of DT collaboration in smart cities when designing digital services. Our results provide initial guidelines on how to involve diverse actors, when to integrate trained DT coaches, and how to design collaborative innovation in a digital way. The practice-oriented insights gained in the study can be applied, adapted, and discussed in other smart cities and citizen-centered projects.*

Keywords. *Smart City, Smart Governance, Citizen-Centric Government, Collaborative Innovation, Design Thinking, Digital Services*

17.1 Introduction

Today, information and communication technologies (ICT) are used in big cities and small municipalities alike for the creation of new societal developments. However, a technology-focused perspective on smart-city development often excludes citizen involvement. While an informative and constructive exchange between residents and their representatives can lead to solutions that shape life in a social, ecological, and economic sense, smart governance encourages the development of smart-living environments (D'Onofrio, Habenstein, et al., 2019; Pereira et al., 2018; Tomor et al., 2019). A citizen-centered approach can enable the development of new socio-economic and participatory models of society.

As tremendous need for collaborative innovation in smart cities exists (Wegrich, 2019), public managers and elected officials must make use of new problem-solving tools in order to account for today's "wicked problems" (Linders, 2012). A multi-actor collaboration strategy in the public sector (Torfing, 2019) may help provide the information needed to develop these tools. Such a collaboration can foster "thinking outside of the box" and lead to the development of practice-oriented solutions that can be immediately tested and evaluated. The Design-Thinking (DT) approach appears suitable for implementing such a strategy and taking collaboration in smart cities to the next level because its principles (e.g., radical collaboration, experimentation, prototyping,) reflect the citizen-centered, problem-solving perspective of collaborative innovation while being concrete and adaptable.

The DT approach can be useful in addressing central challenges to today's smart cities, including how to access, process, and use data in the urban landscape (see Finger & Portmann, 2016; Tabacchi et al., 2019). To determine the effectiveness of this approach, we investigate a joint project between seven German municipalities that utilizes in the concrete implementation of a project based on a use case. To use urban knowledge and to redesign the information exchange in these municipalities, we place equal weight on technical and human factors in the design process. Moreover, we promote transparent collaboration between partners (universities, businesses, administrations, and society).

Our analysis involves a use case in which traditional health resorts are intended to be transformed into modern health resorts as well as attractive residential and business locations. Taking good care of the citizens' health and well-being, is a central task of smart cities, which is why the important area of smart health has emerged. Germany has more than 350 health resorts (*Kurorte* and *Heilbäder*) that combine health services and therapies, treatment programs, naturopathic treatment, wellness programs, nutrition programs, and tourist offers. However, the number of visitors and the average length of stay has been decreasing over the past two decades, and an innovative approach to remaining an important healthcare provider is thereby needed. In redesigning these health resorts, we highlight the value of a user-centered solution that is implemented via DT collaboration. While our project clearly only represents one scenario in a small number of rural municipalities, it offers a valuable starting point for drawing conclusions about how to implement a multi-actor collaboration strategy in the public sector. Our use-case is a suitable example because the respective municipalities aim to organise, coordinate, and manage the smart redesign of their cities through joint activity.

Using information systems (IS) and Design Science Research (DSR) (Hevner et al., 2004), we derive a theory-driven, practice-oriented concept for smart cities with the aim of translating citizen centricity into action. In greater detail, we draw on the work of Peffers et al. (2007), Sonnenberg and vom Brocke (2012), and Sturm and Sunyaev (2019) in developing a DSR framework. Our research question (RQ) is:

How can DT collaboration be implemented in smart cities in the designing of digital services?

In answering this question, we offer three main contributions: First, we provide a toolbox for transparent and participatory collaboration in smart cities. Second, we add to literature by demonstrating how information exchange between citizens and public representatives in smart cities can be improved. Third, we contribute to existing theoretical knowledge and provide new information that can be used to inform smart-governance models. Our insights can thereby help inform future practice, design, and research.

The manuscript is structured as follows: First, we describe the current state of research and highlight the streams of collaborative innovation and DT. Second, we derive a suitable method for answering our RQ while keeping in mind our health-resort use case. Third, we switch from theory to practice and share insights on the concrete implementation of our use-case-based project. We illustrate our findings and the resulting design rationales, which lead to a guiding project plan regarding how to implement DT collaboration when designing digital services. Fourth, we discuss our insights and address exemplary solutions to the challenges as well as the limitations of our work. Finally, we provide a summary and suggest avenues for future study.

17.2 Theoretical Background

In this chapter, we briefly sum up existing literature to deduce and develop the potential of DT collaboration for a structured future-oriented progress in smart cities. To this end, we will explain the framework conditions in rural and urban areas and shed light on new forms of participation and governance. In addition, we will discuss the role of ICT in today's smart cities and the resulting need for innovation strategies in the public sector. Moreover, we will describe the DT approach and illustrate why it offers huge potential to rethink old habits, come up with new ideas and to work with one another in an up-to-date way. It was not our aim to depict the literature in full, but rather to comprehensibly refer to the relevant aspects to answer our RQ and to illustrate our use-case example.

Collaborative Innovation in Smart Cities

Managing urban and rural areas is one of the most important social and economic requirements of the 21st century (Gil et al., 2019). This management poses challenges to infrastructure, education, health, security, and energy alike and thus goes hand in hand with vast socio-economic problems, such as resource scarcity, poverty, and the digital divide. To address these issues, local processes of societal and economic reform have been increasingly often discussed in recent years. In addition to growing research on metropolitan regions and big cities, a deeper understanding of rural regions is needed as the people who live in these regions are equally culturally diverse. Notably, however, a higher proportion of residents in rural areas are active in associations or are civically involved (Ruhlandt, 2018), which invites us to take a closer look at smart governance in these areas.

As there are comprehensive literature reviews in the field of smart city, smart city governance or participation in smart city, we will only provide a brief overview to thereupon show how our innovative approach will make the analysis, design, and development of smart cities more effective and efficient (Nilssen, 2019; Pereira et al., 2018; Shelton & Lodato, 2019; Tomor et al., 2019; Viale Pereira et al., 2017). The term "smart city" refers to developments aimed at increasing efficiency, sustainability, social inclusivity, and technological advancement in cities. Smart cities make use of ICT in order to increase the quality and efficiency of services while simultaneously reducing costs, inequality, and consumption (Yigitcanlar et al., 2018). Moreover, these cities aim to improve interactions between government, citizens, and businesses (Alawadhi et al., 2012). Due to the complex nature of smart cities, the definition of the term differs among disciplines and has evolved over time. Chourabiet al. (2012) identify eight critical factors of smart-city success (i.e., management and organization, technology, economy, infrastructure, natural environment, people and communities, policy, and governance), with smart governance representing the critical challenge that smart cities must tackle.

Governance refers to a form of governing in which a network of public- and private actors (i.e., stakeholders) share the responsibility of regulating and providing public services (Chourabi et al., 2012). The concept gained momentum in the late 1980s in response to citizens' demand for transparency, efficiency, and legitimacy (e.g., the "Governance and Development" report by the World Bank (Governance and Development, 1992)). In the 2000s, other institutions supported strategies aimed at consolidating governance via the Web and social media (e.g., the European Union (European Governance – a White Paper, 2001)), which marked the beginning of so-called electronic governance (e-governance), or smart governance. Smart governance is defined as applying ICT in a government's interactions with its citizens and businesses as well as in government operations (Backus, 2001). Citizen participation has become prominent (Allen et al., 2020; Sharp, 1980) in the form of input or feedback from citizens on the administration in regard to design policies, programs, and services (Feeney & Welch, 2012).

However, participation ("being involved") has now been replaced by the demand for collaboration ("working with partners") because public managers and elected officials need new problem-solving tools to account for today's challenges (Linders, 2012). Although there is, to the best of our knowledge, no use case with several rural smart cities where the DT approach is used, the topic of participation is already much discussed (Gohari et al., 2020). Most of these so-called "wicked problems" cannot be appropriately tackled by traditional leadership or from a single-stakeholder perspective (Poocharoen & Ting, 2015). Instead, the concept of "vivid collaboration" was introduced and involves "(…) the process of facilitating and operating in multi-organizational arrangements to solve problems that cannot be solved or solved easily by single organizations" (Poocharoen & Ting, 2015, p. 588). The prospective aim of smart-city stakeholders is thus to constantly integrate multiple actors into their decision-making processes in order to increase value for the general public (Chatfield & Reddick, 2018; Hilgers & Ihl, 2010; Hossain & Kauranen, 2015). This citizen support can take the form of crowd sourcing, co-delivery, and reporting in addition to consultation and ideation in designing services (Allen et al., 2020). While informative and constructive exchange between residents and their representatives can lead to solutions that shape life in a social, ecological, and economic sense (D'Onofrio, Habenstein, et al., 2019), it is necessary to determine how smart governance can encourage the development of smart-living environments.

Throughout the evolution of smart governance, citizen centricity has remained a critical point. Although the number of smart-governance solutions and participation initiatives has increased remarkably in recent years, critics claim that technological possibilities rather than user need often determine the design of such solutions (Verdegem & Verleye, 2009). However, a technology-focused perspective of smart-city development often excludes citizen involvement, and the call for citizen-centered solutions has thus grown louder in order to increase citizens' satisfaction and engagement (Dawes, 2008). Against this background, smart cities can be conceived as spatial units that use ICT for the progress of society and space. By using technology, governments seek to provide resources, set rules, and mediate disputes, all while empowering their citizens, unleashing social innovation, and reinvigorating democracy (see O'Reilly, 2011). The citizen-centered approach thus helps in developing new and sustainable socio-economic and participatory models of governance.

To promote innovation, society itself has become a critical source of new ideas alongside science, business, and government. Collaborative innovation represents one promising approach to strengthening citizen centricity in smart cities (Angelidou, 2015; Wegrich, 2019) and requires new infrastructures for networking, exchange, and coordination as well as new regulatory frameworks. Against this background, scientists have initiated studies on managing knowledge and innovative capabilities (Wulfsberg et al., 2016). In line with Wegrich, we define collaborative innovation as "[…] a governing arrangement where one or more public organizations engage other state or non-state stakeholders in a collective, consensus-oriented, and deliberate decision-making process with the goal to design and implement new, creative solutions to current governance challenge." (2019, p. 12).

Collaborative-innovation strategies can help meet social needs, yet most public organizations are plagued by a scarcity of resources (Torfing, 2019). Moreover, these strategies can foster an exchange of urban knowledge and thus better tackle the aforementioned "wicked problems" because newcomers can learn from those who are more experienced at building a broad knowledge base and at allowing new ideas to emerge (ibid.). Furthermore, collaborative innovation strategies in the public sector differ from those in the private sector as they lack competition and profit motives (Roberts, 2000), which facilitates a focus on value and purpose. In addition, collective creativity (Crosby et al., 2017) is enabled by promoting perspective-taking and empathy, which allow people to share risks and fail early. The emergence of collaborative innovation has thus fundamentally changed the innovation landscape. Nevertheless, how this innovation can actually be implemented remains to be determined.

We identify and address two major challenges to collaborative innovation in smart cities. First, executives must strike a balance between homogeneity and heterogeneity in their groups (see Koppenjan & Klijn, 2004; Skilton & Dooley, 2010). Homogeneity results in a decreased ability to think outside the box, whereas heterogeneity may lead to chaos due to many differing viewpoints. If stakeholders' viewpoints are too similar, fewer innovative solutions are found, but if they are too distinct, it becomes difficult to find common ground. To overcome this dilemma, we more-closely examine the different steps of the creative process: During problem solving and ideation, it is important to bring several perspectives and diverse expertise to the table (i.e., heterogeneity). During problem identification, synthesis, and implementation, it is crucial to combine ideas and develop concrete solutions that can be tested or evaluated (i.e., homogeneity). In a nutshell, after important stakeholders have been involved (i.e., they are all invited to the table), they do not all have to be present at every stage of development (i.e., they do not all have to partake in every course). Throughout the present work, we expand on this metaphor in greater detail.

Second, smart-city representatives aim to legitimize their decision-making by implementing collaborative strategies with multiple feedback loops (Allen et al., 2020). Thoughtfully improving the relationship between governments and their citizens enables governments to better justify their actions to public-sector organizations. To fulfill this social responsibility, promising scientific approaches are required that offer recommendations based on empirical evidence and that can be directly implemented. However, most of the literature either proposes conceptual work with broad claims and theoretical analysis (Wegrich, 2019), neglects close interaction with practitioners (Torfing, 2019), or offers narrow recommendations for specific techniques that do not account for the broad picture of collaboration. In order overcome these limitations, we combine theoretical and practical implications that can be applied to different target groups. The strength of our work lies in the concrete implementation of a use-case-based project in which we empower various stakeholders to design social solutions for their living environments that can be directly implemented.

DT Collaboration as Multi-Actor Collaboration

The DT approach is suitable for implementing a multi-actor collaboration strategy in the public sector and for taking collaboration in smart cities to the next level. This addresses the need to find a suitable approach for implementing collaborative innovation approaches to involve multiple actors in decision-making processes (Torfing, 2019). DT is a practical approach that fosters innovation, and design thinkers seek to realize the citizen-centered, problem-solving perspective of collaborative innovation through concrete, agile, and adaptable working methods. The DT approach involves – inter alia – radical collaboration, human values, experimentation, drafting, prototyping, and process orientation and has tremendous potential to foster smart-city innovations. The approach comprises a concrete process for designing citizen-centered solutions. However, no common definition of DT exists in the academic literature (Liedtka, 2015).

To render the concept more tangible, we briefly present the historical development of the approach.

In the 20th century, theorists in architecture- and design schools began to examine the process of designing (Bazjanac, 1974; Liedtka et al., 2017). As linear problem-solving methods often fail when problems become complex and ambiguous, designers began to deal with increasing uncertainty and diversity, with problem-centeredness, nonlinearity, optionality, and ambiguity affecting their work (Liedtka, 2015, p. 926). As a result, Cross introduced the DT approach (Cross, 2011; Liedtka, 2015) and described how to think and work as a designer. Management science adapted the concept to business (Schön, 1983; Simon, 1967) and invited design thinkers to change the way organizations develop products, services, models, and strategies (Brown, 2008). As the transition to digital working methods resulted in an enormous need for agile management, businesses began to determine who should design (Owen, 2006) and to value empathy in better understanding collaborators and users (Brown, 2008; Liedtka, 2015). Not only did the private sector begin to implement DT increasingly often, but so, too, did the social and public sectors, for example, in their development of policies and services (Mintrom & Luetjens, 2016; Sirendi & Taveter, 2016). In recent years, elected officials and managers came to take on the role of agents of their citizens and opened the door to frequent innovations and new forms of governance. DT has undergone constant modification and is now used in many ways in various professions and sectors.

DT is a rich and complex process. In order to answer our RQ, we define three particularly important pillars of the approach (see Liedtka et al., 2017; Schmiedgen et al., 2016, see also Schindlholzer, 2014): 1) the team, 2) the process, and 3) the workspace. These pillars lead us to conclude that DT is successful due to its use of multidisciplinary teams, an iterative process, and an adaptable workspace. The DT approach 1) consists of teamwork. Being welcome to change and open and to experimentation is necessary. DT also requires a culture that views mistakes as learning opportunities ("fail early and often" (see for a further discussion Schön, 1983)). The literature emphasizes the importance of the team (Beckman & Barry, 2007; Liedtka et al., 2017) because an interdisciplinary group can generate more as well as more-original ideas than can one single person. Bringing various perspectives to the table, sharing knowledge and expertise, and appreciating different viewpoints are tools that enable both a better understanding of the task at hand and the development of useful solutions (Liedtka et al., 2017). Engaging different stakeholders, however, goes hand in hand with a certain challenge (i.e., the balance between heterogeneity and homogeneity) that needs to be considered when addressing our RQ.

The DT approach 2) entails a certain process whose structure helps make people "feel comfortable in being uncomfortable" (Liedtka et al., 2017; see also Uebernickel et al., 2015) because it manages the ambiguity, complexity, and messiness of solving "wicked problems" (Liedtka et al., 2017). Although each DT school uses its own labels for the steps in the design process and subdivides them in some cases, a uniform structure of problem centricity and solution centricity can be recognized (Figure 26**Fehler! Verweisquelle konnte nicht gefunden werden.**): To begin, it is important to understand the problem (understand, observe, synthesize). Next, the participants generate ideas (ideation, prototyping), which encompasses divergent and convergent thinking as well as experimenting. In the end, the participants test their most-promising ideas (testing) to evaluate their usefulness and ease of use. All steps are interconnected and can be repeated iteratively. DT provides a toolbox for every step of the process (Carlgren et al., 2016). The tools are constantly combined, expanded, and further developed in different ways and within various event formats (Elsbach & Stigliani, 2018).

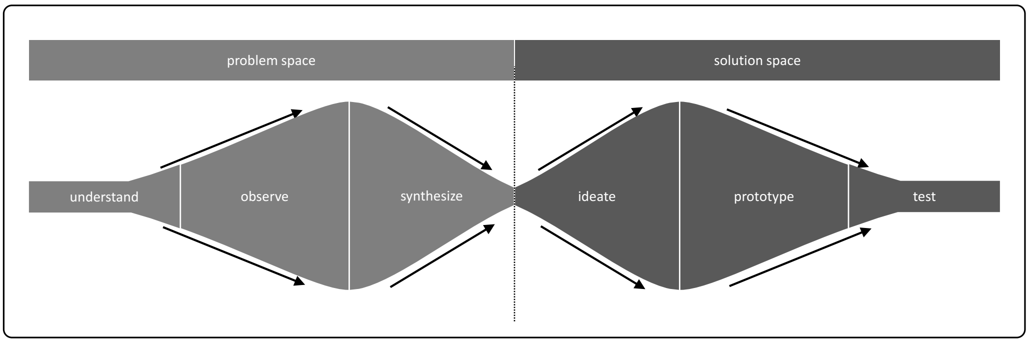

Figure 26. The DT Steps according to Dark Horse Innovation

In addition to accounting for the team and the process, DT highlights the importance of the workspace because the environment impacts significantly on the creative capacity of a DT group (Doorley & Witthoft, 2012). The surroundings should allow for constant interaction and collective learning and should be optimized in order provide the best environment for executing the steps in the design process. In practice, this requirement can be fulfilled by bringing easily movable furniture into largely empty rooms as well as by providing easily adaptable working material (Carlgren et al., 2016). A relaxed atmosphere (e.g., with pleasant colors, fresh air, music, and nooks in which one can retreat) is as important as supplies (e.g., healthy food and coffee, craft supplies, and protective clothing) and assistance (e.g., a help desk). Everything should be designed to be as pleasant, easeful, and uninterrupted as possible. In sum, Liedtka (2017) emphasizes the notion that the collaborative DT workspace should allow for a structured DT process, a deep understanding of user context, group heterogeneity with dialogue-based conversations, and the creation of and experimentation with multiple real-world solutions.

The DT approach facilitates to come up with solution-oriented results in systems with diverse actors. For instance, business models have been developed for agile networks (Kammler et al., 2020). In addition, it has been used in public-private partnerships and increased the innovative capacity of entrepreneurship in small and medium-sized enterprises, after they were supported by scientists and public officials (Becker et al., 2020). The approach even worked well in cases where there were not many human or financial resources available (ibid.). This holds true for smart health, where cities consider the well-being of their citizens (Lepekhin et al., 2018). It worked especially well in contexts of administrative openness to change and of transparent open government partnerships (Habenstein et al., 2016). All in all, by thinking like a designer in a multi-actor environment, it became possible to develop both common values and to enable concrete practice-oriented solutions. As such, the approach has been used as an efficient method in renowned smart cities such as Bergen, Oslo, and Trondheim for a long time (Nielsen et al., 2019). All in all, we deduced our RQ from this background (i.e., *"How can DT collaboration be implemented in smart cities in the designing of digital services?"*).

17.3 Method

Using the information-systems- (IS) and DSR paradigm (Gregor & Hevner, 2013; Hevner et al., 2004), we derive an applicable approach with which smart municipalities can translate the targeted citizen centricity into action. DSR[3] is built on theories of design in action (Theory Type V by Gregor (2006)) that provide explicit prescriptions (e.g.,

[3] DSR and DT are often confused because they are not clearly delimited from one another. We view DSR as a scientific approach to producing knowledge – be it conceptual (e.g., theories, frameworks) or empirical (e.g., methodologies, research designs). In contrast, DT is an applied procedure that is utilized to satisfy user needs and create solutions that are testable in real-world environments.

methods, techniques, principles of form and function) for construction. In contrast, theories that explain, predict, or analyze – which are known from the natural and social sciences – are not yet able to develop solutions for complex situations because they do not bring something new ("artificial") into existence, as Simon refers to it in his well-known work (Simon, 1967).

While traditional IS research focuses closely on technological artifacts, Lee et al. (2015) expanded this narrow perspective in line with the work of Hevner (2004), who introduced several forms of design-science artifacts: 1) constructs, 2) models, 3) methods, and 4) instantiations. In order to provide a better understanding of artifacts, Lee et al. (2015) divide artifacts into "information artifacts" (e.g., messages), "technology artifacts" (e.g., hardware and software), and "social artifacts" (e.g., charitable acts). For our work, this approach offers a promising opportunity to understand DT collaboration in smart cities because it explicitly considers social artifacts (e.g., citizen centricity as a social artifact). In addition, the approach also maintains a technology-focused perspective on the IT artifact – which is designed via collaboration (i.e., a technology artifact) – or on its content (i.e., an information artifact). This perspective is important because the three divided artifacts can interact and result in synergies that amount to more than the sum of their parts (Lee et al., 2015).

In seeking to generate knowledge, DSR phases (e.g. Hevner et al., 2004) can be identified that are similar to those in DT process (see Footnote 1). All phases relate to iterative feedback loops to more-precisely determine either (1) what the problem is (the relevance cycle), (2) how to build and evaluate artifacts or processes (the design cycle), or (3) which experiences or expertise to consider (the rigor cycle). According to Schön (1983), who introduced the concept of reflection-in-action to the field, the timing of these loops can be varied. Building on this stance, Peffers et al. (2007) call for immediate reflection and feedback on the artifact at every stage of the design cycle. Moreover, Sonnenberg and vom Brocke (2012) introduced not only a single ex-post evaluation, but also two evaluations (ex ante and ex post) for four core design activities that are linked via evaluation (i.e., problem identification, design, construct, and use). This approach opens two doors to our work (see Hevner et al., 2004): First, we can improve rigor by adding scientific theories and methods along with domain experience into our work. Second, we can highlight relevance by demonstrating the usefulness of the artifacts' design and by considering the requirements from the contextual environment into our research. Third, it offers pragmatic value by constantly testing and evaluating the design artifacts and processes. All in all, our project can simultaneously produce knowledge (i.e., DSR) and offer an applied procedure that enables solutions to be designed that are testable in a real-world environment (i.e., DT). Because DSR aims to explain the learnings through the process itself, we will now illustrate the concrete starting point as well as the various changes and evaluation criteria.

The applied methodology consists of four design activities (c.f. Figure 27), namely: 1) problem identification, 2) design, 3) construct, and 4) use. These activities are linked via iterative evaluations. The ex-ante evaluation consists of two evaluations: Evaluation I and Evaluation II. Evaluation I informs the design activity, and Evaluation II assesses this activity. The ex-post evaluation consists of two evaluations: Evaluation III and Evaluation IV. While Evaluation III deals with the construct, Evaluation IV appraises the use of the collaborative innovation in a smart-city context and thus judges whether the solution appropriately meets the initial problem. The ex-post evaluation is conducted in a real-world setting (e.g., via workshops) and entails multiple feedback loops, which enables short evaluation cycles.

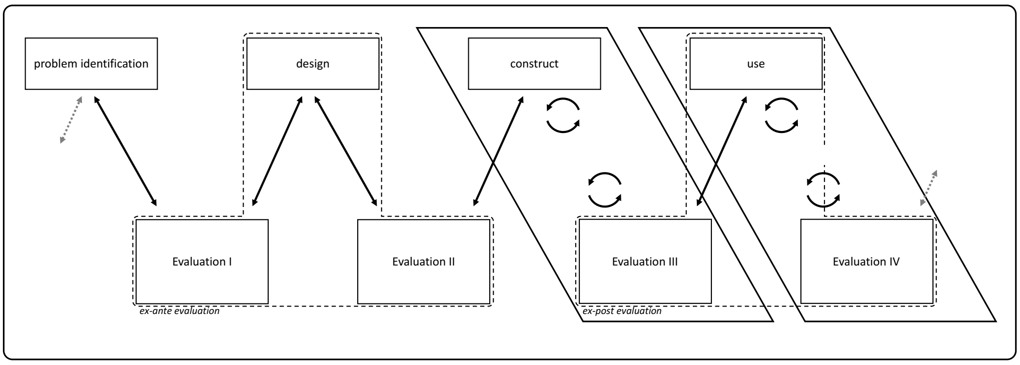

Figure 27. Our General DSR Framework (adapted from Sonnenberg and vom Brocke (2012))

17.4 From Theory to Practice: Redesigning Health Resorts

To challenge our theoretical assumptions, we tested them in a real-world environment. Our case of the so-called Open Government Laboratory is funded by [name left out for review]. Its overarching goals are to enable cooperation between administrations, businesses, and the society; to foster open governance; and to develop innovative services for smart cities. On an international level, it is a member of the international Open Government Partnership initiative. On a regional level, it embraces smart health initiatives in the rural region of Western Germany. This said, the crucial stakeholders are local administrations and politicians, clinic operators, citizens, and research institutions. Bridging the gap between public administrations and privately-run health care suppliers was done by sharing a joint vision: to design health resorts of the future, and to provide digital services. Providing these user-centric services in rural regions is complex and multi-layered – and thus, very rare to this day.

A traditional health resort from North Rhine-Westphalia in Germany approached us with severe difficulties in preparing their municipality for the future (problem identification). They were struggling to derive promising measures to react to the major trends of our time, such as sustainability and digitalization. Together, we outlined the problem and agreed on a general goal, which was to define recommendations on how traditional health resorts can be transformed into modern health resorts that can also serve as attractive residential and business locations. By using urban knowledge and redesigning the process of information exchange in these health resorts, we aimed to place equal weight on the technical and human elements of the design process. Moreover, we promoted transparent collaboration between partners (universities, businesses, administrations, and society). After a discussion, our team conducted additional literature research and discovered that there are more than 350 health resorts in Germany (*Kurorte* and *Heilbäder*) that combine health services and therapies, treatment programs, naturopathic treatment, wellness programs, nutrition programs, and tourist offers. However, the number of visitors and the average length of their stay have been decreasing over the last two decades, and an innovative approach is therefore urgently needed to come up with sustainable, economically sensible solutions. To the best of our knowledge, no best-practice example yet exists for study.

In line with the current state of research (see Chapter Theoretical Background), we followed a DSR framework to refine our plan and aimed to provide a validated artifact that offers promising recommendations on how to design innovative-collaboration strategies in these areas that can be directly implemented. Again, it was critical to give equal weight to technical and human elements of the design process. For each step, we will explain why it was taken, how the criteria were selected, and how the process was defined.

After the problem had been observed and documented, we conducted additional reviews of practitioners and highlighted the need for further research. In Evaluation I, we identified collaborative innovation as an essential tool in sustainable innovations. Our evaluation criteria were applicability, suitability, novelty, economic feasibility, and importance. They were developed by Sonnenberg and vom Brocke (2012) and our literature review's focus. This said, the criteria of applicability and importance were of particular importance to us, because they aim at receiving a justified problem statement. We therefore explicitly addressed them in our interviews in Potsdam (see below). Based on these evaluation activities, we derived initial ideas and design principles on how to implement collaborative innovation in traditional health resorts in Germany such that the people on site would feel empowered to design a health resort of the future. We discussed these propositions with various stakeholders in five different health resorts (i.e., from local administration, local companies, tourism, and gastronomy) and concluded that the DT approach could be a suitable way of tackling the identified problem. We then consulted DT experts from the Hasso-Plattner-Institute (HPI) in Potsdam, Germany, who supported our assessment. Based on this preparatory work, we sharpened our overarching RQ (i.e., *"How can DT collaboration be implemented in smart cities in the designing of digital services?"*). Moreover, we agreed on a shared first objective, which was to apply for financial support from a federal ministry. To receive this support, we submitted a project application in which we specified our core project pillars (team, process, workspace) as well as our initial project plan (design). The project application was submitted jointly by a university, six municipalities (health resorts) and partners from practice [names left out for review]. In this phase, we selected two different approaches that were proposed by Sonnenberg and vom Brocke (2012). First, we carried out a literature review to highlight the importance and relevance of our research endeavor. Second, we conducted an expert interview with a scholar from HPI about DT's applicability in the public sector. Based on this exchange, we conducted an expert interview with an employee from a municipality to discuss our insights. Thereupon, we were able to adapt our past propositions. The most important issue was the need to be truly user- and citizen-centric.

Evaluation II was thus carried out by the ministry's jury, which assessed the design objectives, tools, and methodology as well as the stakeholders of the design specification. The experts evaluated the various criteria (e.g., feasibility, internal consistency, clarity, completeness, and applicability) that reminded us of the work by Sonnenberg and vom Brocke (2012). Our idea was then approved for funding. However, the formal assessment was not accessible to us. After we had completed the initial phases of the DT-collaboration approach (i.e., problem identification (with Evaluation I) and design (with Evaluation II)), the project “Health Resort of the Future” (“*Kurort der Zukunft*”) was officially launched. We drafted a preliminary project plan (construct), which served as a prototype that illustrated how DT collaboration can be implemented in health resorts. We discussed this prototype in multiple feedback loops with selected stakeholders in our consortium. In this phase, we used the funder’s assessment as an evaluation. With taking their feedback very seriously, our application was successfully evaluated by the panel of experts. No changes were need, as the funding was soon approved. In the meantime, we participated in three expert workshops (Evaluation III) with renowned DT experts, namely Dark Horse Innovation in Berlin, Germany, which helped us to validate our project plan and to set it in motion (use). The proof of applicability of the prototype was based on the criteria of feasibility, ease of use, suitability, effectiveness, efficiency, compatibility with real-world phenomena, and operationality. Sonnenberg and vom Brocke’s (2012) evaluation criteria of feasibility and ease of use were of particular importance to us. We asked the experts to pay special attention to these aspects. The methods encompassed a demonstration with the prototype (i.e., project proposal) and further expert interviews in a workshop setting. In this phase, we visited several workshops by DarkHorse. The methods were diverse, but all helped identify user needs. Next, we subdivided or adapted the DT process into three steps (need findings, ideation, testing) to apply it in our use case. Sticking to this three-step process enabled us to develop own DT collaboration tools and interactive online workshops. We share our insights in the project plan.

Evaluation IV followed in a stakeholder workshop in which we implemented what we had learned about our core project pillars (team, process, workspace). The artifact paved the way for the three-year research project. The evaluation criteria were applicability, effectiveness, efficiency, compatibility, impact on the environment and user, internal consistency, and external consistency. The criteria of artifact environment and applicability were most relevant. Again, we asked the experts to pay special attention to these aspects. The validation of the artifact (i.e., the collaborative innovation as illustrated the project plan) in a naturalistic setting produced new knowledge and proved useful. In this phase, we carried out our own workshop, which we then evaluated in two ways. On the one hand, we received feedback from a quiet observation who was present throughout the whole workshop. On the other hand, we conducted semi-structured interviews after the workshop, and derived an analysis of our workshop’s strengths, weaknesses, future opportunities, and threats (SWOT). The adjustments based on this phase are found in the form of the learnings in the next section.

In our illustrative-use case, we promoted transparent collaboration between our partners and applied the DT approach to create a citizen-centered solution to redesigning these health resorts. As indicated above, we referenced Peffers et al. (2007), Sonnenberg and vom Brocke (2012) and Sturm and Sunyaev (2019) and then refined the framework (c.f. Figure 28).

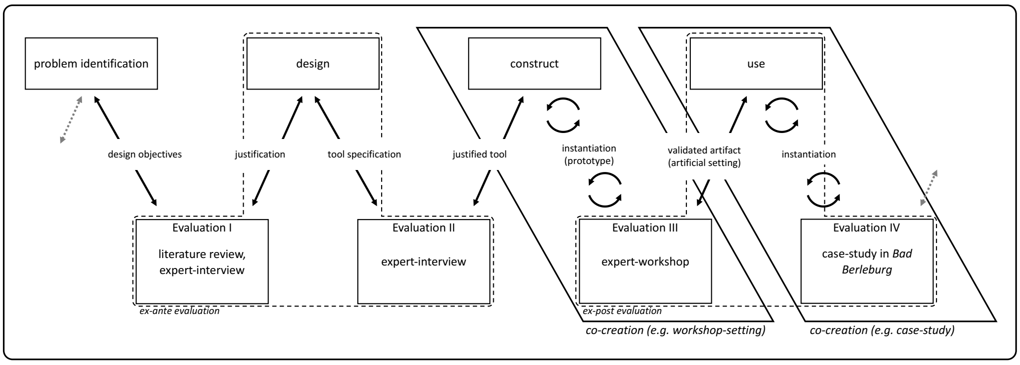

Figure 28. Our DSR Framework for German Health Resorts

The outcomes at each phase can be summarized as follows: The identification of specific challenges and needs as well as a broad literature review resulted in the overarching RQ of our work. Based on this question, we derived our research design and iteratively refined it. We summarized our approach within a project application to a federal ministry, in which we presented our overall goal and a detailed project plan. It was granted. We transferred our ideas to a real-world setting and tested the feasibility of our approach in the field. Based various feedback rounds, we successfully implemented DT collaboration in the involved municipalities.

Implementing DT Collaboration in the Designing of Digital Services

The use case provides an opportunity to learn and to derive recommendations for action that are useful in addressing the challenges to collaborative innovation. We again focus on the three important pillars of the DT approach (team, process, workspace) because DT is useful thanks to its use of multidisciplinary teams, an iterative process, and an adaptable workspace. We interacted closely with practitioners and citizens throughout every step in the design process to derive theoretical and practical implications as well as social solutions to citizens' living environments that can be directly implemented. The exemplary project plan is illustrated in Figure 29.

Team-oriented findings. In smart cities, multiple stakeholders are of crucial importance and need to be invited to the table. However, they do not need to participate in every step of the process, especially if they personally benefit or suffer from the solution to the problem (emotional component), if cooperating with them has been difficult in the past or could be difficult in the future (behavioral component), or if they need to be intensively trained or carefully briefed beforehand (cognitive component). DT collaboration should bear in mind that some actors have little time or prior knowledge or prefer to stick to the status quo, especially when it comes to new approaches to work (c.f. Figure 29). Political considerations play an additional role and sometimes limit the feasibility of collaboration (e.g., social desirability, proximity to elections). Consequently, public relations-, communication-, and marketing needs matter. In our project plan, we clearly defined the project team, the stakeholders, and the thematic experts. The project team's ambidexterity comes into play in balancing administrative tasks and preparing for the changing demands of DT. To guarantee the success of collaboration, we therefore promote the inclusion of DT coaches who are open to the unexpected.

The team-oriented dimension consists of five different actors. First, the project team that consists of three research associated and one administrative employee. Together, they plan and monitor the project, and are responsible for public relation and communication measures. Second, there are content-related stakeholders such as clinic operators and smart health suppliers. The six municipalities involved act as experts for the public sector and as transfer partners who provide important feedback. Third, the users in our project are citizens, patients as well as visitors. We thereby bridge the gap between regional development, health care supply and touristic activities. Fourth, there are paramount framing stakeholders, namely the providers of our project funds. They need to be involved in a monitoring and evaluation measures. Fifth and finally, we invite further thematic experts to join the discussion. As we lacked expertise in medical informatics, the chair for microsystem design shared his expertise. In addition, we are supported by chairs for business informatics and tourism management as well as from marketing. To decide upon the question who to invite to the table, trained DT coaches can be an asset.

In each phase, the participation of different stakeholders was key (see Figure 29). The content-related stakeholders such as clinic operators and smart health suppliers were heavily involved in Evaluation III and IV. The users mainly played a key role during problem identification and use. The framing stakeholders undertook Evaluation II and were involved in Evaluation III and IV. Further thematic experts joined the discussion when designing, constructing, and co-creating as well as in all evaluations. Finally, the project team was involved in all phases.

Process-oriented findings. To account for the balance between heterogeneity and homogeneity, we propose including a different number of actors in the different steps of the DT process: During problem solving and ideation, it is important to bring several perspectives, user groups, and diverse expertise to the table (i.e., heterogeneity). During problem identification, synthesis, and implementation, it is crucial to combine ideas and develop concrete solutions that can be tested or evaluated (i.e., homogeneity). Again, after important actors have been involved (i.e., everyone has been invited to the table), not everyone has to be present at every stage of development (i.e., not everyone has to partake in every course). All in all, based on our insights from the project, we recommend a group size of five to six people. Additionally, we propose the use of micro-planning to comprehensibly acknowledge the different DT phases. It appears wise to involve coaches who can guarantee that the steps, tools, and feedback loops are followed and applied smoothly. Figure 30 presents such a micro-planning agenda for a workshop. Micro-planning the project plan (c.f. Figure 29) allows for a clear overview of the team-oriented time budgets (working months) and the project's milestones.

The project plan illustrates which stakeholders need to be involved in which phase and how this can be done. In the preparation phase user reveal their needs, come up with ideas and test them. After synthesis, these steps are repeated. Whereas the project team monitors every step, the framework stakeholders are only present during kick-off and synthesis. The content-related stakeholders and thematic-experts play a crucial role in the preparation phase (e.g., in exploratory interviews and persona development with patients, tourists or inhabitants). We noticed that it makes sense to have the needs determined by a trained team, because experience and training are needed to identify specific user needs. During ideation, we then invited as many people as possible to the table. During testing, however, only users and content-related stakeholders joined. As various moderation techniques are involved, a trained team of DT coaches is a plus.

Workspace-oriented findings. Collaborative innovation requires a workspace. In addition to the findings from the literature, our project had to meet radically new demands because it began during a worldwide pandemic. The coronavirus (COVID-19) has clearly demonstrated that implementing digital events is a must. In DT's newly emerging digital formats, it is important to ensure that assignments and tasks are clearly define as well as to avoid interruptions. An exemplary task is to find as many solutions as possible to a given challenge in five minutes. Because digital workshops can be quite exhaustive, the ease of use and the usefulness of the applications at hand need to be optimized, which is important in reducing participants' digital stress or technostress and focusing on the problems and solutions at hand. This optimization includes guaranteeing that workers have enough breaks and get enough physical activity during remote work. Several experts from Dark Horse Innovation had the idea of working with Zoom (zoom.us/) and with MURAL boards (mural.co/). We also involved DT coaches with further training in digital didactics.

To illustrate how to implement DT collaboration when designing digital services, we provide a project plan below based on findings from the literature and from several iterative discussions with DT experts. This project plan illustrates our design artifact and is conceptual in nature. It is considered a DSR social artifact and brings together our considerations about people, organizations, and technology. The plan can be freely accessed upon request from the authors, reproduced, and adapted. To highlight the applicability of the project plan, we refer to a sub-question of our use case, namely a question on designing the intelligent use of urban data in a health resort of the future. This sub-question has the advantage of being neither overly broad / general nor overly narrow / specific.

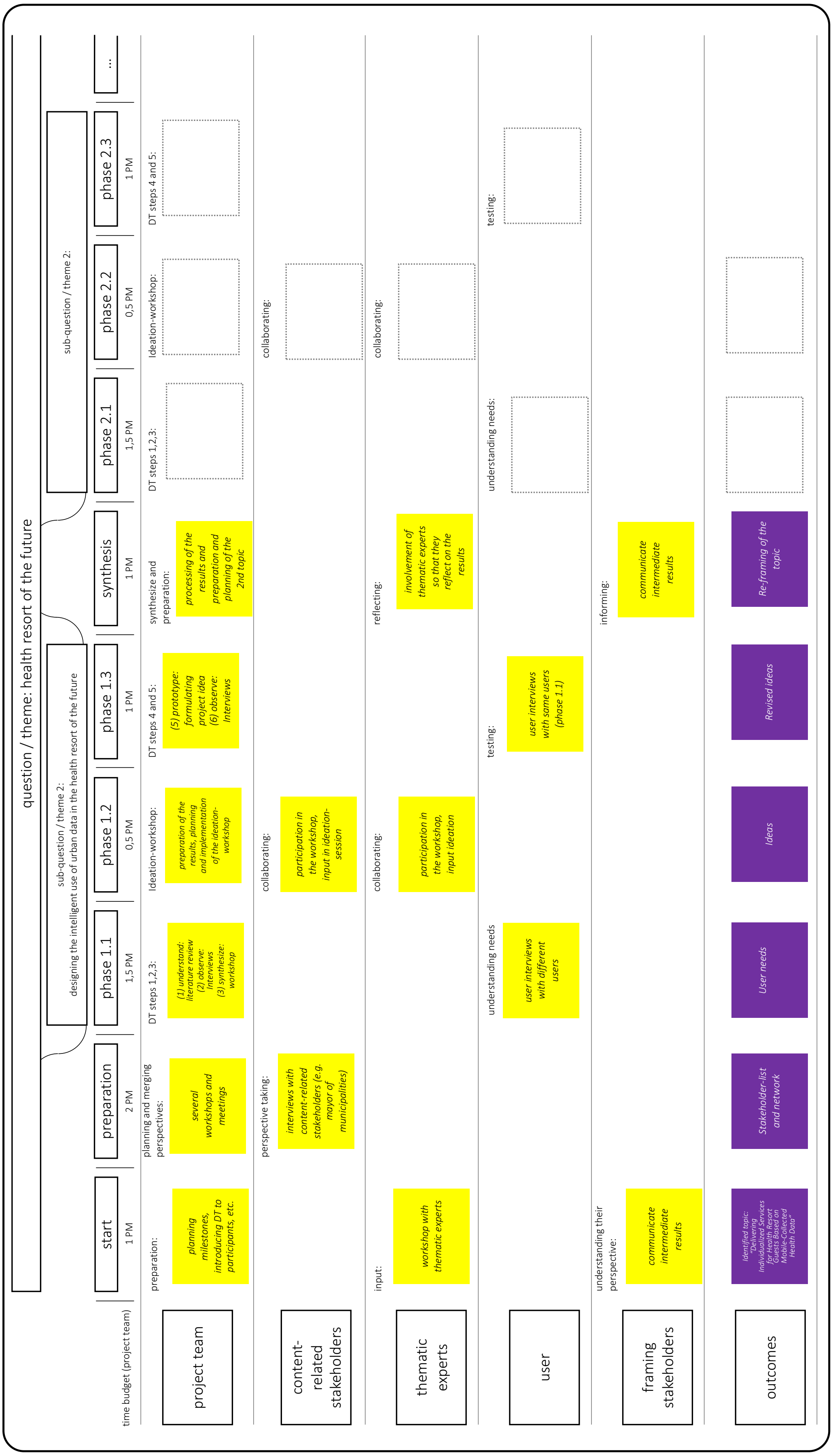

Figure 29. A DT-collaboration Project Plan for German Health Resorts (4)

time	duration (min.)	activity
__:__	0:10	*zoom-room opening*
__:__	0:10	welcome and introduction
	0:03	*technical check-in*
	0:03	*welcome by host*
	0:03	*introduction of coaches*
__:__	0:20	check-in of the participants
__:__	0:15	overview and schedule of the workshop
	0:05	*Introduction to the project-theme*
	0:05	*roadmap of the project*
	0:05	*presentation of the workshop goals*
__:__	0:05	presentation of the sub-theme
__:__	0:15	break
__:__	0:40	presentation of the user testimonials
	0:10	*presentation of research agenda*
	0:10	*presentation of user testimonial (1)*
	0:10	*presentation of user testimonial (2)*
	0:10	*presentation of user testimonial (3)*
	0:05	*q&a*
__:__	0:10	warm-up
__:__	0:10	introduction to the brainstorming-session
	0:03	*introduction and brainstorming-rules*
	0:03	*presentation of the method (how-might-we-?)*
	0:03	*q&a*
__:__	1:25	ideation (break-out session)
	0:05	*introduction*
	0:10	*silent brainstorming*
	0:30	*idea pitch*
	0:10	*idea selection*
	0:10	*idea napkin*
	0:20	*idea presentation*
__:__	0:20	further procedure
__:__	0:10	check-out
		adoption

Figure 30. A DT-workshop Approach to German Health Resorts (5)

17.5 Discussion

Our results provide initial guidelines on how to involve diverse actors, when to integrate trained DT coaches, and how to design collaborative innovation in a digital way. The practice-oriented insights gained in the study can be applied, adapted, and discussed in other smart cities and citizen-centered projects. They reveal a way to effectively implement DT collaboration when designing digital services – suggesting three critical components: (1) team, (2) process, and (3) workspace.

First, when dealing with smart-city developments, it is important to consider both urban and rural areas. In addition, it is necessary not only to adopt a technically driven perspective but also to include citizen centricity and the latest scientific insights in smart governance. Striking the right balance between heterogeneity and homogeneity, bridging the divide between theoretical recommendations and practical learning effects, and – finally – delivering a concept of how collaborative innovation can actually be implemented in smart cities all proved challenging. As was demonstrated, it is expedient to invite everyone to the table, but not to every course. To make collaborative innovation in smart cities more tangible, we illustrated the cognitive, emotional, and behavioral components of working collectively, all of which need to be considered. Our project plan serves as a social artifact that also considers the dimensions of information and technology. The three pillars of team, process, and workspace help to structure the plan. For every pillar, the implementation of iterative feedback loops and adaptations is important to account for every new challenge, including a global pandemic. The following Figure 31 shows the most compelling guidelines that can be derived:

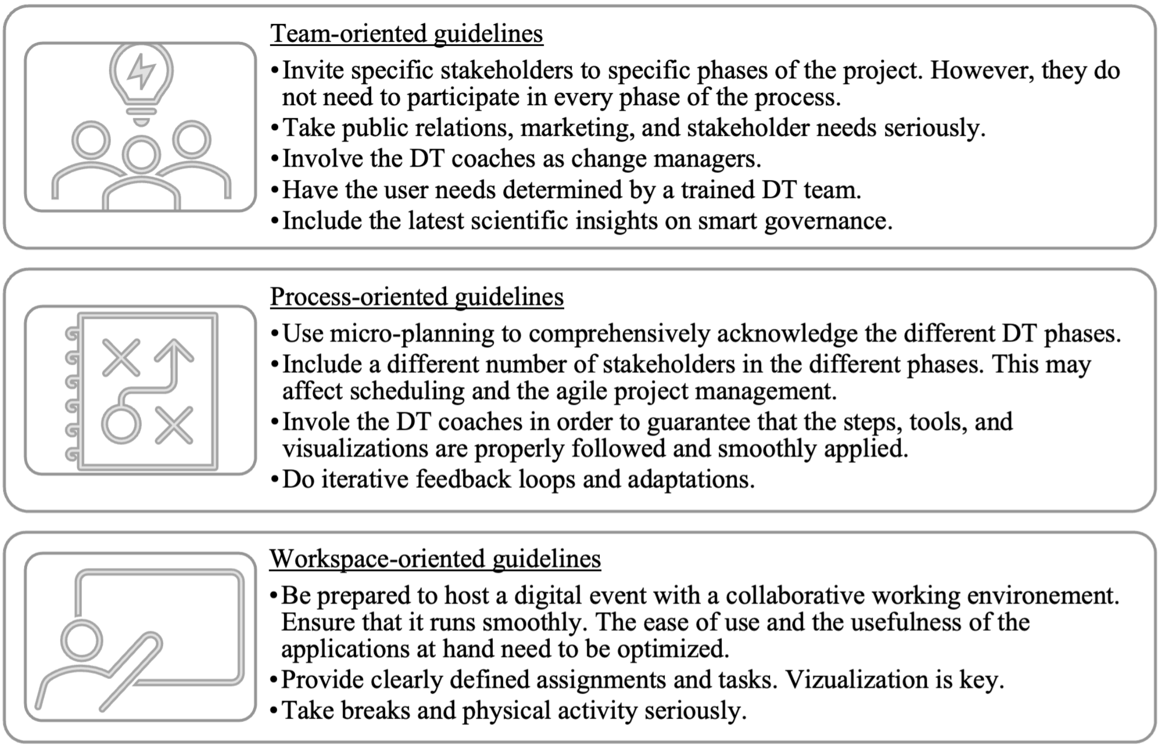

Figure 31. Key Guidelines for Implementing a DT-workshop Approach (6)

When addressing our RQ (i.e., *"How can DT collaboration be implemented in smart cities in the designing of digital services?"*), we noticed that participation ("being involved") became replaced by the demand for collaboration ("working with partners"). However, collaboration at any cost neglects the fact that the constant integration of multiple stakeholders also requires enormous resources, both human and financial. This conclusion does not contradict citizen centricity; rather, it simply calls for a very precise consideration of the design of participatory models. By doing this, our work offers interesting implications for theory. The emerging domain of collaborative innovation among different stakeholders attracts significant scientific and policy attention. This paper contributes to developing a framework for DT collaboration for designing smart services and opens the door for future research on collaborative governance, knowledge sharing, citizen involvement, and transparency.

From a methodological point of view, case study analysis often faces challenges of rigor and external validity. We addressed the first criticism by following a systematic procedure. Nevertheless, generalizability is a shortcoming we are aware of and never claimed. Our study's strength was its exploratory, insightful, and theory-building nature. As such, our structural approach and the design rationales of our artifact provided a promising starting point for future research. Bearing this in mind, we invite to test our findings in other governance cases, e.g., in complex settings, where the digital society needs to find a way to work together (e.g., district development) (D'Onofrio, Habenstein, et al., 2019; D'Onofrio, Papageorgiou, et al., 2019; Habenstein et al., 2016). On top of that, we recommend using specific metrics for assessment and evaluation in future research. Measurable values and quantifiable outcomes will become necessary when applying our approach in different domains.

We offer relevant implications for practice, because DT collaboration can be adapted in smart cities of every scale. Of course, this involves not only in health resorts with a focus on smart health supply, but all smart city fields of action (e.g., sustainable transport, future-oriented education, commerce infrastructure). After agreeing on the "why", the task of redesigning health resort is about the "what" and the "how". We aimed at developing a transferable procedure. This remains challenging, as we did not focus on the development of the content of the services themselves, but rather on the collaboration and DT approach. Moreover, we focused on rural areas instead of urban areas. Because public-private partnerships that involve the society are a topic in smart cities of every size, future studies are invited to rest our approach on a larger scale. Our work – like any other – has weaknesses due to its limited scope. Conducting more workshops and iteratively revising the project plan for German health resorts can yield additional insights in the future. In addition, we are aware that every public-sector organization has individual characteristics and that our findings may not be transferable in an un-edited manner.

Our insights did not suggest that this project plan effectively addresses the demand for transparency, efficiency, legitimacy, consolidation, and consequently, comprehensive smart governance because our project represents only one scenario in a small number of rural municipalities. Nevertheless, we offer a possible point of departure and open the door to further steps toward appreciating the application of ICT in the interactions of governments with their citizens and businesses as well as in government operations. In addition, we drew conclusions about how to implement a multi-actor collaboration strategy in the public sector and how to integrate citizens into the development of governance models to better inform researchers, designers, and practitioners.

Our main contribution to theory is our use of the DSR approach, which provided an appropriate framework for conducting research on DT in the setting of public-sector organizations. Future research can build on these findings and transfer the approach to other practical applications. For practice, the most-important benefit is using DT as a collaboration strategy and bringing collaboration to public-sector organizations as well as bringing smart governance to life. DT opens the door to collaborating without previous knowledge and to adapting to tomorrow's changing demands and questions in an agile manner. Our use-case example provided an adaptable project plan that combined our findings about the needs of teams, processes, and workspaces. Of course, our approach is only one of many possibilities. Nevertheless, we have taken a beneficial first step that can be followed by other steps in other projects. While future studies may build on or even contradict our findings, we welcome active participation in our project and new developments that change, transfer, and expand it.

17.6 Summary

Our conceptual work based on a use case offers a first step to making smart cities more efficient, sustainable, socially inclusive, and technologically advanced. The DT approach was used in several health resorts in Germany to address various central questions, such as how to use urban knowledge and how to design information exchange between multiple stakeholders. We summarize our findings on how municipalities can make use of ICT to increase the quality and efficiency of their services, to reduce costs, and to improve interactions between government, citizens, and businesses. Our exemplary project plan can be transferred and adapted by other smart cities to guide collaborative innovation and thus serves as a transparent tool that can inspire future participatory models.

When promoting innovation, society provides essential ideas in addition to those from science, business, and the government. Citizen-centered strategies can foster an exchange of knowledge about cities and can thus better tackle "wicked problems" because these strategies allow for building a broad knowledge base and for the emergence of new ideas. Collaborative innovation thus represents a promising approach to strengthening citizen centricity; however, it requires infrastructures for networking, exchange, and coordination as well as new regulatory frameworks. Regarding the involvement of different actors, the following rule can be applied: Everyone should be invited to the table, but not everyone should partake in every course. In the future, establishing additional frameworks and guidelines as social artifacts, combining insights from different disciplines, and continuously evaluating and adapting these artifacts will lead to the further development of smart-living environments.

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17.8 Appendix

<table>
<tr><td colspan="4">The following section is based on the Theoretical Background and structured by the order of appearance. We present the overall contribution of each publication, derive an emerged challenge, and draw conclusions for our work. Some articles can be assigned to more than one challenge. For the sake of parsimony, however, we assigned them only once.</td></tr>
<tr><td colspan="4">Subsection: Collaborative Innovation in Smart Cities</td></tr>
<tr><td>Related literature</td><td>Overall contribution of the related literature</td><td>Emerged challenges</td><td>How this work addresses the challenges</td></tr>
<tr><td>(Gil et al., 2019).</td><td>Technology is an important aspect in smart cities and an opportunity to address today's challenges</td><td rowspan="2">The concept of smart cities is broad. The focus is set on urban areas, while there are also opportunities for rural areas.</td><td rowspan="2">Our proposal for DT collaboration is designed and tested in the context of rural areas.</td></tr>
<tr><td>(Ruhlandt, 2018),</td><td>A systematic literature review that clarifies and proposes</td></tr>
</table>

	conceptual insights of smart cities		
(Nilssen, 2019)	DT can help to generate concepts, products, insights, and knowledge which is relevant for solving "wicked problems" in smart cities	Smart city governance is an important approach to address the challenges in smart cities. For smart city governance, ICTs have two implications. On the one hand, they enable participation and on the other hand, participation is required to design ICTs.	We implement DT collaboration to design digital services considering ICT (e.g., new data-based services). Moreover, we use ICT (e.g., digital events) to design these services in a participatory manner.
(Pereira et al., 2018)	A literature review that defines smart city governance and the role of ICT smart governance		
(Shelton & Lodato, 2019)	Discussion on the role of citizens and their participation in the context of smart cities		
(Tomor et al., 2019)	A literature review of smart governance in the context of sustainable cities. Contextual conditions are an important factor for mixed findings		
(Viale Pereira et al., 2017)	Collaboration and participation are important factors in smart cities and for smart city governance. ICT can promote collaboration		
(Yigitcanlar et al., 2018).	A literature review that clarifies the concept of smart cities and emphasizes the role of ICT		
(Alawadhi et al., 2012).	Collaboration is a main aspect to improve smart cities. It categorizes eight relevant aspects (technology, management and organization, policy context, governance, people and communities,		

<table>
<tr><td></td><td>economy, built infrastructure, natural environment)</td><td></td><td></td></tr>
<tr><td>(Chourabi et al., 2012)</td><td>A framework for the concept of smart cities. It identifies different factors for success</td><td rowspan="5">Including citizens is a key challenge when designing smart cities.</td><td rowspan="5">We included several actors in the DT process (e.g., context-related stakeholders, thematic experts, and users).</td></tr>
<tr><td>(Backus, 2001)</td><td>Definition of smart governance and the role of ICT</td></tr>
<tr><td>(Allen et al., 2020)</td><td>Analysis of the importance of citizens’ e-participation and co-production, which is positively associated with urban services and public sector accountability</td></tr>
<tr><td>(Sharp, 1980)</td><td>Discussion on co-production and the use of e-participation, which can lead to better services through feedback</td></tr>
<tr><td>(Feeney & Welch, 2012)</td><td>E-participation is presented as a prominent tool. The intensity of e-participation technology use is associated with managers’ perception of outcome</td></tr>
<tr><td>(Linders, 2012).</td><td>Examination of the role of citizens. The work proposes a unified typology for co-production in the age of social media</td><td rowspan="3">To achieve a sustainable success of smart city projects and to reduce the risk of failure, the co-production of many stakeholders needs to be facilitated and designed.
Citizen-centricity is crucial and has two</td><td rowspan="3">We enabled the collaboration with citizens through our DT approach and used a user-centered perspective. We aimed for empathically addressing the users’/citizens’ needs.</td></tr>
<tr><td>(Gohari et al., 2020)</td><td>Unconventional approaches outside administrative structures can be at the expense of participatory mechanisms</td></tr>
<tr><td>(Poocharoen & Ting, 2015)</td><td>Co-productions effectiveness depends on network process,</td></tr>
</table>

	network structure, and characteristics of actors	ankles: We need to enable collaboration with citizens and this collaboration must address the citizens' needs.	
(Chatfield & Reddick, 2018)	Different perspectives help to create public value in disaster management		
(Hilgers & Ihl, 2010)	External collaboration and innovation help to enhance public value through citizen integration and participation		
(Hossain & Kauranen, 2015)	Crowdsourcing is a successful tool for public participation		
(D'Onofrio et al., 2019),	Socio-technical relation is important in smart cities. Human-machine symbiosis can lead to carefully designed smart cities		
(Verdegem & Verleye, 2009)	A technology-oriented view may lead to more efficient services; however, smart cities need more user-centricity		
(Dawes, 2008)	The use of ICT can lead to enhanced public services and improved government operations; however, technological innovation does not necessarily lead to citizen engagement		
(Angelidou, 2015)	Citizen-centricity can be addressed by collaborative innovation in smart cities. Collaboration is necessary for promising smart city solutions	Collaborative innovation is a promising approach, but its principles must be transferred	We involve different roles and stakeholders. Heterogeneous and homogeneous

<table>
<tr><td>(Wegrich, 2019)</td><td>Collaborative innovation is not just a matter of effort and de-bureaucratization</td><td rowspan="7">to and adapted in various different contexts. It faces two main challenges:
a) In multi-actor settings, it is challenging if the perspective of the actors is either too similar or too far away from each other.
b) Smart city representatives need appropriate approaches to justify and legitimize their decision-making processes. Collaborative innovation needs additional justification from practice.</td><td rowspan="7">perspectives are generated in the different DT phases as needed.
In our transparent process, smart city representatives can report initial findings in an open, comprehensive way, and can thereby improve their decision-making and accountability.</td></tr>
<tr><td>(Wulfsberg et al., 2016)</td><td>Managing knowledge and innovative capabilities is important in smart cities</td></tr>
<tr><td>(Torfing, 2019)</td><td>Collaborative innovation in form of multi-actor collaboration is promising in the public sector; however, it needs additional research and “(…) in situ knowledge about what works in practice”</td></tr>
<tr><td>(Roberts, 2000)</td><td>The public sector encounters “wicked problems” and differs from the private sector (e.g., it lacks competition and profit motives)</td></tr>
<tr><td>(Crosby et al., 2017)</td><td>For the public sector, innovation, design, and collective creativity can help to create public value</td></tr>
<tr><td>(Koppenjan & Klijn, 2004)</td><td>Possible tensions can arise due to different perspectives (e.g., homogeneous / heterogeneous groups)</td></tr>
<tr><td>(Skilton & Dooley, 2010)</td><td>Homogeneous groups can lead to less creative outcomes</td></tr>
<tr><td colspan="4">Subsection: DT Collaboration as Multi-Actor Collaboration</td></tr>
<tr><td>Related literature</td><td>Overall contribution of the related literature</td><td>Emerged challenges</td><td>How this work addresses the challenges</td></tr>
<tr><td>(Liedtka, 2015)</td><td>Clarification of the potential of DT. The work illustrates the</td><td>DT is rich and complex. No</td><td>Our DT collaboration approach is based on</td></tr>
</table>

	approach's ability to help decision-makers by reducing cognitive biases	common definition exists; however, we need a clarification of the concept to develop applicable solutions.	the related work and adapted to the context of DT collaboration in a smart city.
(Bazjanac, 1974)	Historical precursor and clarification of the DT concept		
(Liedtka et al., 2017)	The challenges in the social sector are meaningful. DT is a suitable approach to address them		
(Cross, 2011)	Description how designers work and how creative thinking skills and processes evolve		
(Schön, 1983)	Historical precursor and clarification of the DT concept		
(Simon, 1967)	Historical precursor and clarification of the DT concept		
(Brown, 2008)	Transfer of design principles to the business world		
(Owen, 2006)	DT is a complement to science. DT is a new and creative way of decision- making and leadership, which needs a new understanding and new tools		
(Mintrom & Luetjens, 2016)	DT is an alternative for governments to collaborate with citizens in the decision-making process. It is "varied and scattered" and at risk of not being taken seriously		
(Sirendi & Taveter, 2016)	DT is a new approach for public service design. Proactive service		

	design is proposed as a new approach		
(Schmiedgen et al., 2016)	In the private sector, DT is understood and implemented in many ways. The report clarifies that DT is used in a variety of ways.	Related work on DT, which needs to be adapted to the public sector.	Based on related work, our focus became set on the dimensions of team, process, and space. We identified this as a good starting point for adapting the principles of DT to design new products, services, and processes in the public sector.
(Beckman & Barry, 2007)	Development of a generic innovation process of designing and learning		
(Uebernickel et al., 2015)	DT is more than a method. It is a rich approach combining innovation and new attitudes. Ambiguity and complexity are central aspects of DT		
(Carlgren et al., 2016)	A DT framework that combines different levels (i.e., themes, principles / mindests, practices, techniques)		
(Elsbach & Stigliani, 2018)	Identification how DT can produce products and services. DT tools are essential for changing culture and vice versa		
(Doorley & Witthoft, 2012)	Space is important for creative collaboration		
(Kammler et al., 2020)	Cooperation in innovation networks is promising. Design-	Related work on DT reports promising	We tested DT collaboration in the

	oriented collaboration can be beneficial for such cooperation	use in different collaborative settings; however, it lacks smart city best practices. There is a need to study digital service design in the context of open government initiatives in rural areas.	context of smart cities. Moreover, we evaluated the design of digital services in the context of open government initiatives in rural areas.
(Becker et al., 2020)	Open innovation is promising for small and medium-sized enterprises (SMEs). Compensation of low resources (i.e., personnel and financial capacity) is possible through DT use		
(Lepekhin et al., 2018)	Design-oriented approaches for service design are promising in smart health and other smart cities areas		
(Habenstein et al., 2016)	Development of the Open Smart City concept based on the principle of the Smart City and Open Governance / Open Government Data. Opening administrative action brings advantages		
(Nielsen et al., 2019)	DT can address emerging challenges in smart cities, and in a collaborative setting of diverse stakeholders		

18 Paper 12: InspAIred - Drivers and Barriers for AI-Driven Decision Support Systems: The Case of Architectural Design Assistance.

Titel	InspAIred - Drivers and Barriers for AI-Driven Decision Support Systems: The Case of Architectural Design Assistance.
Autoren	Hans Christian Klein[1] Sebastian Weber[1] Bjoern Niehaves[1] [1]University of Siegen, Siegen, Deutschland
Typ der Veröffentlichung	Journal Paper
Outlet der Veröffentlichung	Communications of the Association of Information Systems
Outlet Informationen	JOURQUAL, 3: D
Status	Under Review (major revision)
Zitation	Klein, H. C., Weber, S., Niehaves B. (2022). InspAIred - Drivers and Barriers for AI-Driven Decision Support Systems: The Case of Architectural Design Assistance. In: Communications of the Association for Information Systems.

Table 24. Fact Sheet Paper 12

Drivers and Barriers for AI-Driven Decision Support Systems: The Case of Architectural Design Assistance

Abstract: The rapid development of artificial intelligence (AI) has enabled its use in a growing number of fields. However, for complex design tasks, the question arises as to how AI can effectively support humans and thereby lead to a symbiotic collaboration without outright resulting in the replacement of humans. During the design process of buildings in the architecture, engineering, and construction industry (AEC-industry) there are lots of points of choice and decision, where a data-based support system can complement the designers' experience and hence augment strategic and managerial decision-making. With this in mind, the presented paper identifies design principles (DPs) for an AI-driven decision support system for architectural design and explores the use of Generative Adversarial Networks (GANs) as creative stimuli providers (e.g., building footprints). We employ a design-oriented research approach (design science research) that paves the way to a concept of an AI-driven Architectural Design Support System (ADSS). We evaluate our design-activities iteratively in real-world settings.

Keywords: artificial intelligence, decision support system, design science research, architectural design

18.1 Introduction

Artificial intelligence (AI) has proven its ability to make value-added contributions to many fields as a new method and component for enhancing decision-making (McCarthy, 2007; Mrosla & Koch, 2019). Indeed, AI has become an indispensable tool in many fields, ranging from Industry 4.0 (Cioffi, Travaglioni, Piscitelli, Petrillo, & De Felice, 2020) to medicine (Topol, 2019). In deterministic environments and when problems are structured clearly, it is not surprising that a machine makes fewer errors and works faster than humans. This data-based approach has been accompanied by a paradigm shift and thus contributes to better decision-making that is not solely based on heuristics. However, it remains unclear what role AI can and will play and how people perceive it with respect to unstructured, complex, and multi-layered problems that require creative problem-solving (Zhang, Raina, Cagan, & McComb, 2021) and for which human heuristics serve as a core element of design (Kretz, 2019; Schön, 1983; Stone, Wood, & Crawford, 2000). Meanwhile, decision support systems (DSS) have already shown that their support can lead to better decisions (e.g. Koornneef, Verhagen, & Curran, 2020) and that they are promising for situations of uncertainty and where creativity or creative problem solving is in demand (Burstein & Widmeyer, 2007; Malaga, 2000; Pinto et al., 2015).

In the context of design an AI-based DSS might support designers to reduce design time (i.e., by finding a viable concept faster), while improving design by providing stimuli to support the design process. The design process is an iterative process of variety generation and variety restriction, whereby several points of choice and decision determine the situation and require decision-making (Rittel, 1992). In this work we examine the case of architectural design as an example for design in the architecture, engineering, and construction (AEC) industry. Using the example of a system in the architectural domain that is capable of generating building footprints (and thus designing buildings), we designed a generative human–AI system based on Generative Adversial Networks (GANs) to delineate what human–AI interactions and decision making could look like in a design task. While first attempts by other researchers have yielded promising results (As, Pal, & Basu, 2018; Chaillou, 2020; Huang & Zheng, 2018), these attempts have taken place at the level of technical innovation and lack both further integration into work processes and investigation into the technological artefact in situ. Chaillou (2020), for example, made a promising proposal regarding how to use Generative Adversarial Networks (GANs) and how to render them manageable for architectural application in a practical context; however, this proposal lacked an empirical examination of the interaction between the potential users and the system.

To inform the design of our AI-driven Architectural Decision Support System (ADSS), we reviewed the literature on how designers think. In order to meet the demands of scientific rigor, the existing literature was used to provide a theoretical foundation for our study (i.e. kernel theory (Hevner, 2007)). Therefore, we built mainly on the works of Donald Schön and Simon Kretz (Kretz, 2019; Schön, 1983). Both authors have contributed to the understanding of how architects work and think, which allowed us to derive a framework that provided an orientation to our research and informed our DS design process.

Design Science Research method (DSR) (Gregor, 2006; Hevner, March, Park, & Ram, 2004) has already shown that is promising and a growing approach in the field of DSS (e.g. Koornneef et al., 2020). Using DSR, we derive an approach to understand how designers react to a generative AI-driven system, and how such a decision support system (DSS) can be designed and address the following research question (RQ):

Which beliefs and attitudes do determine the potential use of a generative AI in the case of designers?

Against this backdrop, we aimed to develop prescriptive and descriptive knowledge for an ADSS. In so doing, we uncovered the enormous practical potential that AI has to support designers. Moreover, we made a theoretical contribution by identifying and evaluating design principles (DPs) for an AI-driven ADSS.

18.2 Background

Architectural Design and Machines

To understand the role that technology plays in architectural design thinking, a brief historical classification follows that outlines the changes that have taken place in the design methods of architects in conjunction with technological progress (Chaillou, 2020) and that helped us to design a system. The following sections are not intended to provide a comprehensive overview, but to identify knowledge that served as source of inspiration for our DSR project because the first step is to "define the research problem and justify the value of a solution" (see Peffers, Tuunanen, Rothenberger, & Chatterjee, 2008) – or "as Simon (1967) says, the researcher may be guided by nothing more than 'interestingness.' In part, a key contribution is the conceptualization of the problem itself."

Computational Design. Due to rapid technological development and the possibilities created by computers, the use of CAAD (Computer Assisted Architectural Drawing) software and digital design has become widespread in recent decades (Hyde, 1989; Oxman, 2008). This development has a long history ranging from the first CAD prototype in the 1950s to modern complex three-dimensional CAD-CAM software that enables completely new building forms (see Frank Ghery in (Boland, Collopy, Lyytinen, & Yoo, 2008) and (Zellner, 1999)). In addition to the possibility for architects to better express themselves, computational design also has obstacles, such as the realisation of complex forms (which is not a goal in and of itself) and low automation (i.e., drawing as with pen and paper, but on the computer). Thus, the use of CAAD can only be viewed as an additional possibility for expressing ideas by visualising them digitally (Oxman, 2006) while using (imitating) traditional methods (Salman, Laing, & Conniff, 2014). Indeed, according to Hyde, "[t]his factor should be coupled with providing a level of friendliness that allows the designer the same level of rapport with the system as can be found with the pencil and paper" (Hyde, 1989, p. 245). In developing CAAD, traditional ways of designing play a critical role, as has been made clear by Hanna & Barber: "The findings from this study have confirmed the importance of sketching as an act of designing" (Hanna & Barber, 2001, p. 278).

Parametricism. This new paradigm was made possible in the beginning of 21th century by the development of programs that are capable of transforming certain parameters into a set of rules, which can then be automated. Thus, architects are now able to define certain parameters and convert them into a program that executes the task. Architects can also change the parameters (Oxman, 2017) and create several variations at the same time. Grasshooper – a piece of software that has a visual programming interface – plays an important role in this process. Without the program, many works would probably not have been possible, including that of Zaha Hadid (Schumacher, 2009). However, architects need new knowledge in order to express their ideas because parametricism is a kind of new language that needs to be learned (Oxman & Gu, 2015; Woodbury, 2010). Another point of criticism is that the variation of many designs does not necessarily result in a good design and that focus is placed on geometric modelling and form (Yu, Gero, & Gu, 2015), where form takes precedence over "wider comprehensive aspects of architectural knowledge, principles and concepts" that lie "outside of the primary focus" (Oxman & Gu, 2015, p. 478).

Artificial Intelligence and GANs. Recent developments in the field of AI can lead to another type of paradigm shift: While designs had previously been based on the heuristics of the designers, AI as a statistical and data-based approach is capable of supporting this decision process (Chaillou, 2020). The machine can learn based on data, and the system develops "intuition" that can both complement and support human intuition (Huang & Zheng, 2018; Newton, 2019). Based on the data and the underlying patterns, the system is able to formulate solutions based on statistical principles (Oxman & Gero, 1987). A decisive step in the application of AI was taken by machine learning algorithms based on neural networks. For this purpose, new algorithms in the field of adversarial learning are promising. Generative Adversarial Networks (GANs) are a special form of such adversarial learning algorithms and are capable of producing data themselves (Chaillou, 2020). The concept of GANs dates back to 2014 (Goodfellow et al., 2014) and its underlying principle can be described as follows: A GAN consists of two neural networks: a generative model G that aims to create results of a certain distribution out of training data, and a discriminative model D that estimates the probability of whether these results came from G or from the training data. As such, G aims to maximise the errors of D in order to create realistic results that cannot be distinguished from real data. With this methodology, GANs are capable of creating realistic images, the quality of which has improved rapidly over time (Karras, Laine, & Aila, 2019). GANs have been used in a wide variety of applications, including face aging (Antipov, Baccouche, & Dugelay, 2017), image inpainting (Pathak, Krahenbuhl, Donahue, Darrell, & Efros, 2016), and building footprint recognition and generation (Chaillou, 2020; Huang & Zheng, 2018). The ability of GANs to recognise patterns and reproduce them opens new windows of opportunity for AI. However, technological capability alone will not succeed in creating a human–AI system that can help to discover and implement better design solutions. For this to happen, the design of the AI – and the human–AI collaboration, in particular – must be understood and shaped in a sustainable manner.

How Designers Think

To understand how AI can assist in design, we first clarify our understanding of what happens in design and how architects think in practice. The vast majority of approaches to explaining design thinking emphasise the importance of human creativity (Boden, 1996; Cross, 1997; Oxman, 2017). Two approaches can be distinguished (Ammon, 2015, 2017; Kretz, 2019):

First, we have creative design as a process. Here, a great deal of focus is placed on the approach and the different sequential steps in order to explain how architects arrive at a design (Kretz, 2019). In addition to proceeding step by step, iteration plays an important role (Rittel, 1992). Through many iterations, variations are created and discarded, thereby allowing concepts to evolve.

In contrast to creative design as a process is the idea that designing is an act of creation. This act is very chaotic, non-linear, and related to personal experience; moreover, it can be described as a quantum leap in terms of finding solutions (Gänshirt, 2012). This approach – which uses intuition and emotionality to explain design as an act of creation (neuroscience) – thus involves the use of more of a feeling or that special something (cf List, 2015).

Both approaches are insufficient for understanding the thoughts of designers via the example of architects (Ammon, 2015, 2017; Kretz, 2019). Accordingly, the second approach – creative creation – aims to mystify the process of designing in an unnecessary way. In so doing, it explains neither the emergence nor the ubiquitous development of designs in practice. This dimension can be neither investigated nor explained using the second approach. In contrast, the first approach aims to assimilate design into a scientific method and to explain and understand it using a kind of manual. Here aspects like "eureka"-moments and aspects like chance are disregarded, which are doubtless of great significance.

However, with Schön's work and the concepts of reflection-in-action and thinking on one's feet (Schön, 1983), both approaches can be mediated without losing the respective aspects of the processual approach and the creative act (Kretz, 2019). The three dimensions (the changing dimension, the investigation dimension, and repertoires) (Kretz, 2019) are discussed in the following sections.

The changing dimension: This dimension is obvious to most people who are familiar with design and is the one that every designer is explicitly aware of. In relation to a design project, the changing dimension involves creating possible future scenarios and the "potential changing of reality in space and time […]. Potential is possibility in a specific context. Design is the tool that renders this potential for change visible" ((Kretz, 2019, p. 104), own translation). Schön describes the dimension as change in a situation (Schön, 1983, p. 68). Indeed, designers change their designs with the goal of developing a future that is a satisfactory solution in relation to the specific design task.

The investigation dimension: This dimension describes another facet of designing. It does not exist downstream or upstream from the modifying dimension; rather, it represents another side of the same coin. The investigation dimension is implicitly applied, and very many designers are not aware of it. According to Schön, the two dimensions of a change in the situation and a new understanding of the phenomenon cannot be separated. According to Schön,"[the designer] carries out an experiment which serves to generate both a new understanding of the phenomena and a change in the situation" (Schön, 1983, p. 68)

Only in a retrospective view can both dimensions be distinguished, which thereby allows for a kind of justification for a seemingly arbitrary design operation. Kretz ((Kretz, 2019, p. 104), own translation) describes this dimension as follows: "Designing is an action that transformatively examines realities and consequently allows them to be perceived in a different way. In this process, not only is an operation tested in the respective reality, but reality is also tested in the operation. Consequently, designing can be an epistemic experiment in which the properties and conditions of a reality are examined."

Repertoire as a product of experience: Designers from as far back as the time of Aristotle have noted that design operations are based on personal experience. Contrary to the widespread belief that designing can emerge from nothing or that only a eureka moment alone can give rise to a design idea, personal experience ensures that designing does not emerge from nothing (Ammon, 2015). Experience does not mean that old solutions, patterns, or schemata are simply transferred to a new design task; rather, it means that the specific characteristics and conditions of the new situation are investigated and that potential is invented (found) in the process by means of previous procedures, forms, practices, and bodies of knowledge. In this way, it is possible to develop suitable projects for a new situation (cf Schön, 1983). The use of repertoires does not follow any rules or procedures that can be generalised. Repertoires involve"[...] not rules, but thousands of examples, comparative, directly and intuitively based on experience[...]" (Flyvbjerg, 2001). Thus, over time, a collection of patterns emerges (cf Alexander, 1977).

Repertoire I – Design Operations: "Tools of directed irritation acquired through the design itself" ((Kretz, 2019, p. 105) own translation)."Turning a building transversely toward a main orientation" is such a design operation in the form of directed irritation. The design operation is always embedded in an iterative process and is thus informed by prior activities. Design operations can be viewed as a kind of motor that is directly connected to the design. All designers have a repertoire of design operations stemming from their experience.

Repertoire II – Situations: "Situations of reality acquired through the investigation dimension itself" ((Kretz, 2019, p. 105) own translation). This dimension involves situations that trigger further thoughts in designers. Examples include situations that offer high spatial quality and great potential for the design task. This situation can be conceived of as a thought experiment that must be tested and verified by an experiment (e.g., using a sketch, CAAD, or parametric design tools) on reality. Discovering the potential for the design is the overall goal with which the repertoire is linked.

Repertoire III – Strategies: "Methods of realisation obtained through the changing dimension" ((Kretz, 2019, p. 105) own translation). A special formal approach to organising a floorplan (e.g., amorphically) is a strategy of realisation. Here, designers draw on strategies that are familiar to them and that have been stored in their experiential repertoire from a previous example or design task. The associated ideas (i.e., a jagged floorplan structure that could allow all visitors to enjoy a view) are directly linked to the changing dimension and are tested against reality.

18.3 Research Method

DSR is an established approach in the field of DSS (Barrera Ferro, Brailsford, Bravo, & Smith, 2020; Carvalho, 2021; Koornneef et al., 2020; Oruç, Eren, & Koçyiğit, 2022). It is promising because it seeks to combine theoretical and practical contribution. In combination with case studies, it has the potential to enable better designs by fostering collaboration between the decision-maker and the system designers' DSS (Koornneef et al., 2020). We follow the DSR process according to Peffers et al. (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007).

Our approach consists of six activities (see Figure 32): 1) Identify problem and motivate, 2) Define objectives for a solution, 3) Design and development, 4) Demonstration, 5) Evaluation, 6) Communication. The activities structured the design of our ADSS and presented in the following sections. Figure 32 provides an overview of our activities.

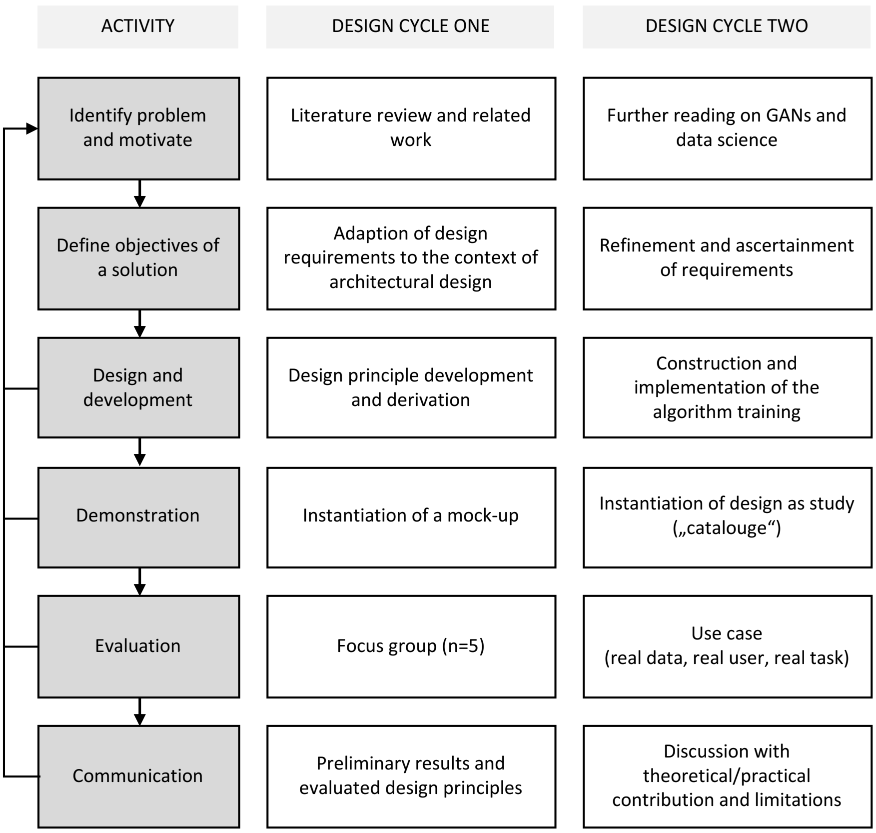


Figure 32. Research Approach (adapted from Peffers et al. (2007))

18.4 Objectives of the Proposed Solution

Personal experience is a factor that explains how architects design. Based on their experience, architects build up a repertoire that they use to evaluate situations and to design. However, each architect's repertoire is highly individual, and having a limited repertoire may prove problematic. Going further, every architect has a limited capacity to build a repertoire, and therefore, no architect could ever form a fully comprehensive repertoire with regard to what is theoretically possible (i.e., all repertoires). In other words, no architect could ever have a complete repertoire that enables all potential possible solutions in a certain design task.

One possible theory for explaining this phenomenon is the theory of bounded rationality. According to Simon (1956), bounded rationality states that people have limited capacity (e.g., know-how, information, time) to act fully rationally. People tend to aim to merely satisfy others via problem-solving and are often not able to find optimal or perfect solutions. The concept of bounded rationality can also be transferred to the domain of design (Baskerville, Kaul, Pries-Heje, & Storey, 2019; Baskerville, Kaul, Pries-Heje, Storey, & Kristiansen, 2016). We therefore adapt the definition of bounded rationality put forth by Baskerville et al. (2019) to the design domain of architecture and to our concept of repertoire.

According to Baskerville et al., “in [architecture], bounded creativity (the amalgamation of Simon’s bounded rationality in design and bounded creativity in engineering) means that humans are limited in their ability [i.e. their repertoire] to make perfectly creative designs” (Baskerville et al., 2019, p. 3). This definition leads to our problem statement. According to Kretz (2019), we know that repertoires serve as stimuli during the design process. Thus, a small repertoire can be the bottleneck of stimulation in the design process. It is therefore critical to examine and address this challenge in our DSR (Sonnenberg & Vom Brocke, 2012, p. 394).

To address our identified problem, we suggest designing a system that is capable of enhancing architects’ repertoires using a data-based approach without replacing the architects’ intuition or creativity. The approach by Chaillou (2020) has already proven that it is possible to generate an AI approach that informs architects about design possibilities and enriches their heuristic methods by using a statistical and data-based approach. In Figure 33, we present the first step of the generation pipeline by Chaillou (2020). The idea is to generate building footprints that serve as a starting point for our design activity.

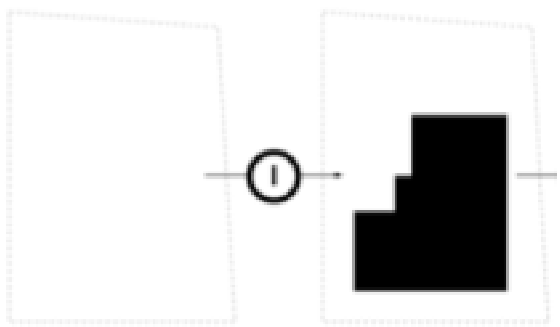


Figure 33. Generation Pipeline by Chaillou (2020)

This approach (i.e., machine-learning algorithms) appears promising for addressing our problem because the stimuli can serve as input for “1. Design Synthesis: the (AI) expert capable of design generation” and “2. Design Diagnosis: the expert system can function as a design critic to evaluate, criticise and recommend corrections in design” (Oxman & Gero, 1987, p. 4).

Design Requirements (DR) define the criteria in terms of goodness of a solution. They should be derived from different categories and perspectives to inform human computer collaboration (Brocke, Winter, Hevner, & Maedche, 2020). DR are part of the problem space and guide the development and design of components. They are prescriptive and descriptive knowledge to guide design activities (Brocke et al., 2020; Gregor & Hevner, 2013). There is a gap in reusing known design knowledge and it is important to build on previous work. In our case we want to aid the decisions of designer during the design process. Therefore, we use the known DR to build conceptualize and transfer our DR, based on the AI-based DSS literatur. Especially when designing descision support systems it is promising to adapt general design requirements to the special domain of interest and transfer the general DR into domain-specific DR (Meske & Bunde, 2022; Meth, Mueller, & Maedche, 2015; Zschech, Horn, Höschele, Janiesch, & Heinrich, 2020).

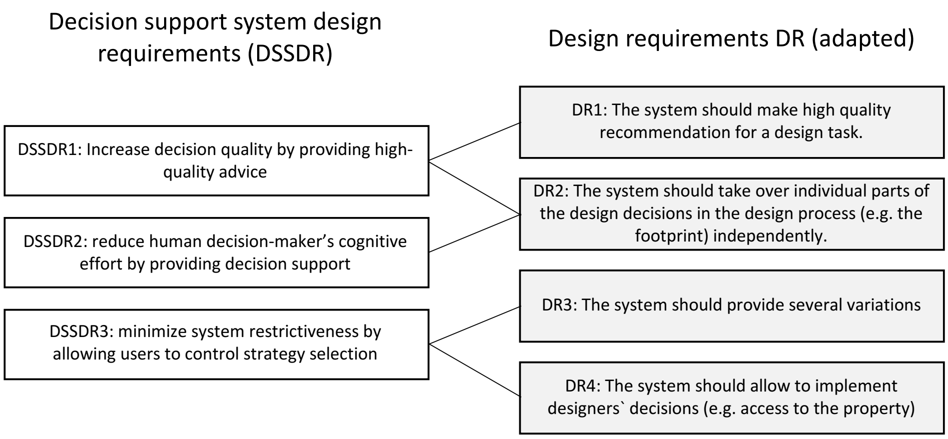


Figure 34. Research Approach

18.5 Design and Development

Derivation of Design Principles

Design Principles (DP) allow communication of design knowledge (Gregor, Kruse, & Seidel, 2020) and can further be translated into Design Features (DFs). DFs allow the implementation into instantiations and prototype artifact. In iteration one and iteration two the following DPs (Table 25) were identified and iteratively developed.

Theme	Category	Design Principles

Degree of freedom	Fear of lack of self-expression	Provide the system with the capability to enable designers' expression
	Fixed boundaries	Provide the system with features that allow ignoring the AI-based stimuli
	Abstraction	Provide the system with the capability to illustrate stimuli in an abstract way
Trust in the system's creative performance	Missing explanation of the methodology	Provide the system with features based on XAI to generate a general explanation that enable users' interpretation of the stimuli
	Lack of creative competence in AI	Provide the system with features based on XAI to generate trust
Variations	Broad repertoire	Provide the system with the capability that enhances designers' repertoire so that a designer can overcome fixation and bounded creativity
	Ambiguity	Provide the system with the capability that allows several solutions for the task and to present several variations of the stimuli for the same task

Table 25. Design Principles

Instantiation of a Mock-up

Based on the idea of generating building footprints as stimuli that are integrated into the design process as an ADSS, we developed the following mock-up (Figure 35) for our design phase of the artefact:

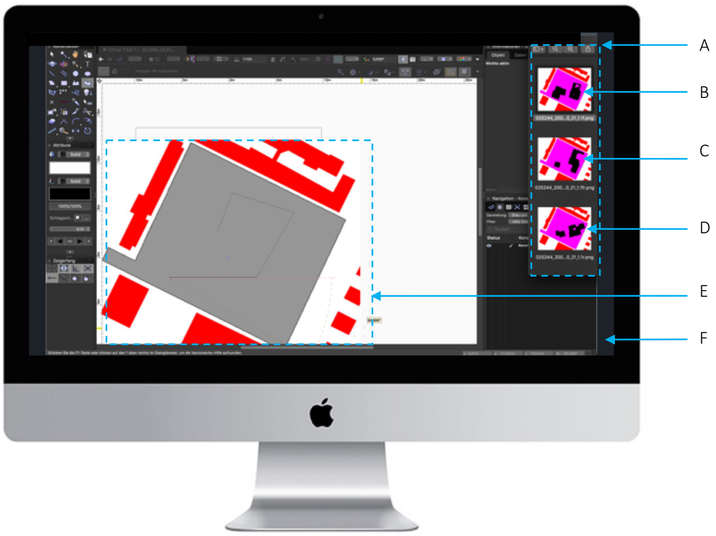


Figure 35. Mock-Up (shown in focus group)

A: exemplary stimuli shown on screen; B-D: proposed footprint I-III (black) on site (magenta) with surrounding buildings (red); E: drawing in CAD-program with site (grey) and surrounding buildings (red); F: CAD-environment

The construction and development activities broadly consisted of three phases: data acquisition, data annotation, and the implementation of the algorithm training.

Data acquisition. Since the quality of the AI approaches' outcomes depend on the quality of the data, it was important to use data that had already been evaluated. Previous approaches have their weaknesses here because they have relied on public data (e.g., Google Maps or other public datasets), but these data have no guarantee of a certain level of architectural quality. In our case, we created a dataset based on the results of architectural competitions over the past ten years. The fact that we only used the best results from publicly announced competitions, ensures an increase in quality compared to existing solutions. Additionally, we learned that architects already use published results of competitions as inspiration. Thus, the attitude of architects towards the credibility of this source should be positive. We collected site plans of competition results that had been published throughout the preceding years and only used site plans from the first three places as well as (potentially) honourable mentions. We decided on this method for only one typology (i.e., educational buildings) because underlying patterns between different typologies could have distorted the results of the algorithm. Thus, we collected data from 165 site plans.

Data annotation. In this activity, we ensured that the data were correctly annotated. In our case, we aimed to address DR 1 and DR 2. Therefore, we had to annotate the site plan to make appropriate information visible. Thus, we annotated the following elements of the site plan: surrounding buildings, existing buildings on the site, the site, the building, access to the building, and access to the site. Figure 36 highlights this annotation process. Raw data (i.e., footprints in the magazine) were extracted and annotated with different colours matching the mentioned elements (e.g., surrounding buildings in red, existing buildings on the site in black, the site in magenta).

Figure 36. Exemplary Data Annotation

The implementation of the algorithm training. With the annotated data, the next step was the training of a GAN that allowed image synthesis. While many approaches for this endeavour exist, we used the so-called GauGan (Park et al., 2018), which is a conditional GAN that allows semantic image synthesis. Using this method, we were able control the semantic of images created (e.g., the existence of surrounding buildings) using a label map. To train the model, we accordingly annotated the data as described above and created a semantic-label map that allowed the GAN to comprehend which pixel colour belonged to which label (e.g., red pixels = surrounding buildings, blue pixels = existing buildings on the site). To maximise the quality of the results, we further enlarged our dataset of 165 images to include 460 images via image transformations (i.e., rotations, flips, or both). Because of the transformations, the potential relationships between sun position and footprint are no longer considered, but the potential relationships between site-size, site-shape, and especially surrounding buildings are strengthened. Since the position of the sun is important especially for the later room occupancy (which does not play a role in the application example of our ADSS yet), we accept this disadvantage due to the advantages.

In order to evaluate the design of our concept, we conducted the following activities because “the evaluation of the design activity result serves the purpose of showing that an artifact design progresses to a solution of the stated problem” (Sonnenberg & Vom Brocke, 2012, p. 394). We conducted two simulations (Sonnenberg & Vom Brocke, 2012, p. 394).

(a) One dataset (test data) was used to test the algorithms. The results revealed that the algorithm was capable of producing stimuli. Our criteria were land use, scale, the location of the building, the number of buildings, and graphic quality.

(b) The second simulation for evaluation was performed in the context of a real competition. The real-world design task was to design a primary school for a municipality with around 20,000 inhabitants. The competition was held by the municipality and organised and accompanied by a project manager. It was a limited, anonymous competition for rendering architectural services. The competition was based on the Guidelines for Planning Competitions (RPW 2013) and was submitted to the Chamber of Architects of North Rhine-Westphalia for consultation and registration. The registration number of the Chamber of Architects NRW is WB 69/20. Ten designers submitted designs to be evaluated and judged by an expert jury. We then compared the winning design with the stimuli of our AI and used this comparison for evaluation. Our criteria were land use, scale, the location of the building, the number of buildings, and graphic quality. The stimulus was positively evaluated for further design activities.

Theme	Design Principle	Implementation
Degree of freedom	An AI-driven ADSS should provide a high degree of freedom	To achieve a high degree of freedom, we considered the actual method of work performed by the architects. As architects use pen and paper and real models, we provided the stimuli in the form of building floorplans in a printed catalogue that allowed manifold ways to use, manipulate, or ignore the floorplans.
Trust in the system’s	An AI-driven ADSS should provide information about the	To facilitate trust, we held an initial presentation and informed the architects about the principles of the AI-

creative performance	principles of machine learning, the dataset, and the principles of generating stimuli.	driven ADSS and the database we had used to generate the stimuli.
Variations	An AI-driven ADSS should provide a high number of variations of the shown stimuli.	To achieve a high number of variations, we enabled our system to be fed with input. We implemented this via two additional parameters (i.e., a planned entrance to the site and a planned entrance to the building), which could be changed. Thus, we allowed for several items of output.

Table 26. Design Principles and Implementation

18.6 Demonstration and Evaluation

Cycle One (focus group)

In order to evaluate our design activity (i.e., construct), we conducted an exploratory focus group with domain experts (n = 5). We pursued a strategy of human risk and effectiveness (Venable, Pries-Heje, & Baskerville, 2016) because this strategy helps to minimise the risk of user-oriented and social elements (Venable et al., 2016). Therefore, we assessed whether the user would be open to using such a system and what design decisions would affect the users' beliefs and attitudes towards the system. We then evaluated the idea by conducting an exploratory focus-group workshop. The focus group was conducted with five architects from Germany. One architect was a partner in an architectural office, one was an office owner who taught at a university, two were employed architects, and one had just completed university at the time of the focus group. In total, two male and three female participants with an average age of 37.8 years (SD = 6.1) and an average working experience of 8 years (SD = 4.29) participated in the workshop. The workshop was divided into two parts: In the first part, we asked the participants to discuss the general idea of using artificial intelligence as a form of support during a design task. We then demonstrated the idea of AI-based building footprint stimuli (instantiation) and asked the participants to discuss the idea. The complete workshop was audio-recorded and then transcribed in typed form. For the coding and analysis of the qualitative data, we carried out a qualitative content analysis (Mayring, 2014) with the help of MAXQDA 2018 software. In summary, the analysis procedure suggested that coding categories be defined, that related data be coded according to the categories, that the coding be re-checked, and that results be provided (Mayring, 2014). Through our data analysis, a categorisation scheme emerged (Tremblay, Hevner, & Berndt, 2010). We analysed the raw data (i.e., we transcribed data and notes from the second observer) and inductively defined categories based on the statements made. Positive and negative factors mentioned regarding such a system were seen as categories. The following categories emerged and were clustered into three themes, which are addressed below (Table 26). In summary, an ADSS should give a certain degree of freedom to its user, generate trust in the system´s performance, and offer various stimuli. The themes were guiding our design principles with iterative modifications of the ADSS and the implementation in the use and evaluation IV activities.

Theme	Category	Illustrative Statements
Degree of freedom	Fear of lack of self-expression	"Doesn’t it [the AI] put a lot of pressure on you? […] I imagine that would be difficult. You would get kind of distracted.”
	Fixed boundaries	“You begin with pre-conceived boundaries that you may not want to cross.”
	Abstraction	"The more abstract the impulses are, the better it works."
Trust in the system’s creative performance	Missing explanation of the methodology	"The stimulus does not help because it does not follow a strategy."
		“But to just accept the results without knowing what factors played a role and how everything was done… to just accept the AI – I don’t know… I don’t think I would."
	Lack of creative competence in AI	"There are a lot of offices that source out a lot to the computer and algorithms. For me, design always involves more chance – artistic elements that stem from outside of the box and that the algorithm just doesn't find." “The AI does not have to become an artist; the artist still sits in front of the computer.”

Variations	Broad repertoire	"It's actually always about generating variations in the design and then finding the best solution based on that." "I find the situation with the building footprint interesting – getting to see variations and getting inspired." "When I look at the results of competitions [as inspiration] with different tasks, I always find all the results interesting. And it's always probably more of a mixture of all the results that you find most convincing… or things that you discover that you had not thought of yourself."
	Ambiguity	"I would tell the AI to do something else. I would want to be surprised. That way, there would be no mistake. And even if I wouldn't have come up with a structure like that, I could see the value in it, too." "I would find a kind of random button interesting. Like, you could click on it and (tell the AI to) find a solution. You could click on it again and let it inspire you."

Table 27. Design Principles and Implementation

Cycle Two (use case)

The goal of Phase IV was to "show that an artifact is both applicable and useful in practice" (Sonnenberg & Vom Brocke, 2012, pp. 395–396) and to investigate how the architects react to our instantiation and what are the beliefs and attitudes towards the ADSS in practice. To reach this end, it was necessary to embed an artefact instance and evaluate it in organisational practice (i.e. real tasks, real systems, and real users; (Sonnenberg & Vom Brocke, 2012, pp. 395–396)). Based on our framework and the results of Evaluations I–III, we developed a technical foundation for an artefact instance that could be implemented in a realistic setting (i.e., printed catalogue with stimuli). Our proof-of-concept case was a German architectural office with 10 employees that was active in the architectural competition industry. In total, five male and five female participants with an average age of 39,9 years (SD = 8,5) and an average working experience of 16,8 years (SD = 8,9) participated in the case. After a consultation about their current competition (i.e., the competition for designing an educational building), our system was fed with the necessary data, and a tangible artefact in the form of a catalogue that matched the requirements as best as possible was created. The architects could use the tool for one week during the stage in which an initial building footprint for the building was to be created. According to our findings from the Evaluation II (Table 3.) we modified the system and identified ways to implement and operationalize the derived design principles.

In the first category degree of freedom we addressed the following three themes. Fear of lack of self-expression – The stimuli was printed as a catalogue and allows many ways of use and promotes a creative use of the stimuli. For example, the stimuli can be overdrawn, cut out and used in a physical model or a new solution can be generated in the CAD program based on the stimuli shown. The ADSS thus enables to develop new solutions and make new decisions in the design process based on the shown stimuli. Fixed boundaries – the shown stimuli can be easily ignored without any hurdle. This was another reason for making the stimuli available in printed form as a catalogue. The actual work and design process in the CAD program or when sketching is not restricted. The stimuli do not limit the actual design process in any way, if there should be any reasons for the architect to do so. Abstraction – the theme abstraction is already part of the solution itself. We have used an abstract representation. We show only the surrounding development the plot and the variables of accesses. At the same time also adjusted the colours and show no details or realistic features.

The second category trust in the system's creative performance was addressed and operationalized by one design feature. Missing explanation of the methodology; Lack of creative competence in AI – We addressed both themes by choosing a data source (i.e., magazine) that was already known, is respected and that was already being used by the architects as a source of inspiration in the design phase. Specifically, we used only drawings as training data from this magazine in Phase II. This is the magazine [left out for review]. In addition, we explained machine learning principles and explained the process at the beginning before using it.

Variations as third category was also addressed and operationalized as follows. Broad repertoire – As we saw in Phase II and the literature confirms, it is common for architects to work with multiple variants. Thus, the system should provide variants to best complement the architects' repertoire as stimuli. Specifically, we implemented this by annotating information about access to the building site and building entrance/entrances of the schools. This allowed the architects to use these two aspects as variables, thus the ADSS delivered several stimuli/solutions. This allowed the architects to change and "play" with the variables (access to the building site and building entrance/entrances) and link them or use individual aspects for another variant. This created additional freedom for individual creativity. Ambiguity – The ambiguity was reinforced by the fact that the system proposes several variants, emphasizing and underlining the ambiguity and, at the same time, the possibility of large number of solutions. Table 27 summarises our design principles and their operationalisations.

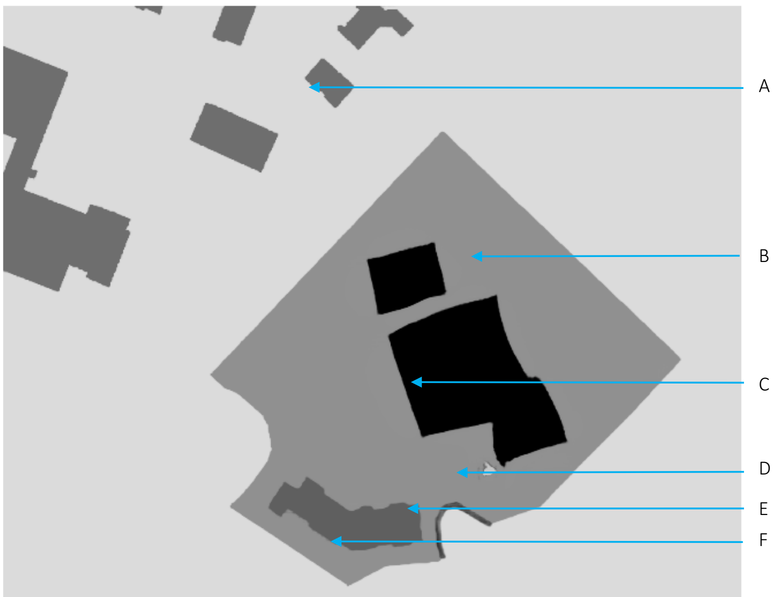


Figure 37. Exemplary Stimulus

A: surrounding buildings; B: site; C: proposed footprint; D: building entrance set by architects; E: access to the building site set by architects; F: existing building on site

We then interviewed the project team on their experience regarding the usefulness of the ADSS and evaluated the design principles. The semi-structured interviews were conducted by two researchers and lasted 60 minutes. The interviewees supported the idea of introducing such a tool to inspire them with further ideas and to challenge their existing ideas. In particular, the architects argued that the tool – in general – and the created designs of the AI – in particular – had been helpful for their decision making. Regarding the design principles, the architects positively evaluated the artefact (see Table 25) instance in terms of the categories derived in the Phase II.

Theme	Evaluation Category	Illustrative Statements
Degree of freedom	Fear of lack of self-expression	“It did not put pressure on us or limit us; it is a bit like how you look at other architects’ sketches. You always look at those.” “But if […] the AI said that it had the one and only solution, I would feel uncertain and sceptical.” “In the end, it’s the emotional level that AI doesn’t have. And we make our decisions on this emotional level.”
	Fixed boundaries	“It didn't limit me; it's basically like looking at the works of other architects.”
	Abstraction	“I thought the images were very good. They were pictogram-like and did a great job at getting the AI’s idea across [...]. I could imagine working with the AI like that.”
Trust in the system’s creative performance	Missing explanation of the methodology	“These simple structures... the algorithm also understands that they are actually the right solution at that point.” “This would be really beneficial. Even though you explained how the AI works, we tried to understand why [it proposed certain solutions]. It would be interesting to know why the AI makes a certain suggestion.”
	Lack of creative competence in AI	“Since you can't define so many parameters from the beginning, it [the AI] is not yet so specifically tailored to our competition, so we could still incorporate more parameters. But I could imagine that if you could map out all this complexity, the situation would be completely different. Right now, we still have the feeling that we are superior to the AI.”
Variations	Broad Repertoire	“We [architects] work with variations, so it was good to have [several suggestions and ideas].” “The AI also helped us to exclude variations.”

	Ambiguity	"We sat here and really reflected [on the stimuli] bit by bit, which led to new perspectives and insights… and we even changed our opinion completely." "I found it quite helpful because it gave us different perspectives that we hadn't considered at all."

Table 28. Evaluation of Design Principles

Aside from having generally appreciated the tool, the interviewees also revealed further potential for improvement. For example, they were curious to learn more details about how the AI had derived a solution and about its strategy. Additionally, the interviewees noted that it would be interesting to feed the algorithm with more parameters. Regarding the evaluation of the design principles, it was also interesting that the ex-ante evaluation was different from the ex-post evaluation in a realistic setting. While participants expressed concerns about their freedom in the ex-ante evaluation, the ex-post evaluation revealed a more-differentiated picture in favour of the tool. Accordingly, in practical application it was useful.

18.7 Concluding Remarks

Results

In our investigation we identified attitudes and beliefs that determine the potential use of an ADSS. The ADSS was introduced to learn how to design such an artefact and how to take the attitudes and beliefs of the target group into account so that the system is used.

We identified three main variables that had affected the perceived usefulness of our system. 1) The perceived degree of freedom: We operationalised this variable using principles that enabled us to minimise boundaries, allow personal expression, and deliver stimuli in an abstract manner. In our study and the final prototype, there was no evidence of perceived constraints, and there was a high perceived degree of freedom among the architects vis-à-vis the AI. Our low-fidelity prototype solution seems to have worked well here. However, we have not yet tested how our results could change when dealing with a high-fidelity prototype in a digital context. Interacting directly with a system that could allow parameters to be changed directly (i.e., a highly interactive system) would require both re-evaluating the perceived degree of freedom and further examination. 2) Trust in the system's creative performance: We operationalised this variable using principles that addressed the explanation of the methodology of the AI and the lack of confidence in AI's ability to provide inspiration. While our assumptions based on the evaluation II about the perceived degree of freedom and about variations were both confirmed, the variable of trust is two-sided. In the end, the architects decided not to trust the AI in certain instances and their final decision (i.e., they had placed the building elsewhere on the site). Nevertheless, they found the system useful and interesting as it enabled new ways of thinking and a better argumentation why their solution is superior. In other words, one may say that the architects seem to trust the stimuli in general and as a muse during the iterative design process, however the last design activity in the design process must made by themselves. This leads to an interesting path for future research considering a differentiated view during the different stages in the design process. In general, we assume that a certain threshold of trust must be met. Trust must be high enough that the architect is willing to use the system. After that only trust in the system´s creative performance determines the perceived usefulness of the ADSS. For future research it would also be interesting to see how the use develops over time based on the decision whether one decides to reject or accept the system's advice. 3) The number of variations: We operationalised the variable using principles that were able to enhance architects' personal repertoire and ambiguity, which allowed for different interpretations and solutions. We did not test different numbers of shown solutions. However, in the case study, we discovered something new, which we call agility. The architects asked for another variation and asked to produce some stimuli that had not been presented by us before. The ability to produce more variations seems to be an important aspect of our system, which should be able to adapt to new parameters / requirements (the architects asked to neglect existing buildings) in an agile manner.

Our ADSS contributed to practice through enhancing the repertoire of the architects. We will illustrate the practical contribution and repertoire-enhancing information using an exemplary stimulus. At the same time Table 28 illustrates how we contribute to the problem statement of our DSR and how the artefact contributes to the problem domain. Therefore, we use the example of a shown stimulus, which is one of sixteen shown stimuli in the catalogue.

Graphical explanation	Illustrative examples of repertoire-enhancing information

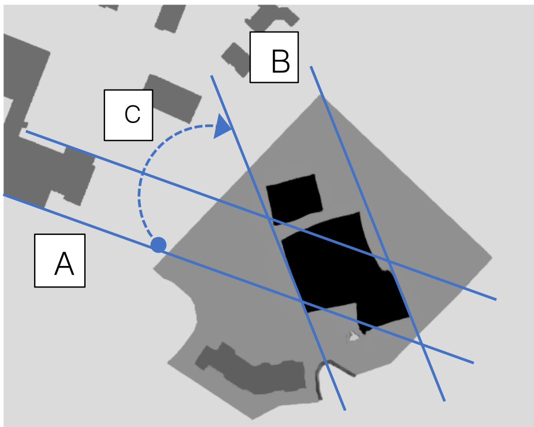
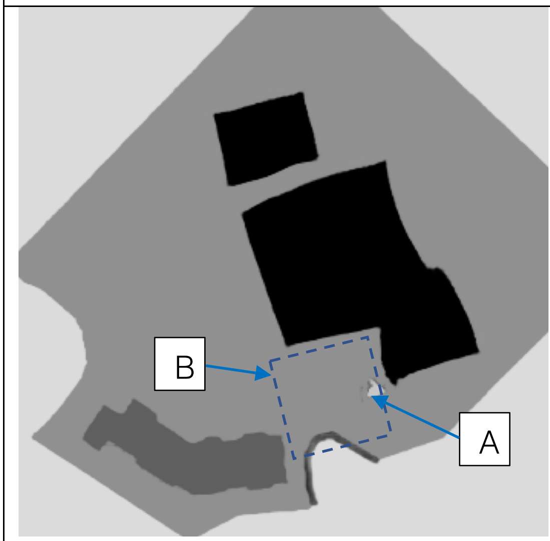
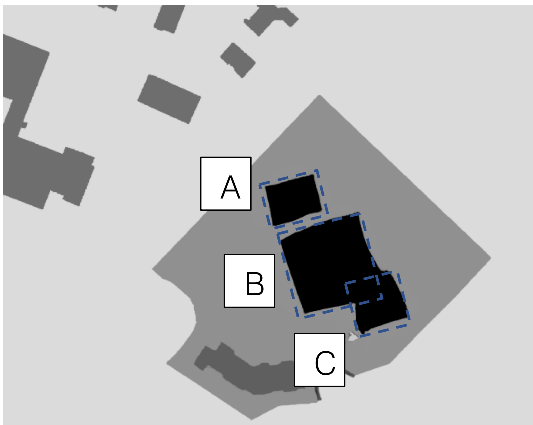
	At first the architects wanted to consider the orientation of the surrounding buildings (A). The shown stimuli suggested another orientation (B). Thus, the ADSS enhanced the repertoire I by suggesting a different orientation (i.e., transformation: “rotate orientation”) (C).
	The architects set the position for the building entrance (A). The shown stimulus suggested a well-balanced front yard (B). Thus, the ADSS enhanced repertoire II by suggesting a special “situation”. (i.e., “welcome-situation” where students and visitors arrive and can enter the building).
	The shown stimulus suggested a footprint/figure that consists of three rectangles. While one structure (A) is set isolated the structure (B/C) are interlaced. The corners describe a right angle as far as possible. Thus, the ADSS enhanced repertoire III by suggesting a strategy (i.e., right angles, three building structure while two are interlaced and an isolated one)

Table 29. Exemplary Repertoire-enhancing Information

Discussion

Our study represents an initial step towards a new system and a new design for ADSS and aimed both to produce new knowledge about the interaction between machines and designers and to build a new decision support system. The AI-driven ADSS enhanced designers' repertoire and uncovers a new and promising approach. While known approaches aim at making the product design process (Xu, Li, Li, & Tang, 2007), the integration of manufacturing and design process (Kristianto, Gunasekaran, Helo, & Sandhu, 2012) or modular design in distributed environment (Tseng & Huang, 2008) more effective and efficient, our approach seems to target both aspects - the known and the heuristic, creative, discovering, and artistic aspects of design. These are essential for architects (Kretz, 2019; Schön, 1983) and it is an exciting way to consider not only supporting the rational decision-making process, but also supporting the process of (bounded) creativity with a data-based approach. We also contribute through our research to DSR (guideline 4: research contribution (Gregor, 2006; Hevner et al., 2004)) by solving the problem of making new machine learning algorithms available for architects and their design process. We propose to classify our research as exaptation (Gregor & Hevner, 2013) (i.e. extending known techniques to a new area of problems (van Capelleveen, van Wieren, Amrit, Yazan, & Zijm, 2021)).

While in deterministic and structured tasks it is important to investigate in "black-box" approaches and their effects on rational decision-making in designing and decision-making in wicked problems [48], we propose to differentiate between trust in the algorithm and trust in the system's creative performance of the ADSS. The latter one seems to be promising, because the stimuli do not have to be a final and credible solution, it functions as a creativity stimulus and thus fulfils its purpose by inspiring the designer to find a new solution (Kretz, 2019; Schön, 1983).

The ADSS had no direct influence on the architect's final design for the competition, however influenced the design through both, the investigation dimension and the changing dimension as an inspiring stimulus ("We sat here and really reflected [on the stimuli] bit by bit, which led to new perspectives and insights… and we even changed our opinion completely."; "The AI also helped us to exclude variations."). Further studies could increase the external validity of our results by using our system to conduct additional empirical investigations. Additionally, we explored the case of architects and transferring our approach towards other design disciplines (e.g., urban design, product design or engineering) would be a promising route. Another interesting path forward would be to further develop the system (i.e., by incorporating more data, more typologies, or other stimuli), individualise the system to user preferences (e.g. only use selected training data), and realize an interactive collaboration tool. Finally, when using technology (in our case, AI) in the design process (in our case, architectural design), questions such as “Who does the designing – the technology or the designer?” and “Whose knowledge and data are encoded?” (cf. Lloyd, 2019) inevitably arise. While our paper does not claim to provide general answers to these questions, we contribute to social and ethical questions by demonstrating that the answers are a matter of design.

The role of AI in design, and how innovation can take place with practical relevance and accountability, also depends on the following questions, where our work contributes as an initial step. The question arises as to what will happen if all designers resort to the same stimuli and the repertoire is reduced at the level of society. It also arises the question of how to implement ADSS in students’ curriculum. It is important that they build up a repertoire and experience and do not exclusively rely on AI. Additionally, the role of general DSS changes with the raise of AI and further avenues of how human machines (i.e. so-called cognitive computing systems) arise (Schuetz & Venkatesh, 2020). We also contribute to that stream with our proposed ADSS and open the research opportunity to investigate on how systems can foster humans’ trust [see (Schuetz & Venkatesh, 2020)] in the case of design. DSR can further succeed in addressing the aspects of technological possibility and social aspects simultaneously.

Conclusion

Our study instantiated an ADSS and identified beliefs and attitudes that affect the perceived usefulness of the system. We illustrate how such a system can be designed to support designers’ decision making while creative problem-solving tasks by enhancing their repertoire. The relevance for practice is enormous because AI is new to the field and has potential to lead to many opportunities to produce better designs by augmenting decision-making through inspiration. Future research could benefit from our design of AI-driven ADSS by gaining insights from our investigation and by learning that architects´ attitudes and beliefs towards the ADSS are affected by the variables of trust in the system’s creative performance, the degree of freedom, and the number of variations.

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19 Paper 13: Status quo bias-perspective on user resistance in building information modeling adoption – Towards a taxonomy

Titel	Status quo bias-perspective on user resistance in building information modeling adoption – Towards a taxonomy
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Table 30. Fact Sheet Paper 13

A status quo bias perspective on user resistance in Building Information Modeling adoption – Towards a taxonomy

Abstract. The architecture, engineering, and construction (AEC) industry is undergoing a rapid IT-based change due to the digital transformation, which comes with chances and challenges. Technologies and methodologies such as Building Information Modeling (BIM) are intended to assist in this regard and simplify processes. However, its use reveals barriers and reservation. We investigate the resistance towards using BIM, building on the status quo bias (SQB) perspective and the technology acceptance literature from Information Systems (IS) research. We develop a taxonomy that identifies SQB in BIM adoption. To this end, we run a quantitative study (n=155) in the architectural domain, which results indicate a strong resistance towards BIM and classifies different biases. Based on our taxonomy, we discuss valuable directions for future scientific work and provide initial recommendations for the AEC industry.

Keywords. User resistance; Building Information Modelling (BIM); Technology acceptance; Taxonomy; Status quo bias (SQB) perspective

19.1 Introduction

The architecture, engineering, and construction (AEC) industry is one of the main global industry sectors. At the same time, it is one of the main consumers of resources and energy [1]. Furthermore, it is expected to grow at about 85% until 2030 with a 4% annual growth between 2018 and 2023 [2], [3]. At this particular time, the industry is undergoing a rapid change, which is predominantly IT-based [4]–[6]. This comes with challenges in the traditional 'brick and mortar' sector [4], [7], [8]. The digital transformation of the companies in the AEC industry makes user adoption and resistance a relevant and interesting topic for research contextualized at the intersection between technology and people/organizations.

Data clearly shows that the digital potential in the AEC industry is not fully exploited [9], [10]: 93% of the stakeholders agree that digitization will affect every process of the industry. While 100% of the building material firms believe that they have not yet exhausted their digital potential, only less than 6% of construction companies make full use of digital planning tools [9]. A prior investigation of ours supports this tendency and shows that only 36% of the architects in Germany use BIM, although far more would be possible. The literature identified several challenges (e.g., financial, technical, organizational) that hinder the adoption of BIM [11]. These studies mainly take a rational-decision-making viewpoint. This perspective does not necessarily hold true in practice, where a more limited and bounded rationality is at play. While the literature examine various factors on the organizational level that challenge the exploitation of BIM, the work on biases in individual decision-making that hinder user acceptance is rare. Understanding the mechanisms of the decision-making can help to fully exploit the opportunities and potentials of BIM (e.g., digital collaboration). This seems crucial, because understanding the role of biases in individual decision-making is a key factor for understanding challenges on the organizational level.

People often rely on habitual decision-making and heuristics [12]. This may result in resistance towards new ideas, technologies, and methods, although change could be beneficial from a rational point of view. In specific, people often face cognitive biases which are systematic errors in the human decision-making, e.g., the status quo bias (SQB) [12]–[14]. The SQB is a broad and paradigm-like perspective, that integrates existing literature and well-known concepts from the bounded rationality paradigm in order to explain user resistance. Its theoretical and explanatory power is not yet examined in full range across industrial sectors [14]. There are several constructs (i.e., rational decision-making, cognitive misperception and psychological commitment) with have more than a dozen variables and items. While traditional models identified factors that influence technology acceptance, they oftentimes did not account for the users' cognitive biases. In addition, previous research has focused on cost-benefit analysis and has weaknesses in conceptualizing the various SQB constructs in this regard [14].

We want to contribute to existing literature by comparing the concepts of the SQB perspective and classifying the concepts towards BIM adoption in the application domain of architects. Against this background, we want to answer the following research question (RQ):

> *What are the individual biases based on the SQB perspective that determine irrational decision-making towards BIM adoption?*

To answer that RQ, we build a taxonomy to classify concepts that determine individual decision-making [15]. Related work provides a solid theoretical background based on

Technology Acceptance Models (TAM) and the SQB. Based on this, we reconceptualized the three concepts of SQB to provide a broad theoretical approach, which can be tested and compared. Subsequently, we conducted a study and followed the empirical-to-conceptual approach [15]. As a first step, we did two expert interviews to identify a preliminary scenario for the development of the model and the quantitative questionnaire. As a second step, the questionnaire was sent to architects in Germany (n=155) as they are a relevant representative in all phases of the life of buildings through their coordinating role and key role in designing the BIM-model [16]. Finally, we derived a taxonomy that identifies SQB in BIM adoption.

Consequently, our study will help research to identify and reconceptualize important concepts and SQB variables to better understand user resistance towards BIM. Accordingly, we will provide some interesting opportunities for further research and add a new facet to existing research. Our investigation provides important insights for the AEC industry to better implement new information systems, as the demand as well as the potential are huge.

19.2 Related Work

Building Information Modeling

Building Information Modeling (BIM) is under focus in the AEC industry [17]–[19]. Also, the research stream on BIM is a relevant topic for research in several disciplines. Especially, disciplines at the intersection of technology and people/organizations (e.g., information systems (IS) research) seem to be promising by providing a theoretical foundation for investigations [20]. For IS research, BIM is an important reference and has already gained attention in the literature [6]. There is various work on the design, construction, and management of facilities, which examines different factors of the adoption of BIM in the AEC industry [10], [19], [21]–[24]. However, most research examines factors that facilitate the adoption of BIM [10], [25]. Notably, research on resistance as well as on individual barriers or cognitive biases is rare [21].

Literature emphasizes the multifaceted challenges of BIM adoption and shows different perspectives [11]. For example, there are several financial challenges that affect BIM adoption [26]. Iterations in the design phase of a building must be meticulously integrated in the digital model. Otherwise, the model is worthless and does not correspond to reality. Complicating, customers are not always willing to pay for the added value. Additional effort and the coordination of the model creation and maintenance is another challenge. Additionally, there are several technical hurdles. For example, there are problems with data-interoperability [27]. For example, there are problems in data standards from 3-D measurement to integration of the data into the model [28] or from the model into further software application [29]. Organizational challenges and cultural barriers are another challenge [16]. One challenge to adoption of innovations in the AEC industry, such as BIM, is the missing intent to use new technologies, the lack of openness to change or willingness to learn.

Due to often insufficient information, the decisions are based on feelings and personal experiences rather than on data and facts [30]–[32]. Against this background the overarching question arises: Are decisions made rationally based on objective challenges and barriers or more irrationally based on heuristics? For example, the theory of irrationality sticking to the status quo "aims to explain people's preference for maintaining their current status or situation" [12, p. 569]. Even though psychological evidence has found that "irrational" thinking can be beneficial (e.g., by providing simple behavioral guidelines), we focus on challenges that arise from this. The SQB is a widely accepted approach in this regard that illustrates the tendency of a decision-maker to stick to an existing situation or decision [33]. Every decision has a status quo option that serves as an anchor for other alternatives and can influence the final decision.

Technology Acceptance

The acceptance of new information systems plays a major role for the successful implementation of IT artifacts [34]. Thus, in research, we find several models and theories which seek to explain user acceptance of technology. At the core of all these models (e.g., Theory of Reasoned Action (TRA), Theory of Planned Behaviour (TPB), Decomposed Theory of Planned Behaviour (DTPB), Technology Acceptance Model (TAM), Diffusion of Innovation Theory (DOI), Social Cognitive Theory (SCT), Model of Personal Computer Utilization (MPCU), Motivational Model (MM), Unified Theory of Acceptance and Use of Technology (UTAUT), and Extended Unified Theory of Acceptance and Use of Technology (UTAUT2) [34] is the Technology Acceptance Model

(TAM) [35]. TAM provides a justified theoretical basis and is a common and parsimonious foundation for IS research.

There are two main concepts that influence user acceptance towards a technology. The first one is the perceived usefulness of a system. Perceived usefulness is “the degree to which a person believes that using a particular system would enhance his or her job performance” [35, p. 320]. The second one is the perceived ease of use, which is defined as “the degree to which a person believes that using a particular system would be free of effort“ [35, p. 320]. Based on TAM, Venkatesh and Davis [36] developed TAM 2 as a theoretical extension by adding explaining variables such as social factors (i.e., subjective norm, voluntary nature, image) and cognitive instrumental processes (i.e., job relevance, output quality, result demonstrability, perceived ease of use) [36].

As the dependent variable of TAM is actual technology use, the explanation of technology resistance is not satisfactory with this model. Resistance can be multifaceted: The resistance to change is general, while the resistance towards innovation and disruptive ideas or the resistance to change to using a new information system are more specific [37].

While previous literature often neglects technology resistance, Lapointe and Rivard [38] identified four comprehensive studies: First, M. Lynne Markus [39]; second, Kailash Joshi [40]; third, George M. Marakas and Steven Hornik [41] and fourth Mark J. Martinko, Robert W. Zmud and John W. Henry [42]. Within these studies we can derive several theoretical insights. The context of use (e.g., the believe of having more power when using a system in the context of an organization) can cause resistance towards an artifact [39]. A process-oriented point of view can illustrate how individuals evaluate a new information system. When changing systems within their organization, they compare these changes with the actual status quo. Based on the comparison, the decision is evaluated [40]. An emotional approach was suggested in the model of passive resistance misuse that describes resistance as a passive-aggressive resistance response. The emotional response can be triggered by threats or stress [41]. Another perspective on technology resistance is offered in the attributional model of reactions. Here, an individual’s personal experience with success and failure when completing tasks that require using technologies will result in causal attributions [42].

Status Quo Bias

As human's decision-making is not purely rational, the architects' decisions about using technology are also influenced by cognitive biases. This mostly unconscious bounded rationality in decision-making and judgement can be defined as "case in which human cognition reliably produces representations that are systematically distorted compared to some aspect of objective reality" [43, p. 968]. The pivotal work on cognitive biases in IS research by Kim and Kankanhalli [12] identified the SQB theory as a missing part to explain user resistance to change and to new information systems. Based on this approach, we study the architects' decision-making. The origins of the approach by Kim and Kankanhalli [12] can be found in the work by Samuelson and Zeckhauser [44]. The SQB perspective entails three categories: rational decision-making, cognitive misperceptions, and psychological commitment. We will now describe them in more detail.

Rational decision-making describes the comparison of positive and negative effects of change (cost and benefit). Based on this assessment, an individual decides to change or not. Regarding costs, two types of costs are identified. First, transition costs correspond with the costs of switching to a new system. They can occur when architects evaluate the effort (monetary effort for buying licenses or the time effort for special training) to switch to a new system such as BIM. Second, uncertainty costs arise. When a user is missing knowledge or practical experience, she or he can feel unsure and may decide irrationally [12].

The cognitive misperception of loss aversion is another SQB category [44] consisting of loss aversion and anchoring. Loss aversion has been identified and introduced by Kahneman and Tversky [45] who found that people assess losses greater than gains. Another bias of cognitive misperception is the so-called anchoring effect. The actual assessment of a past situation (e.g., using a past construction system) will function as threshold for the evaluation of changing to a new system. Thus, the architects' efforts spent during the learning phase is seen as an anchor, which influences the assessment of the learning needed for the new system.

Psychological commitment is the third SQB category and includes three facets, namely sunk costs, social norms, and efforts to feel in control [44]. Sunk costs encompass previous commitments (e.g., financial investment, time), which cause aversion to switching the system [46]. Social norms encompass the dimension of the working environment. These environmental circumstances can influence decision-making [12]. For example, a partner's or a colleague's opinion – or even their perceived opinion – can influence the acceptance or resistance to change. Efforts to feel in control illustrate the users' wish to control and determine their life at work [12]. Due to the fear of losing control and overview, people often remain in the current situation and prefer the status quo.

19.3 Research Approach

Methodology

To answer our RQ, we identify the key characteristics of SQB in relation to user resistance to BIM. Our research is guided by the work of Nickerson et al. [15]. We build a taxonomy by using their conceptual-to-empirical approach and iterate an empirical-to-conceptual approach. Related work determines the (1) meta-characteristics and (2) end conditions for the development of the taxonomy. The taxonomy is intended to allow the identification of a potentially irrational decision-making to BIM adoption. This allows us to recommend specific actions to be taken after detecting irrationally. Irrational decision-making can have both advantages and disadvantages (see Section Building Information Modelling; conceptual-to-empirical). Despite the solid theoretical foundation, we over empirical evidence (empirical-to-conceptual). We discuss the findings of a nationwide survey (n=155) that allowed us to identify common characteristics. Finally, we create the taxonomy after revising the SQB dimensions and characteristics.

Problem Identification

The resistance to use technology is an important factor in the AEC industry that needs to be investigated with a theoretical foundation. As a part of this theoretical investigation, the SQB categories are examined in the context of resistance to technologies among architects. Architects often face new technologies with skepticism (a cognitive barrier), fearing or even worrying from the outset that they will lose control and be replaced. Against this background, instead of the desired advantages, many disadvantages arise. To broaden and deepen our understanding of how this downward spiral of constraints can be prevented, we base our research model on the existing literature and adapt it to the context of architects. Our work provides a holistic view of the architects' behavior toward using new technologies. It aims to extend theory and to derive useful recommendations for action. Our approach is based on the SQB perspective by Kim and Kankanhalli [12]. Next, we follow the model of Müller et al. [47] who examined the SQB perspective in health care. Also, we build on the work in the public sector [48], [49] that included a fourth SQB category, namely organizational support. The theoretical model is presented in Figure 38.

The first category - rational decision-making - originally consists of two variables according to Kim and Kankanhalli [12]: uncertainty costs and transition costs. Müller et al. [47] extended the two variables by two more factors to obtain a more holistic view. Perceived value explains the usefulness of the system and whether it is evaluated as high or low. Switching benefits relate to the occurring value when switching to a new system.

In category two - cognitive perception - two variables are present. The first one is loss aversion, because people weigh losses higher than gains [45]. The second one is the anchoring effect, which is determined by the experience of using past systems.

In category three – psychological commitment – two variables are present. According to Müller et al. [47], we include sunk costs and the efforts to feel in control. Sunk costs tempt user resistance because people do not want to give up their previous investments. Efforts to feel in control explain the users' wish to control and determine their life [12].

The fourth category – organizational and social influence – consists of four variables: Colleague opinion, management as a role model, organizational support, and perceived value for others. First, colleague opinion is the influence of the opinion of colleagues as well as of higher-ranking employees such as managers. Second, management as a role model is the act of being an example by more high-ranking people. Third, organizational support is defined as the "perceived facilitation provided by the organization to make user's adaption to new IS-related change easier" [12, p. 573]. Fourth, we include the perceived value for others. As Müller et al. [47] integrated that variable based on the relationship between physician, patient, and the system, we suggest to include it, too, because it reflects the important relationship between the architect, the client or the end-user and the system.

In addition, we added several control variables in order to investigate possible alternatives to explain the user resistance. These control variables are self-efficacy, experience to use technologies during work, personnel responsibility, ranking within the organization, duration of work and demographic data (e.g., age and gender).

Hypothesis

Based on SQB perspective, we derived our research model. We now want to identify individual biases as potential dimensions of our taxonomy that determine user resistance towards BIM. Therefore, we generate hypothesis that help to examine the individual biases. Furthermore, our taxonomy development is embedded in an iterative process guided by the work of Nickerson et al. [15]. We first start to conceptualize the different biases (conceptual-to-empirical), as there is already a lot of information on SQB [15].

Rational decision-making. Switching from one system to another causes switching benefits [12]. However, when perceived individual performance increases, user resistance decreases. That may occur, when the architect obtains the complete values and surface sizes of all interior walls by a simple button-press. Transition costs occur during or after an implementation of a new information system [12] ,[44]. Uncertainty costs occur in situations in which people feel incompetent and uncertain [50]. Thus, if an architect subconsciously suspects such a uncomfortable situation, she or he will probably prefer to stick to the status quo. Perceived value is the evaluation of the relative costs and perceived benefits of the change. If people asses the value of change as high, they tend to use the new technology and conversely will show low resistance [44]. In terms of the taxonomy, the concept of rational decision-making allows to identify individual biases towards decision-making under uncertainty and without full information about costs and benefits.

> *Hypothesis 1: Rational decision-making has a negative relation to user resistance.*
>
> *Hypothesis 1.1: Switching benefits have a negative relation to user resistance.*
>
> *Hypothesis 1.2: Transition costs have a negative relation to user resistance.*

Hypothesis 1.3: Uncertainty costs have a negative relation to user resistance.

Hypothesis 1.4: Perceived value has a negative relation to user resistance.

Cognitive misperception. People asses their situation according to past experiences [14]. They minimize losses [45], as they weigh them higher than gains. Even small losses are perceived to be greater than they actually are. When implementing a technology, people tend to draw on their memories and knowledge to evaluate the implication of a new technology. They build up expectations in advance [14]. In terms of the taxonomy, the concept of cognitive misperception allows to identify individual biases where individuals perceive losses greater than gains.

Hypothesis 2: Cognitive misperception has a negative relation to user resistance.

Hypothesis 2.1: Loss aversion has a negative relation to user resistance.

Hypothesis 2.2: Setting pleasant anchors has a negative relation to user resistance.

Psychological commitment. Investments that architects have already made (sunk costs) influence their resistance to use a new technology especially as they want to know whether to change and invest or not (effort to feel in control) [51]. People do not want to make wrong investments [44]. In terms of the taxonomy, the concept of psychological commitment allows to identify individual biases based on effort that individuals have put into systems and therefore decide irrational towards using it.

Hypothesis 3: Psychological commitment has a negative relation to user resistance.

Hypothesis 3.1: Effort to feel in control has a negative relation to user resistance.

Hypothesis 3.2: Sunk costs have a negative relation to user resistance.

Organizational and social norms. Based on the qualitative findings obtained in our study, we depart from Kim and Kankanhalli [12] and expect organizational and social influence. The resources provided by the organization can help to make change easier.

Furthermore, we know that change requires guidance and resources [52]. As the support from the organization increases, the users' resistance may decrease. Moreover, the role of management is important. Literature shows that management can influence the ease of using technology [53]. A supervisor (e.g., group-leader or senior employee) can act as a role model. If the management uses a new system, the probability of resistance to the new system by the employees often decreases. On top of that, as the colleagues' opinion is defined as the perceived support from colleagues in order to change and since we know that social companionship is a salient influence at work [53], we suggest that a positive colleague opinion may reduce user resistance. In addition, we introduce perceived value for others as the effect of one's work for others may be a factor for user resistance. We suggest that the resistance to use a technology decreases when an architect assumes a positive effect of using a system for others. In terms of the taxonomy, the concept of organizational and social norms allows to identify individual biases which are based on different aspects based on the social environment.

Hypothesis 4: Social norms have a negative relation to user resistance.

Hypothesis 4.1: Organizational support has a negative relation to user resistance.

Hypothesis 4.2: Management acting as role model has a negative relation to user resistance.

Hypothesis 4.3: Colleague opinion has a negative relation to user resistance.

Hypothesis 4.4: Perceived value for others has a negative relation to user resistance.

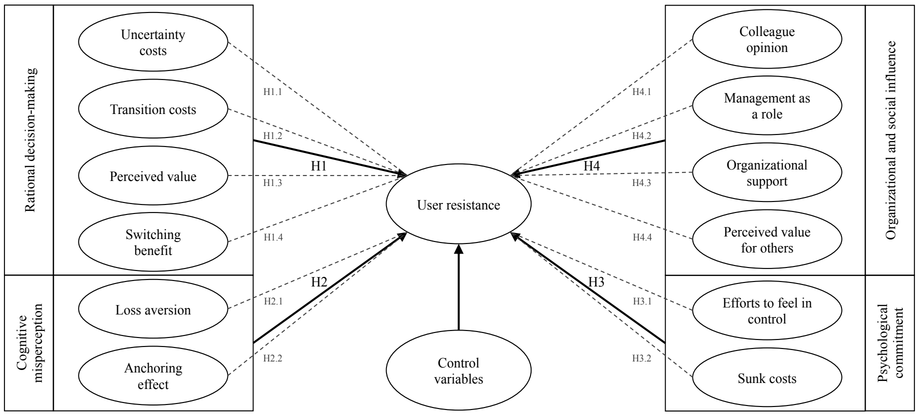

Figure 38. Research Model

19.4 Towards a Taxonomy

In this step, we present a survey (conceptual-to-empirical) to identify common *characteristics and group objects* [15] in our application domain (i.e., architects). We conduct the survey and analyze the statistical data to identify these characteristics (i.e., the SQB). Then, we empirically test our hypothesis that were derived in Section 3.3.

Quantitative Questionnaire Study

Data collection. We collected data from 450 architects via the web application Uni-park. The email with the link was sent to architects in Germany. 155 responses were fully completed and valid (i.e., a correct answer to the control question “please tick strongly agree”).

Representativeness and data analysis. We used IBM SPSS Statistics 26.0 for the descriptive data analysis. For drawing statistical inferences, we used the R package “stats” [54]. We tested the sample on representativeness with respect to demographic variables. No significant differences could be found. The average age was between 40 and 44 years (M = 5,55, SD = 0,906). Most of the participants identified as female (female = 79 (50,3%); males = 38 (24,2%); no answer = 38 (24,2%)). In addition, most of the participants did not use BIM (yes = 57 (36,3%); no = 93 (59,2%); no answer = 5 (3,2%)). Most were CEOs or owners (87) followed by project-leaders (35), and project staff (14) and department heads (13). We tested four different models using multiple linear regression. In this context, we transformed demographic variables into dummy variables [55] and adjusted the significance levels of the regression coefficients by using

Bonferroni correction [56]. Table 1 depicts a summary of the results including R-square values and F-statistics. For each model, we estimated the regression coefficients of the included variables, alongside with their significance level and standard error (in brackets).

Model comparison. Based on the research model, we constructed different models to statistically investigate user resistance based on rational decision-making (RDM), cognitive misperception (CM), psychological commitment (PC), organizational and social influence (OSI), and the control variables (CV). In a first step, we tested model 1 (CV). Then we examined the four second order constructs RDM, CM, PC, and OSI. In a third step, we investigated the RDM in model 3 and PC in model 4 separately as they showed significant results (see Table 1). Model 1 was constructed by the control variables (CV), which were BIM usage, position, and demographic characteristics. For model 1, only specific demographic characteristics reached an appropriate significance level. Besides the variable BIM usage, the position of the architect predicts the resistance towards BIM. As BIM usage is only a control for the overall theoretical approach, the variable is not further considered in the taxonomy because of redundance of the logic. Still, position is considered an important dimension for our taxonomy. Model 2 included the four different SQB categories that we conceptualized in Section 3.3 (SQB). Model 2 included the second order constructs of all involved biases, namely rational decision-making, cognitive misperception, psychological commitment, and organizational and social influence. Notably, only rational decision-making and psychological commitment reached appropriate significance levels. We therefore decided to exclude cognitive misperception and organizational and social influence in our taxonomy. We further decided that we construct two more models where we further investigate RDM and PC. Model 3 (RDM) was constructed by uncertainty costs, transition costs, perceived value, and switching benefits. Interestingly, only uncertainty costs appear to have an significant impact on user resistance. Therefore, we excluded transition costs, perceived value, and switching benefits from the taxonomy. Model 4 (PC) was constructed of efforts to feel in control and sunk cost. It only contained one significant variable, namely sunk costs. As a result, we only considered sunk costs in our taxonomy.

All models reached highly significant F-values, meaning that all of them obtained validity to be assigned to the basic population. The results are shown in Table 31. As models 2 and 3 reached the highest coefficients of determination, they appear to be most promising for future work.

Predictor variables	Model 1 (CV)	Model 2 (SQB)	Model 3 (RDM)	Model 4 (PC)
Intercept	4.59*** (1.36)	3.77*** (0.93)	2.25*** (0.48)	.0.10 (0.57)
Using BIM (2)	0.94*** (0.23)	0.32 (0.19)	0.27 (0.19)	0.51 (0.21)
Position (5)	2.31*** (0.71)	0.92 (0.53)	1.27 (0.51)	1.03 (0.59)
Rational decision-making (RDM)		-0.48*** (0.09)		
Cognitive misperception (CM)		-0.13 (0.10)		
Psychological commitment (PC)		0.40*** (0.09)		
Organizational and social influence (OSI)		-0.14 (0.11)		
Uncertainty costs			0.36*** (0.06)	
Transition costs			0.12 (0.07)	
Perceived value			-0.21 (0.10)	
Switching benefits			-0.13 (0.09)	
Efforts to feel in control				0.24 (0.10)
Sunk costs				0.33*** (0.05)
R2	0.299	0.524	0.531	0.396

R2 adjusted	0.201	0.491	0.499	0.363
F-statistic	3.039***	15.85***	16.32***	11.98***

Table 31. Data Analysis

Based on the findings, we accepted the hypotheses H1, H1.3, H3 and H3.2 (see Table 32. Overview of the Hypotheses and Results

).

Results		Hypothesis Acceptance
H1	High rational decision-making → (-) User resistance	yes
H1.1	High switching benefits → (-) User resistance	no
H1.2	Low transition costs → (-) User resistance	no
H1.3	Low uncertainty costs → (-) User resistance	yes
H1.4	A high perceived value → (-) User resistance	no
H2	Low cognitive misperception → (-) User resistance	no
H3	Low psychological commitment → (-) User resistance	yes
H3.1	Low effort to feel in control → (-) User resistance	no
H3.2	Low perception of sunk costs → (-) User resistance	yes
H4	High value in social norms → (-) User resistance	no

Table 32. Overview of the Hypotheses and Results

19.5 Taxonomy

Our taxonomy shows the user resistance of architects (Figure 39). Still, it is only a first step towards a complete taxonomy. The second column "e.g., Engineers" illustrates that our taxonomy can also applied to other jobs in future research. In the literature, three dimensions are repeatedly pointed out in relation to BIM adoption: the technical, the financial and the organizational dimension. The two dimensions, technical and financial, have already been extensively explored. The organizational/cultural dimension has also already been studied in detail. Now, our study provides insights to irrational decision-making on the individual level. It is based on empirical findings and offers a preliminary framework for further research. The greyed-out boxes indicate our own research, the so-called irrational cultural dimension, which can be divided into five categories: position, rational decision-making, psychological commitment, uncertainty costs and sunk costs.

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="3">User resistence</td></tr>
<tr><td colspan="2">Architects</td><td>e.g. Engineers</td></tr>
<tr><td rowspan="8">Dimension for barriers of BIM adoption</td><td>Technical</td><td colspan="2">e.g. data-interoperability (Shehzad et al. 2021)</td><td rowspan="8">…</td></tr>
<tr><td>Financial</td><td colspan="2">e.g. Unclear roles (Becerik-Gerber et al. 2012) or no client demand (Heaton et al. 2019)</td></tr>
<tr><td rowspan="6">Cultural</td><td colspan="2">Rational: e.g. no time for training or lack of legal framework(Becerik-Gerber et al. 2012)</td></tr>
<tr><td rowspan="5">Irrational</td><td>Position</td></tr>
<tr><td>Rational decision-making</td></tr>
<tr><td>Psychological commitment</td></tr>
<tr><td>Uncertainty costs</td></tr>
<tr><td>Sunk costs</td></tr>
</table>

Figure 39. Taxonomy

19.6 Discussion

Findings

We contribute to literature by identifying and classifying the challenges on an individual level. In order to answer our RQ (*"What are the individual biases based on the SQB perspective that determine irrational decision-making towards BIM adoption?"*), we present an empirical-to-conceptual approach for taxonomy building, which is based on the SQB perspective to classify the antecedents for user resistance. It is remarkable that 59% of the participants do not use BIM. This underlines the importance of our work. We explored the different categories of the SQB perspective and highlighted two main antecedents for user resistance: rational decision-making (uncertainty costs) and psychological commitment (sunk costs). Thus, the answer to our RQ is as follows: First, sunk costs are a meaningful factor for user resistance, because they tempt user resistance. The architects' psychological commitment can hinder their acceptance to use BIM, because they do not want to give up previous investments. Second, uncertainty costs are another important factor for user resistance. The architects can struggle to make rational decisions under uncertainty in their complex and ambiguous working lives.

Implications for Practice

User resistance towards BIM needs to be taken seriously in the AEC industry. Preventing irrational user resistance and exploiting the full potential of new technologies in the domain is desirable. First, that can be achieved by considering the meaningful predictor of uncertainty costs. Architects seem to lack knowledge or practical experience [48]. The bias can be reduced by providing more information about future trends and use experiences.

Second, sunk costs are another factor for user resistance. The psychological commitment towards systems already in use seems to be high. The potential change can make users shy away from change [48]. People often do not want to give up their previous investments, such as the effort and time already spent in the past. Therefore, new software should be easy to learn, and the change should actively address the disadvantages of the old system. Special training in an early phase of the implementation can help to show the advantages and make the transition. The efforts need to be as low as possible for the user so that he or she considers the advantages.

Third, organizational support and colleague opinion help to reduce resistance. The opinion of colleagues plays an important role in the decision-making process. Good, positive relationships between colleagues who support and help each other can change the mindset toward the technology in a positive way. Personal exchange with each other and the actual sharing of experiences can reduce resistance. Organizations can strategically design interventions to reduce sunk costs. For instance, a construction firm can help to make the change easy and support education. The professional chambers of architects and engineers should actively support the members by offering clarification and personal exchange.

All in all, when developing new tools or when improving programs, software companies should consider user resistance when designing products. The user resistance can be avoided or kept low by design, when companies consider a smooth transition from an old to a new technology. When people notice that something new does not work as it should, they can develop resistance. Software developers can prevent this with good service and support. They should be involved at an early stage.

Limitations

Our study has several limitations. First, we examined architects in the AEC industry in Germany. This results in the two shortcomings. On the one hand, we only looked at architects as one illustrative domain of the AEC industry, and on the other hand, we only studied a sample in Germany. This helped us to contextualize our research. However, further research could, for example, transfer our findings to other countries or extend our research to other domains such as civil engineers. Thus, the generalization in other professions and sectors needs to be assessed. Nevertheless, our taxonomy is a promising first step and paves the way for further investigation. Additionally, the proposed taxonomy of user resistance is only a preliminary approach and needs to be further generalized and iterated. On top of that, in a multidisciplinary and fast changing environment like the AEC industry, there are various additional factors that can influence user resistance in the coming months. Future research can address this by exploring more factors and characteristics. Finally, our findings are based on self-reports which comes with weaknesses (e.g., social desirability). Thus, we encourage the triangulation of data.

19.7 Conclusion

User resistance plays an essential role in implementing new technologies and methodologies in organizations. It is more important than ever to understand the critical drivers of resistance to these technologies and the barriers for their adoption. Our work presents a first step towards a taxonomy that helps to identify distinct factors for user resistance towards BIM from an SQB perspective. We contribute to existing literature by identifying and classifying challenges on an individual level. Using an empirical-to-conceptual approach to come up with a taxonomy, we were able to identify the key variables that influence resistance to BIM in the AEC industry and point to promising interventions. Rational decision-making (uncertainty costs) and psychological commitment (sunk costs) are the two main factors that correlate with resistance towards using this new information system. Because bounded rationality evidently plays a key role, future work is invited to take cognitive biases into account in following investigations. With our findings in mind, future work is offered a promising way to derive additional strategies to address resistance to new technologies and change in the domain.

19.8 References

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20 Paper 14: One Size Does Not Fit All – Towards a Taxonomy for Individualized Stimuli in Creativity Support Systems

Titel	One Size Does Not Fit All – Towards a Taxonomy for Individualized Stimuli in Creativity Support Systems
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Table 33. Fact Sheet Paper 14

One Size Does Not Fit All – Towards a Taxonomy for Individualized Stimuli in Creativity Support Systems

Abstract. The literature on creativity support systems (CSS) suggests that creative work may be promoted by providing stimuli that are related to the task in different degrees. It is important to note that the perception of stimulus relatedness is subjective. However, few studies have addressed individual differences in perceived stimulus relatedness. Accordingly, little is known about how we can provide individualized stimuli for supporting creative work. In this study, we obtained computationally derived concepts of different levels of stimulus relatedness and had 202 people evaluate the stimulus relatedness. We studied the relationships between the participants' individual characteristics and whether they overestimated or underestimated stimulus relatedness. The participants were clustered based on these considerations. We followed a Design Science Research (DSR) approach that provides methodological guidance. The taxonomy developed in the paper shows that different types (i.e., four archetypes) of user groups exist. Our results help develop a better understanding of the design of context related stimuli in CSS.

Keywords. Creativity; Creativity Support Systems (CSS); Creativity stimulation; Design Science Research (DSR); Taxonomy

20.1 Introduction

Creativity has been a key driver of the success of organizations and the human civilization in general. New customer needs, digital transformation of the environment and organization itself, as well as external influences like the pandemic, are just a few challenges for organizations, where creative problem solving is essential. Creative solutions, however, rarely fall out of the blue. Some stimuli may help innovators find solutions, for example, an apple falling from a tree is said to be an inspiration for Sir Issac Newton in deriving his theory of gravity. Research also backs this idea of promoting individuals' creativity with stimuli (Althuizen & Reichel, 2016; Müller-Wienbergen et al., 2011; Santanen et al., 2004; Wang & Nickerson, 2017, 2019). Therefore, it makes sense to support deliberate processes with tools such as Creativity Support Systems (CSS) to foster creative output.

CSS are systems capable of interacting with users and enhancing creative output (Muller & Ulrich, 2013; Wang & Nickerson, 2017). There are different approaches and classifications of CSS. They can support individuals or groups (Seidel et al., 2010), support the creative process and guide people through different stages (Couger et al., 1993; Elam & Mead, 1990), support people with priming to enter cognitive conditions (Minas & Dennis, 2019), or support people by delivering context-related stimuli and thus enhance the knowledge base in order to widen the problem and/or solution space (Müller-Wienbergen et al., 2011; Wang & Nickerson, 2019). Delivering context-related stimuli is a promising and interesting approach and opens a variety of opportunities to design algorithms that enhance creative thinking – "It is clear that creativity support systems need algorithms that are cautious and selective in identifying stimuli for supporting creative work." (Wang & Nickerson, 2019, p. 1285). Against this background, delivering context-related stimuli to individuals to enhance creative work is promising (Althuizen & Reichel, 2016; Wang & Nickerson, 2019) as original and novel ideas more likely emerge when two or more disparate things are linked - "creativity typically emerges from discovering new associations between previously disparate things" (Müller-Wienbergen et al., 2011, p. 719). Therefore, it is important to activate relevant knowledge and stimuli can help to activate such knowledge (Santanen et al., 2004) that can be used to generate new and useful ideas.

The relatedness of such a stimulus towards a creative task is an important characteristic and indicates the distance between the stimulus and the task (Santanen et al., 2004). In this context, we define two different perspectives on relatedness; individually perceived relatedness "as an inherent cognitive structure of concepts by an individual" and computationally-determined relatedness "as computationally extracted concept structure" in line with Klein et al. (2020). While prior research stressed the importance of unrelated stimuli to create new and useful ideas, some studies also reported more related stimuli as beneficial. Empirical evidence supports both (Althuizen & Wierenga, 2014; Fu et al., 2013; Klein et al., 2020; Wang & Nickerson, 2019). The mixed empirical findings are problematic as knowledge activated by a stimulus can also be harmful depending on the task (e.g., yielding fixation) (Fu et al., 2013).

Furthermore, research stresses also the importance of individual and personal characteristics like experience or knowledge and their relation to creativity (e.g., Briggs & Reinig, 2010). To come back to the example of Sir Isaac Newton - the apple would certainly not have stimulated everyone. This is also in line with theoretical underpinnings (e.g., the cognitive network model) from which we know that cognition is highly individual. This allows the assumption that perceived stimulus relatedness is also individual, which has empirical support (Klein et al., 2020). Since manually finding stimuli tends to be slow and biased, computational methods should be developed to search stimuli of different level of relatedness. While such computational approaches are very promising (Wang and Nickerson, 2019), so far there are no methods to take individual differences into account, which leaves great room for improvement. Ideally CSS should be able to computationally search stimuli and provide individualized stimuli. To reach this goal, we need knowledge about what variables contribute to a different perception of stimulus relatedness, as well as algorithms that take this into account and identify individualized stimuli.

This research aims to explore the variance in *individually perceived relatedness* of *computationally derived stimuli* to inform the design of context-related stimuli provider. A good understanding of how individual perception of relatedness varies based on individual differences is critical. Considering that the current understanding of *computationally derived stimuli* and *individually perceived relatedness* is limited, we propose the following research question (RQ):

> *What are some individual characteristics that affect the perceived relatedness among computationally derived concepts?*

To answer the RQ, we designed and evaluated a taxonomy. Our taxonomy was designed based on the Design Science Research (DSR) approaches by Nickerson et al. (2013) and Kundisch et al. (2021). We followed a conceptual-to-empirical approach and iterated an empirical-to-conceptual cycle. Thereby, we contribute to the research stream in creativity support systems in two ways. First, even though computational methods can be used to find stimuli of different levels of relatedness, we show that perceived stimulus relatedness is dependent on individual characteristics. Second, we identify user groups, which enables context-related stimuli to be individualized and optimized. This normatively affects critical design variables in CSS. In summary, our findings help to individualize tools, methods, and skills for enhancing creative outcomes.

20.2 Background and Motivation

Creativity and Human Memory

Generally, creativity describes the creation of useful and novel ideas (Althuizen & Reichel, 2016; Althuizen & Wierenga, 2014). To achieve a creative idea, it is thus of importance to combine existent knowledge in new meaningful ways. External stimuli, in this regard, can help to activate knowledge and enable new combinations that lead to creative ideas. This process, however, relies on cognitive processes in the human memory. In the human memory, we can distinguish between working memory (WM) and long term memory (LTM) (Baddeley, 1997). The WM has a limited capacity to process knowledge and information and the LTM stores knowledge and experiences over time (Santanen et al., 2004). From a process perspective, ideation is considered a two-step process (Nijstad & Stroebe, 2006). First, knowledge is activated in the WM and loaded from the LTM into the WM. Second, once activated, the knowledge is processed in the WM. Combining two before unconnected items can lead to new ideas. The two step-process is iterative, and a new idea again can activate new knowledge (frames) from the LTM into the WM. This can be an open-ended process. We understand the LTM as the basis (i.e., saved items organized in frames) from which an individual derives the perceived relatedness of a stimulus (Santanen et al., 2004).

The cognitive network model (CNM) explains the organization of knowledge and experiences in the LTM (Santanen et al., 2004). According to the CNM knowledge is organized in groups for the sake of better access and efficiency of cognitive resources, which means that items (e.g., apple, blanket, meadow, or basket) are organized in frames (e.g., picnic). The framing of different items is based on mainly three principles: (a) Items can be framed based on time, (b) Items can be framed based semantic principles (meaning of an item), (c) Items can be framed based on diversity (how similar or unsimilar is an item). Frames and items of frames are organized in a network, which links all the knowledge and experience in an efficient manner and for better accessibility (Santanen et al., 1999). The CNM refers “to these bundles as frames and assume[s] that the frame, rather than the discrete items within each frame, is the basic unit of knowledge that we store and manipulate in our memory” (Santanen et al., 1999, p. 2). Frames and items are not mutually exclusive and one item can be part of several frames (Collins &

Loftus, 1975) and one frame can be part of another frame or have various forms of items. The items and frames are highly interconnected, and another important characteristic of the model is the strength of the links, which explains the quality of accessibility. That leads to the fact that knowledge in LTM is not equally well accessible. The links and their strength are variable and the strength of links various based for example on habit and time. Meaning that items which are often activated are more easily accessible and that items which have been recently activated are also more easily accessible. Conversely, items and frames that have not been activated often or not been activated for a long time are less likely accessible. Hence, external stimuli can help to activate knowledge and stimulate idea generation.

Talking about stimulating idea generation, there are two further theories which can help to understand the implication of stimuli, namely the Search of Associative Memory theory (SAM) (Raaijmakers & Shiffrin, 1981) and Adaptive Control of Thought (ACT) (Anderson et al., 2004). SAM states that once a kernel concept is activated in WM, people automatically start to search for useful association (Raaijmakers & Shiffrin, 1981). Both a stimulus and the task information can be used a starting point for the search cues in the LTM. Highly connected, and closely related stimuli are more likely activated. If the evaluation of the activated frames or items seems to be promising it is progressed in the WM. If not, new search cues are activated in the LTM. ACT states that there is a steady level of activation (Anderson et al., 2004), which ensures the searching process for frames. External stimuli can enhance the steady searching process and based on the strength and relatedness a stimulus will activate other frames.

The Role of Relatedness of Stimuli

Based on the previous assumptions, theories assume a positive effect of stimuli in idea generation. However, studies show a nuanced view on the role of relatedness and effect on creativity. For example, remote stimuli can have a positive effect on creativity (Chan et al., 2011; Chiu & Shu, 2012), which is explained by the effect that remote stimuli decrease a narrow focus (Wang & Nickerson, 2019). However, there are also studies that challenge these findings. For instance, also moderately distant stimuli can help to create useful ideas and too remote stimuli may be harmful (Fu et al., 2013). Furthermore, as already mentioned, these different results also ground on the fact that different approaches of determining relatedness of stimuli have been used, which causes inconsistency. Starting from different approaches of collecting stimuli (e.g., manually by Berg, 2014 or E. L. Santanen et al., 2004) to different levels of differentiation regarding the relatedness degree (e.g., differentiation between unrelated and remote stimuli is infrequent) (Fu et al., 2013). This may result in different empirical outcomes. In this regard, Wang and Nickerson (2019) provided important foundations for objectifying stimuli relatedness by defining it on the linked data structure of Wikipedia.

However, the CNM as well as empirical findings (Klein et al., 2020) suggest that cognitive structures are highly individual. Results show, for example, group differences in the rating of relatedness based on gender and the stimuli (Klein et al., 2020). While Wikipedia is a solid approach to the general definition of computationally determined relatedness, the approach may fail to define individually perceived relatedness, since Wikipedia articles or the knowledge of some authors does not reflect the totality, which paves the way for our research to account for individual variables that influence individually perceived relatedness. Such research may enable the delivery of stimuli in desired ways in the effort to promote creative outcome.

Relatedness of Stimuli and the Dual Pathway Model

There are two different ways to generate creative ideas (i.e., being flexible versus persistent) which are affected by the relatedness of stimuli (Althuizen & Reichel, 2016; Baas et al., 2013; De Dreu et al., 2008; Lucas & Nordgren, 2015; Nijstad et al., 2010). The flexibility pathway can be defined as the number of different categories in which one search for ideas. Flexibility is a cognitive process and a precursor of the production of many and original responses. Therefore, this path is a search process for the breadth of more categories. In turn, persistence can be defined as the number of ideas in a category. Hence, this path is a search process for depth in one category. Thus, examining idea categories help to identify which pathway is used and which individual cognitive processes are used (De Dreu et al., 2008). In addition, the choice of the pathway can be influenced (Minas & Dennis, 2019).

The flexibility pathway and its characteristics can be explained as broad and inclusive cognitive process (Nijstad et al., 2010). One uses different categories or frames in a flexible manner and switches easily between them. The frames that are associated and progressed in the WM - and loaded from LTM - are remote rather than close associations (Amabile, 1988; Nijstad et al., 2010). The attentional focus can be defined as broad. This thinking style is associated with results that are *out of the box* and helps to overcome fixation. We define fixation as the inability to overcome a bias in the representation of a situation by transferring knowledge from prior experience in an inappropriate manner (Dong & Sarkar, 2011). The persistence pathway and its characteristics can be explained as systematic and effortful cognitive process (Nijstad et al., 2010). One does not easily switch between different categories or frames but does explore different possibilities within one category or frame. The content that is loaded into WM is closer and related to the focal point of attention. The searching process is incremental (Newell & Simon, 1972; Simonton, 2018). The first ideas seem not very *out of the box*. They seem to be obvious and conventional. To achieve useful and original ideas it needs persistent and hard work.

Stimuli in general foster an exploration of the idea space. Based on the relatedness of stimuli, they foster a more flexible or persistent exploration of ideas. It is assumed the more unrelated stimuli are the more likely they will trigger a broader thinking style (i.e., the flexible pathway) and support loading different content from LTM into WM. Conversely, the more related stimuli are the more likely they will trigger a narrow thinking style (i.e., the persistence pathway) and support the content that is already loaded into WM and support the progress of the content (Althuizen & Reichel, 2016). Therefore, whether the ideation is more persistent or more flexible can be influenced by the relatedness of the stimuli. The persistent pathway and related stimuli are associated with each other, and the flexible pathway and unrelated stimuli are associated with each other. This makes it possible to design the relatedness of the stimuli to influence on the individuals' creative process.

20.3 Research Method

Procedure

Our method to build and evaluate a taxonomy is guided by previous work (Kundisch et al., 2021; Nickerson et al., 2013) of taxonomy development in the DSR paradigm. We agree with these approaches that it is a DSR-endeavor, and we develop (build) and test (evaluate) a taxonomy. In the field of information systems taxonomies are defined as theoretical artifacts (Gregor, 2006).

To address the research question our design is guided by the process-model according to Nickerson (2013). A taxonomy is a set of "*n* dimensions $D_i(i = 1, \dots, n)$ each consisting of k_i $(i >= 2)$ mutually exclusive and collectively exhaustive characteristics C_{ij} $(j = 1, \dots, k_i)$ such that each object under consideration has one and only one C_{ij} for each stated D_i" (Nickerson et al., 2013, p. 340). Accordingly, we iteratively derive dimensions based on theoretical and conceptual based underpinnings, which are relevant for perceived relatedness and define characteristics for the dimensions, which allow through the mutual exclusive restriction that every object (individual) has only one characteristic in a dimension (Nickerson et al., 2013). We understand our taxonomy development as a search process (Hevner et al., 2004) and want to develop a useful taxonomy. We follow Nickerson (2013) and Kundish (2021) and explore effective and useful classifications that allow further adaptations.

Regarding the methodological requirements, we are aware that an optimal solution cannot be the goal as "the search for the best, or optimal, design is often intractable for realistic information systems problems" (Hevner et al., 2004, p. 88). In our case, it means that we do not enable the optimal and best possible adaptation. Our goal is that we can enable an adaptation through the taxonomy that enables an improvement in the *fit* of *perceived relatedness* and the distance of the stimuli defined according to the computational approach (i.e., *relatedness fit*) across all individuals by understanding how relatedness of stimuli is perceived on certain characteristics that have been associated with individuals' creativity. Hence, the *fit* describes whether a CSS should provide rather more closely related or more remotely related stimuli to reach the desired effect. Iterations are part of the process-model and in our case, we follow the conceptual-to-empirical approach and iterate another empirical-to-conceptual approach. While we described the problem space in the previous section, we describe the requirements for the solution space (see e.g., vom Brocke et al., 2020) in the following two subsections (i.e., meta-characteristics and ending conditions).

Meta-characteristics

Our objects under consideration are the different perspectives on relatedness. Here we refer to *computationally determined relatedness*, *individually perceived relatedness*, and the *fit* between both. As mentioned before, it is important to have an adequate *relatedness fit* to reach the desired effect of a stimulus and to avoid normatively undesirable side effects. Therefore, we define our meta-characteristic of the taxonomy as (1) a taxonomy that allows us to identify individualized stimuli-relatedness based on specific user group characteristics to enable a better fit between computational and individually perceived relatedness by matching computationally determined relatedness to individually perceived relatedness of different user groups. That is a first step towards individualized stimuli-relatedness in a CSS.

Ending Conditions and Evaluation Goals

The purpose of our taxonomy is to identify characteristics that allow CSS designers to better adapt *computationally determined relatedness* in form of correcting or calibrating the existing approaches. There exist different *computationally determined relatedness* approaches with different definitions of relatedness based on technical properties. The taxonomy will help to classify their characteristics.

It would be not very helpful for CSS designers to have too many different objectives (i.e., user groups) to differentiate. The granularity should not make a distinct statement between every user. In the sense of a theoretical contribution (Gregor, 2006) it should be possible to make generalized statements based on the taxonomy that allow to establish a r*elatedness fit* for each user of the CSS that is at least as good as without the taxonomy and to establish a *relatedness fit* across all users that is at least better than achieved by the computationally determined relatedness approaches so far.

The taxonomy should allow the assignment of a CSS user, which happens based on variables related to individual differences. After the assignment, it should be possible to create a *relatedness fit* in the algorithm that is better than the baseline (i.e., the previous computationally determined relatedness approach) by adjustment (calibration or correction). The adaptation should be based on objects and their unique characteristics.

20.4 Taxonomy Development

The development of a taxonomy is an iterative process. When developing it, one must choose between the conceptual-to-empirical and the empirical-to-conceptual approach for every iteration (Nickerson et al. 2013). The conceptual-to-empirical approach is recommended if the researchers are already familiar with the domain of interest. Building on our theoretical background, we first chose this approach to derive the initial dimensions and characteristics of the taxonomy.

Conceptual-to-empirical Approach

Relatedness fit: The *relatedness fit* is based on the approach of Wang and Nickerson (Wang & Nickerson, 2019), who suggested finding concepts of different level of relatedness by using hyperlinked data on popular knowledge sources like Wikipedia. Based on the distance, or more precisely the number of clicks to navigate from the initial concept to the stimuli concept, they define the degree of relatedness (i.e., one click equals one relatedness degree further away). On this logic, they label stimuli as 1st, 2nd, and 3rd degree concepts (method will be explained in more detail in the next iteration). As the results of Wang and Nickerson (2019) suggest, this method works and 1st degree concepts are perceived as closely related, 2nd degree concepts are perceived as moderately related, 3rd degree concepts are perceived as remotely related, and random concepts are perceived as unrelated to a focal concept of interest. However, as highlighted by Klein et al. (2020) and mentioned previously, the *computationally determined relatedness* does not necessarily reflect every *individual's perceived relatedness*. Based on differences in the *individually perceived relatedness*, one can perceive it as more related or more remote. Hence, the *relatedness fit*, which is also the meta-characteristic, is the key dimension and has the characteristics of overestimate (i.e., people who perceive stimuli more related) and underestimate (i.e., people who perceive stimuli as more remote).

Previously, we have stressed out the importance of the individual cognitive structures. Similarly, to creativity processes where people combine and integrate concepts, rating the relatedness can be seen as a pre-stage of these. Based on these theoretically and conceptually based assumptions, we derive further dimensions from creativity research for the taxonomy development:

Knowledge and experience: *Domain knowledge* represents individual knowledge in a special domain and is a vital characteristic, as it forms an important part of task-relevant knowledge. We assume, that higher *domain knowledge* improves the perceived relatedness. It is obvious that *domain knowledge* can influence the perceived relatedness of a concept. For example, someone who has a high *domain knowledge* in sport will perceive a concept like "cooper test" more likely to be more related than someone who has low *domain knowledge*. In the initial taxonomy age is considered as a further dimension as it is an indicator for experience. The assumption behind this dimension is that people who are older are likely to have gained more knowledge and experience in a domain. Similarly, this also applies to education. People who have higher education (i.e., a university degree) are more likely to have more knowledge. Additionally, we included gender, as it forms individually perceived relatedness (Klein et al., 2020) is another dimension that potentially determines individual knowledge and experience. For example, women do perceive concepts in a task with stimuli regarding *breastfeeding* closer than men (Klein et al., 2020). Accordingly, we included these indicators of knowledge and experience as dimensions with its respective characteristics.

Personality traits: Literature emphasizes the link between individual personality traits and creativity (Kaspi-Baruch, 2019; Sung & Choi, 2009). The Big Five, consisting of openness, conscientiousness, extraversion, agreeableness, and neuroticism is a very prominent framework in that regard. In a nutshell, the tendency to be interested, flexible and open to new experiences and ideas is referred to as openness. The inclinations to control one's impulses, be detail-oriented and cautious, and being organized make up conscientiousness. The tendency to enjoy social activities, seek out stimulating experiences, and be confident and leader-oriented in group contexts is known as extraversion. The ability to be warm, kind, and empathetic in social situations is known as agreeableness. Neuroticism is characterized by a propensity for negative emotions such as anxiety, tension, depression, and guilt. Beneath the positive correlation of openness and extraversion that predicted creative performance (Sung & Choi, 2009), agreeableness is rather negatively associated, and conscientiousness and neuroticism provide mixed results (Feist, 1998). A newer and more parsimonious perspective, which stems from critics that the Big Five are not completely independent, is the model of Big Two (i.e., *plasticity* and *stability*) (Feist, 2019). *Plasticity*, which consist of openness and extraversion, is positively and more robust correlated to creative outcomes (Silvia et al., 2008, 2009). *Stability*, which consists of emotional *stability* (low neuroticism), agreeableness, and conscientiousness, in turn, is negatively related to creativity (Karwowski & Lebuda, 2016; Silvia et al., 2008, 2009). Thus, we included the personality dimensions of the Big Two into the taxonomy with the respective characteristics that these dimensions can be low or high. Additionally, *creative self-efficacy*, which is also positively related to creativity (Tierney & Farmer, 2002) and a more direct measure, was included.

Task-specific variables: Finally, we further integrated *task-specific variables* into the taxonomy as such situational-specific variables are also linked to creativity (Baas et al., 2008; Sung & Choi, 2009). We included *task perception*, *task complexity*, *concentration* as dimensions with its respective characteristics in the initial taxonomy. Research has shown that perceptions (i.e., if one perceived the task as utilitarian or hedonic) has a moderating role one creative outcomes (Sung & Choi, 2009). Research has also suggests that it is important to control for situational variables like perceptions of complexity or concentration, as they can indicate if someone perceives stress, which induces cognitive load, and also negatively affects creative performance (Yeh et al., 2015). Table 34 summarizes the resulting initial taxonomy.

Category	Dimension	Characteristics
Relatedness fit	Relatedness fit	underestimate/overestimate
Knowledge-/Experience-based variables	Domain knowledge	low/high
	Age	low/high
	Gender	male/female/other
	Education	non-university degree/university degree
Personality traits	Stability	low/high
	Plasticity	low/high
	Creative self-efficacy	low/high
Task-specific variables	Task perception	utilitarian/hedonic

Task complexity	low/high
Concentration	low/high

Table 34. Preliminary Taxonomy for Individualized Stimuli

Empirical-to-conceptual Approach (Iteration)

After first conceptual-to-empirical iteration, we further developed the taxonomy by conducting an empirical-to-conceptual iteration. For this iteration, we conducted an online survey to test the conceptually identified factors. To do so, we employed 205 workers from Amazon Mechanical Turk to rate the relatedness of concepts towards a main concept. To increase generalizability, we chose the two main concepts (physical fitness and cooking), that represent common activities. For the task, participants had to rate 7 closely related concepts, 7 moderately related concepts, 7 remotely related concepts, and 7 unrelated concepts in relation to physical fitness as well as cooking. To collect computational differently related concepts, we followed the data collection approach proposed by Wang and Nickerson (2019). Therefore, we analogously built a data scraper in python, that collects concepts (i.e., hyperlinked pages) on Wikipedia spreading out from an initial concept through hypertext linkages. Based on their hyperlink distance (i.e., the number of clicks to reach this page), these concepts are accordingly labeled as 1st, 2nd, and 3rd degree concepts. For example, on the page of physical fitness is a hyperlink to the Wikipedia page of health (1st degree concept), on the page of health is a hyperlink to the Wikipedia page of safety (2nd degree concept), and on the page of safety is a hyperlink to the Wikipedia page of insurance (3rd degree concept). We also included random Wikipedia concepts by using the random function (https://en.wikipedia.org/wiki/Special:Random), which provides random concepts. Similarly, the program ensures that no loops exist or that there are no overlaps of concepts on the different orders. The program collects all concepts on one order and looks how many hyperlinks it has to other concepts. As the list of concepts rapidly grows with every degree, we also cut the list on every degree level to the top 30 concepts based on the number of hyperlinks on the respective page. The rationale behind this is that a Wikipedia page with a few links is probably not well known and thus less useful in idea generation. Table 5 in the Appendix shows all collected concepts as well as descriptive statistics of the relatedness rating. The task-related characteristics *task perception* (self-developed), *task complexity* (adapted from Maynard & Hakel, 1997), *concentration* (adapted from Koufaris, 2002), as well as the *domain knowledge* (adapted from Luo & Toubia, 2015; Mitchell & Dacin, 1996) were asked separately after the respective ratings of concepts. Afterwards we asked the participants regarding the personality traits using the BFI-44 scale (John et al., 2008), the task-unrelated trait of *creative-self efficacy* (adapted from Tierney & Farmer, 2002) and their demographics. The maximum time on task allowed was 15 minutes. We included attention checks throughout the survey to ensure that the workers were fully engaged. Each worker was offered and paid one US dollar for successfully completing the task. Nevertheless, three participants had to be excluded as they were extreme univariate outliers. On average the remaining participants were 35.61 years old (SD = 10.21 years), 50% were female, and 75% indicated to have a university degree.

First, we conducted a one-way ANOVA to compare the effect of the relatedness degree of concepts on the average relatedness rating. The results showed that there was a significant effect, $F (3, 804) = 57.01$, $MSE = 1.63$, $p < .001$, $\eta 2 = .17$, confirming that 1st degree concepts are perceived higher related (M = 5.35 SD = 0.66) while 2nd, 3rd degree, and random concepts are less and less related (in this order, M = 4.87, SD = 0.93; M = 4.21 SD = 1.47; M = 3.82 SD = 1.76). Despite large effect size, post hoc Tukey tests showed significant differences between the 1st degree concepts and 2nd degree concepts, $p = .001$, $d = -0.48$, between the 1st degree concepts and 3nd degree concepts, $p < .001$, $d = -1.13$, between the 1st degree concepts and random concepts, $p < .001$, $d = -1.5$, between the 2nd degree concepts and 3rd degree concepts, $p < .001$, $d = -0.66$, between the 2nd degree concepts and random concepts, $p < .001$, $d = -1.05$, and between the 3rd degree concepts and random concepts, $p = 0.01$, $d = -0.40$.

We conducted a multiple linear regression analysis to evaluate the effects of the theoretically derived independent variables on the average rating of relatedness. Prior to this analysis, assumptions for the statistical analysis were tested. As said, three extreme univariate outliers identified in initial data screening were excluded. Firstly, a sample size of 202 can be considered as adequate with 10 independent variables to be included in the analysis (Field et al., 2012). The assumption of singularity was also met as the independent variables were not a combination of other independent variables. The collinearity statistics (i.e., Tolerance and VIF) were all within accepted limits, the assumption of multicollinearity was deemed to have been met (Field et al., 2012; Hair, 1998). An examination of the Cook's distance scores indicated no multivariate outliers. Residual and scatter plots indicated the assumptions of normality, linearity and homoscedasticity were all satisfied (Field et al., 2012; Hair, 1998). The results of the multiple linear regression analysis revealed *concentration*, *creative self-efficacy*, *age*, *gender*, and *education* not to be statistically significant predictors of the model, F (10, 191) = 37.05 ($p < .001$). However, the multiple linear regression analysis showed a statistically significant association between knowledge [B = 0.34, 95% C.I. (0.12, 0.56) p = .003], plasticity [B= 0.35, 95% C.I. (0.01, 0.71) p = .05], stability [B = -0.55, 95% C.I. (-0.83, -0.27) p = .001], task perception [B = 0.13, 95% C.I. (0.08, 0.17) $p < .001$], and task complexity [B = 0.43, 95% C.I. (0.31, 0.55) $p < .001$]. The model accounted for 66% of the variation in the average rating of relatedness.

Furthermore, to analyze the impact of the significant variables that can be captured pre and post a creativity task, a two-stage hierarchical linear regression analysis was conducted. To evaluate the prediction of the average relatedness rating of variables which can be captured before a creativity task, we entered *knowledge*, *plasticity*, and *stability* at stage one. For the second block analysis, the variables *task perception* and *task complexity*, which can be captured after a creativity task, were added to the analysis. Table 35 summarizes the statistics of the hierarchical linear regression analysis.

Variable	B	95% CI for B		SE B	β	R^2	ΔR^2
		LL	UL				
Step 1						0.47	0.47***
Constant	3.59***	2.46	4.72	0.57			
Knowledge	0.54***	0.29	0.79	0.12	0.25***		
Plasticity	1.20***	0.84	1.56	0.18	0.40***		
Stability	-1.51***	-1.75	-1.27	0.12	-0.71***		
Step 2						0.65	0.18***
Constant	2.16***	1.14	3.18	0.52			

Knowledge	0.38***	0.17	0.58	0.11	0.17
Plasticity	0.45**	0.12	0.77	0.17	0.15
Stability	-0.62***	-0.89	-0.35	0.14	-0.29
Task Perception	0.13***	0.09	0.17	0.02	0.29
Task Complexity	0.41***	0.29	0.53	0.06	0.39

Note. CI = confidence interval; LL = lower limit; UL = upper limit.

*p < .05. **p < .01. ***p < .001.

Table 35. Hierarchical Regression Results for Average Relatedness Rating

The results of the first block hierarchical regression analysis revealed that knowledge [*B* = 0.54, 95% C.I. (0.29, 0.79) p < .001], *plasticity* [*B* = 1.20, 95% C.I. (0.84, 1.56) p < .001], and *stability* [*B* = -1.51, 95% C.I. (-1.75, -1.27) p < .001] contributed significantly to the regression model, F (3, 198) = 57,45, p < .001 and accounted for 47% of the variation in the average relatedness rating. Adding *task perception* and *task complexity* explained an additional 18% of the variation in the rating of relatedness and the R^2 value of 0.65 was significant, F (5, 196) = 72.65, p < .001. It was found that knowledge [*B* = 0.38, 95% C.I. (0.17, 0.58) p < .001], *plasticity* [*B* = 0.47, 95% C.I. (0.12, 0.77) p < .01*],* *stability* [*B* = -0.62, 95% C.I. (-0.89, -0.35) p < .001], *task perception* [*B* = 0.13, 95% C.I. (0.09, 0.17) p < .001], and *task complexity* [*B* = 0.41, 95% C.I. (0.29, 0.53) p < .001] significantly predicted the average relatedness rating. Based on these results, the taxonomy yielded a reduction of dimensions. For further demonstration (i.e., application of the taxonomy), we dummy-coded each dimension binary by a median split, taking into account the assumptions to be met (Iacobucci et al., 2015), according to the characteristics of the dimensions. Table 36 highlights the revised taxonomy.

Category	Dimension	Characteristics
Relatedness fit	Relatedness fit	underestimate/overestimate
Knowledge-/Experience-based variables	Domain knowledge	low/high
Personality traits	Stability	low/high
	Plasticity	low/high

Task-specific variables	Task perception	utilitarian/hedonic
	Task complexity	low/high

Table 36. Revised Taxonomy for Individualized Stimuli

20.5 Application of the Taxonomy

Cluster Analysis

We further applied the taxonomy to show usefulness and application of the identified dimensions and characteristics. The taxonomy should help to identify user groups and patterns. Based on group objects adjustments can be proposed. To understand our patterns, we performed a hierarchical cluster analysis (Ketchen & Shook, 1996). The four-step approach according to Sarstedt and Mooi (2014) guided our process. In step one we selected the variables for clustering (Sarstedt & Mooi, 2014), which were all dimensions based on the taxonomy after the empirical-to-conceptual iteration without the task specific dimensions. Namely the dimensions *relatedness fit*, *domain knowledge*, *stability, and plasticity*. We decided to exclude *task perception* and *task complexity* because their usefulness in terms of our objectives were not given, as they can only be evaluated retrospectively. Thus, the prescriptive usefulness was not given. In the second step, we decided for hierarchical agglomerative clustering and the Ward method. This approach is promising also when sample sizes are comparably small (Sarstedt & Mooi, 2014). The Ward method has the advantage that it is useful when no optimal number of possible clusters is known at the beginning. Based on this, we determined the number of clusters.

We produced a graphical representation of the cluster analysis to analyze the distances where the objects are combined, which is a useful approach to decide the number of clusters (Sarstedt & Mooi, 2014). The graphical analysis results in two different clusters (Figure 1). Although the suggested cutoff length was at two clusters (combination at maximum distance), we decided based on theory and the marginal difference to further explore both, the two-cluster and the four-cluster approach. Our procedure allowed to interpret and understand the *relatedness fit* and different patterns occurred. We further validated the clusters. Therefore, we analyzed the absolute occurrences of the characteristics. The results are shown in (Figure 40).

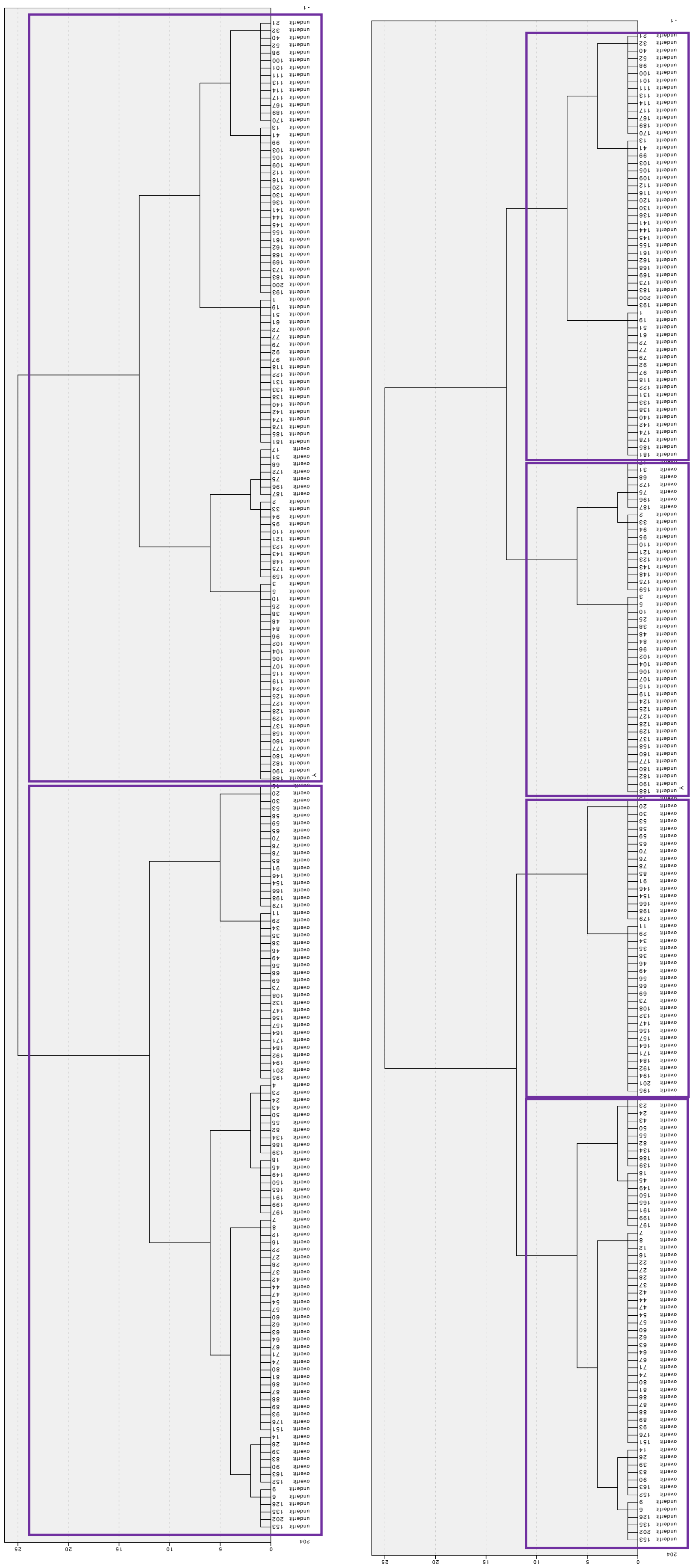

Figure 40. Dendrogram of the Ward Clustering Results (2-Cluster and 4-Cluster Visualization)

Dimension	Charac-teristic	2-Cluster		4-Cluster			
		1	2	1	2	3	4
Domain Knowledge	Low	60%	40%	75%	40%	0%	100%
	High	40%	60%	25%	60%	100	0%
Plasticity	Low	58%	43%	100%	4%	33%	58%
	High	42%	57%	0%	96%	67%	43%
Stability	Low	20%	82%	35%	0%	70%	100%
	High	80%	18%	65%	100%	30%	0%
Relatedness fit	Underestimate	93%	6%	100%	84%	10%	0%
	Overestimate	7%	94%	0%	16%	90%	100%

Note. Due to rounding inaccuracies the sum of each column of a dimension is not always exactly 100%.

Table 37. Distributions of Characteristics in the 2- and 4- Cluster Solution

20.6 Identified Clusters and a Proposal for Archetypes

We identified different patterns and propose two variants (2-cluster/4-cluster), which are mutually complementary to each other and consistent. We explored them iteratively. The descriptive characteristics are shown in (Table 37).

2-Cluster Approach:

Cluster 1: In cluster one 93% underestimate stimuli relatedness. The group estimates the degree of relatedness of given concepts to be rather less related. The group consists of 80% individuals with high *stability*.

Cluster 2: In cluster two 94% overestimate stimuli relatedness. The group estimates the degree of relatedness of given concepts rather more related. The group consists of 82% individuals with low *stability*.

As the taxonomies characteristic *stability* best describes the *relatedness fit* (i.e., overestimate and underestimate). Hence, we propose two overarching groups (high and low stability).

4-Cluster Approach:

Cluster 1: In cluster one 100% of individuals underestimate stimuli relatedness. The group estimates the degree of relatedness of given concepts to be more remote. The group consists of 65% individuals with high *stability*. In addition, the characteristic low *plasticity* describes 100% of this group. Further 75% of the cluster have a low *domain knowledge*. The archetype *low plasticity/low domain knowledge* best describes cluster one.

Cluster 2: In cluster two 84% underestimate stimuli relatedness. This group also estimates the degree of relatedness of given concepts to be more remotely related. The group consists of 100% individuals with low *stability*. Additionally, the characteristic *domain knowledge* describes 60% of this group and thus both characteristics (i.e., *plasticity* and *domain knowledge*) are salient characteristics to distinguish cluster two from cluster one. The archetype *high stability/high plasticity* best describes cluster two.

Cluster 3: In cluster three 90% overestimate stimuli relatedness. 70% of individuals within this cluster have low *stability* and 67% have high *plasticity*. 100% individuals have *domain knowledge* higher than median. The archetype *high domain knowledge/low stability* best describes cluster three.

Cluster 4: Estimating the degree of relatedness of a given concept to be too close in cluster four is existent in 100,00% of individuals in this group. 100% individuals with a low *domain knowledge* dominate this pattern. Other noticeable features of the pattern are that 100% have low *stability.* Low *plasticity* with 58% is not distinct. The archetype *low stability/low domain knowledge* best describes the cluster four.

20.7 Discussion

We developed a taxonomy to identify group characteristics that describe differences between *individually perceived relatedness* and *computationally determined relatedness* and thereby answer the RQ “What are some individual characteristics that affect the perceived relatedness among computationally derived concepts?”. The taxonomy consists of four dimensions (i.e., *relatedness fit*, *knowledge and experience*, *personality traits*, and *task-specific variables*) and enabled a cluster analysis, where we iteratively with regard to the possible design of a CSS decided to use three dimensions (i.e., *relatedness fit*, *knowledge and experience*, and *personality traits*) that can be addressed by algorithms. In doing so, we identified patterns and archetypes based on the conceptually derived characteristics. To classify groups with the same *relatedness fit* the characteristics *stability, plasticity,* and *domain knowledge* seem to play a significant role.

Overall, two major groups can be identified by the application of the taxonomy. First, high *stability* people who underestimate stimulus relatedness and low *stability* people who overestimate stimulus relatedness. Both groups are dichotomous with respect to two characteristics (i.e., *stability* and *relatedness fit*). The dichotomous characteristics of the groups enable new opportunities for designing CSS. We further showed that additional classification can be made based on the developed taxonomy. Both groups can be further divided into high or low *domain knowledge* and high or low *plasticity*. This allows useful individualization based on the group differences (i.e., archetypes) in providing stimuli.

Patterns Determining the Relatedness Fit

Findings indicate *stability* as an important dimension and high or low *stability* as respective characteristics to classify individuals into overestimating and underestimating individuals. High *stability* means that such individuals tend to underestimate the degree of relatedness of a given concept. Research shows, that individuals with a high *stability* tend to be less susceptible to impulses (DeYoung, 2013, 2014), which might explain the underestimating relatedness of stimuli. Further research could examine potential correlations. *Stability* is also known for providing protection against exploratory or reward-related impulses (DeYoung, 2011). This aspect also supports the assumption of defending-mechanisms against distant stimuli (DeYoung, 2011).

Additionally, *domain knowledge* helps to further differentiate within both *stability* groups (i.e., high *stability* and low *stability*). This corresponds to theoretical and conceptual underpinnings of associative memory. The pattern which occurs is that high *domain knowledge* leads to a decrease of perceived relatedness. While 100% of underestimating individuals in cluster one, predominantly indicate a low *domain knowledge* (84%), 60% of cluster two indicate that their *domain knowledge* is high. Respectively, this happens in the case of low *stability*. While 100% are overestimating, where *domain knowledge* is low, 90% (i.e., from 100% to 90%) are overestimating, where 100% *domain knowledge* is high.

The distribution in terms of *plasticity* is basically like the pattern of *domain knowledge*. Compared to *stability*, previous research findings and conceptual assumptions are confirmed. Although, *plasticity* and *stability* seem to be opposed to each other, they are complementary (DeYoung, 2015). However, DeYoung (2015, p. 15) argues that *plasticity* and *stability* are "…also, in dynamic tension, as extreme plasticity may pose a challenge to stability and vice versa.". These underlying assumptions are confirmed.

General Implications

The taxonomy can help to develop a differentiated understanding of creativity and context related stimuli in the context of CSS. Creativity is usually associated with a flexible thinking style and the personality dimensions extraversion and openness (Feist, 2019; Sung & Choi, 2009) – respectively high *plasticity*. However, research also argues that there are two ways to creativity (i.e., flexibility and persistence) (Nijstad et al., 2010). While flexibility and *plasticity* are associated with each other (*plasticity* defined as the tendency to behavioral and cognitive exploration (DeYoung, 2014)) and persistence and *stability* (*stability* defined as the tendency to prevent disruption and defend impulses (DeYoung, 2011)) are associated with each other, both groups offer great opportunity to enhance creative outcome through customized stimuli. Additionally, recent research also showed that more close or moderate relate stimuli can also lead to creative outcome (Wang & Nickerson, 2017, 2019), which argues for a differentiated view of creativity and the role of relatedness in relation to context-related stimuli of CSS. According to these findings, research also stresses the importance of persistence for creative performance (Lucas & Nordgren, 2015). The taxonomy helps to clarify the role of *perceived relatedness* and therefore enables further examination and understanding of creativity, the dual pathway to creativity concept and stimuli.

The taxonomy and the initial archetypes can be used for classification of specific groups in terms of cognitive load. Theoretical underpinnings also emphasize the importance of knowledge distance and cognitive load (Wang & Nickerson, 2019). Germane cognitive load for example can be optimized by given stimuli (Santanen et al., 2004). However, the effect can occur only if the desired distance also corresponds to the actual (Klein et al., 2020). The problem of cognitive overload or fixation can be addressed by considering different types of *relatedness fit* and thus free cognitive load for the respective task (Santanen et al., 2004). Therefore, cognitive load and creativity can be better understood based on our taxonomy. For example, one major concern for future research can be the understanding of a certain threshold which determines the point where fixation or to high cognitive load is triggered.

The results of our research can also help to study a specific archetype in more detail. Our research is only an initial classification. *Stability*-oriented and *plasticity*-oriented characteristics can be found in the dimensions of Big Five, and further research can benefit from our taxonomy to understand the correlations between Big Five and individually perceived *relatedness fit.*

Design Implications

Different critical aspects of CSS can be addressed by our taxonomy, as the perceived relatedness of stimuli is an important factor for CSS (Klein et al., 2020; Wang & Nickerson, 2017, 2019). Different thinking styles relate to different relatedness levels and providing different levels of stimuli or providing the stimuli dynamically during divergent thinking phase is a promising endeavor for designing individualized CSS (Wang & Nickerson, 2017). This is very interesting and useful as both thinking styles can lead to creative outcomes (Lucas & Nordgren, 2015; Nijstad et al., 2010) and can be addressed by the design of a context-related stimuli provider. As stimuli which are too remote can hinder people's ability to think fluently (Wang et al., 2018) and different levels of relatedness can help to foster exploration and exploitation during divergent thinking (Seo et al., 2015), our taxonomy can help designing future CSS. Thus, based on the taxonomy individuals can be classified and customized algorithms delivering matching context-related stimuli can improve outcomes of CSS. Thus, on the one hand algorithms help to avoid undesired effects and on the other hand the taxonomy's classification can help to optimize CSS. For example, the control of different pathways to creativity (i.e., flexible pathway and persistence pathway) can effectively be addressed through individualized and "custom fit" stimuli. This opens new opportunities for CSS.

The rise of AI opens the opportunity for symbiotic interaction between humans and machines. Also, in the case of creativity, AI can be a useful partner to foster creative outcomes (Gobet & Sala, 2019). IT-enabled cognitive stimulation can help to explore people's associative memory if the desired *relatedness fit* can be achieved (Althuizen & Reichel, 2016). However, the implementation of algorithms in CSS is rare (Wang & Nickerson, 2019) and employment has to be carefully considered (Klein et al., 2020). Our developed taxonomy can help to individualize the known Wikipedia approach and set the foundation for customized implementation. There are also other opportunities to identify context-related stimuli, which are not already validated through research. For example, the combination of knowledge graphs like DBPedia as stimuli source and the use of semantic similarity measures (Martinez-Gil, 2014) like the Google Distance Measure as relatedness estimator (Cilibrasi & Vitanyi, 2007; Cohen & Vitanyi, 2013) seems to be promising. Though, the latter is not yet validated this method allows a measurement of relatedness that is not discrete and based on broader range of knowledge (in comparison to Wikipedia, where a few authors write articles) as it determines the relatedness (i.e., semantic similarity) through the use of all indexed pages of search engines. In addition, advances in this area also allow the use of, for example, image-based rather than text-based stimuli. Franzoni et al. (2015), for example, provide a method to determine similarity between images. Regardless, our taxonomy provides an important starting point to consider, investigate, and factor individual characteristics into the design of algorithms.

Practical Implications

Creativity is important for practice as organizations must adapt to an everchanging environment. New products, new services, or new strategies call for creative techniques. Only new ideas and innovations that are once imagined can be elaborated. New approaches and instruments like design thinking or service design thinking make use of divergent thinking and brainstorming techniques to innovate. This is a major challenge for management of organizations. The dependence on a single genius is now rare, and new work and creativity have become indispensable for almost all areas of work. This leads to an understanding in which the aim is to enable as many people as possible to work creatively.

Providing stimuli without hindering thinking fluently and trigger fixation or cognitive overload is important to creativity. In practice, it is also about both, preventing undesired effects and optimizing divergent thinking to obtain the best possible solutions, as human creativity is never optimal (Baskerville et al., 2016, 2019).

Given the results of our research, in terms of stimulus-relatedness "one size does not fit all". However, the identified patterns based on our taxonomy can help to customize stimuli. Therefore, methods like brainstorming and ideation techniques can be optimized with customized IT-based stimuli. The Wikipedia approach in conjunction with our results can also help to design stimuli provider with dynamic adaption. Also new methods like the semantic similarity measures and the use of knowledge graphs or image-based resources can be better designed with the taxonomy in practice. Additionally, with respect to *domain knowledge*, specification can be made to the context of application and group differences (Müller-Wienbergen et al., 2011). Especially *domain knowledge* and the adaptation based on the respective *domain knowledge* offer the possibility to use the taxonomy.

Limitations

Like any other research, this research also has its limitations. While our sample size was appropriately, and assumptions were met for analyses the resulting clusters are rather small and therefore the results associated with the interpretation of the cluster solutions are limited. Further research with more data should be conducted to replicate and improve the findings and yielding in a more precise description and better analyses of the identified archetypes. In this line, as our findings are based on a crowd worker sample (i.e., Amazon Mechanical Turk), further research should also include other populations, as crowd worker samples are, for example, deemed less diverse than general populations (Rouse, 2015).

Additionally, as also highlighted previously, taxonomies in general are not perfect (Nickerson et al., 2013). The method was proven and conducted rigorously. Nevertheless, the taxonomy is part of our “search process” (Hevner et al., 2004) and further needs to be extended and revised. The identified categories and dimensions do not represent a conclusive taxonomy and represent a first step towards a taxonomy to better design CSS. Further research should therefore investigate additional factors associated with an influence on creative processes to confirm and further describe the taxonomy and derived archetypes.

20.8 Conclusion

Previous research showed the importance of providing context-related stimuli to foster creative outcomes. Moreover, computational methods have been developed to identify stimuli of varying degree of relatedness objectively and consistently (Wang & Nickerson, 2019). In this context, however, the limitation that the *perceived relatedness* of stimuli is also dependent on individual factors have also been highlighted (Klein et al., 2020). Our research presents a taxonomy that allows a classification of individuals using stimuli providing CSS. To create this taxonomy, we built upon previous creativity literature. We further refined it with an online survey with 202 people. Based on this, we tested the applicability and usefulness of the taxonomy and derived four archetypes of people that determine their perception of the relatedness of stimuli. The analysis of these four archetypes showed that it is important to distinguish users of CSS according to the identified dimensions and corresponding characteristics (i.e., stability, plasticity, and domain knowledge). Our findings allow to improve the design of future CSS by providing a way for individualized stimuli. Furthermore, we highlight avenues for future research, that can enhance the taxonomy as well as the method to determine the *perceived relatedness* objectively (i.e., algorithms) and the corresponding design by accounting for the four archetypes.

20.9 Appendix

Initial Concept	Computationally determined relatedness	Perceived relatedness Mean (SD)	Concepts
Physical Fitness	1st degree	5.48 (0.73)	Industrial Revolution, Nutrition, Healthy diet, Bodybuilding, Physical exercise, Strength training, Health
	2nd degree	4.99 (0.91)	Metabolism, Circulatory system, Food, Fashion, Education, Yoga, Veganism
	3rd degree	4.37 (1.37)	Olympic Games, COVID-19, Christianity, Deployment of COVID-19 vaccines, Lipids, Face masks during the COVID-19 pandemic, Biological hazard
	Random	3.79 (1.77)	Integrated Motor Assist, Blackish antbird, Credit card fraud, Ribbon knot, Intel 8259, Social stratification, Nirvana
Cooking	1st degree	5.22 (0.81)	Food industry, Human, Transport, Water, Spice, Cuisine, Civilization

	2nd degree	4.74 (1.08)	Role of Christianity in Western civilization, Religion, Temperature, Food, Atmospheric pressure, Life, Tool
	3rd degree	4.06 (1.69)	Catholic Church, Slavery, Metabolism, New Age, Antimodernism, Libertarianism, Coral reef
	Random	3.84 (1.80)	Spearman rank, Trump Air, Philosophy of science, Japanese Folklore, Tragic Kingdom, Diphenoxylate, Dog Tax War

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