Service System Innovation: An Ambidexterity Perspective

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Foreword

Panta rhei—everything flows—said Heraklit, one of the pre-Socratic philosophers in ancient Greece. In Heraklit's view, our world is continuously in motion, making it impossible for us to take its status quo for granted, nor can we rely on it as constant when planning for our future. Quite literally, we cannot step into the same river twice.

We would be wise to more profoundly respect the implications of *panta rhei* in service science, a research discipline that focuses on co-creating value-in-use in service providers' and service customers' cooperation. Mainly, service system engineering has been dealing with developing service innovations for more than two decades now, producing disruptive service types and new methods to perform service innovation. However, a mainstream assumption still seems that innovation processes must be started consciously and end with going to market with a new service or product. However, the term *panta rhei* reminds us that—just like everything—innovation also flows independent from planned initiatives for innovation and change. Innovation also happens in day-to-day situations, maybe even unrecognized by the participants creating them.

In her dissertation thesis, Verena Wolf sheds new light on successful service system engineering and service innovation, building on the theoretical lens of ambidexterity—a concept that originated from organization science—to conceptualize service innovation as an activity that works top-down as well as bottom-up at the same time. Top-down, service system engineering needs to consider the difficulty of transforming structures pre-existing in service system more comprehensively. Bottom-up, humans have agency to perform workarounds, enabling them to conduct their day-to-day work more efficiently. Their actions constitute and change the general patterns that structure organizations as social systems. With this view on service innovation, Verena Wolf allows us to comprehend and to perform service

system engineering more profoundly, building on the forces of structured change and unstructured change at the same time.

The research reported in this dissertation was part of DIGIVATION, a research project funded by the German Federal Ministry of Education and Research. DIGIVATION enabled us to consolidate previous insights on service system engineering, develop agile methods such as those provided in the industry-standard DIN SPEC 33453, and empirically investigate the role of workarounds in shaping organizational routines.

Providing the insights developed in DIGIVATION, I see this dissertation thesis as an essential step towards integrating service system engineering as planned change with the more subtle, unplanned, and sometimes ill-defined implications of performing workarounds in service processes. I wish you a good read on this material and the best for conducting your service innovation projects. *Panta rhei* might indeed remind us that innovation is imperative for firms to survive, but first of all, change makes our lives exciting and rewarding, enabling us to cherish and to build on the unique opportunities emerging each new day.

Paderborn, December 2020 Prof. Dr. Daniel Beverungen

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For data protection reasons, the acknowledgments that appeared in the printed version of the dissertation have been removed in this file.

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List of Abbreviations

BPM	Business Process Management
BPMN	Business Process Model and Notation
DSR	Design Science Research
FPR	Foundational Premise
G-D Logic	Goods-Dominant Logic
ICT	Information and Communication Technology
IoT	Internet of Things
IS	Information Systems
IT	Information Technology
ITIL	Information Technology Infrastructure Library
IV	Interviewee
NSD	New Service Development
OS	Organization Science
PSS	Product Service System
S-D Logic	Service-Dominant Logic
SCOR	Supply-Chain Operations Reference

Part A
Research Overview

1 Exposition

1.1 Introduction and Motivation

A service constitutes the core of economic activities, integrating individuals, organizations, and technologies (Maglio et al., 2009; Peters et al., 2016; Vargo and Lusch, 2004). In Germany, for example, the turnover index for services was, as of 2019, at its highest level since its first record in 2003, with an annual growth rate of around three percent (Statistisches Bundesamt, 2020). Accordingly, service research has gained in importance in Information Systems (IS), providing an integrated perspective for existing theories and IT artifacts (Beverungen et al., 2019a).

A service is defined in the Marketing discipline as the application of capabilities and knowledge for creating and capturing value—a definition that has been widely acknowledged in IS research as well (Katzan Jr, 2008; Lusch and Vargo, 2006; Vargo and Lusch, 2004). The term *service* (in the singular) serves to describe the process of value creation for the benefit of someone, while the term *services* (in the plural) is used to refer to a unit of output (Lusch and Vargo, 2006). A central concept in service research are *value propositions*, which are seen as an invitation for customers to engage with organizations in the process of mutual value creation (Lusch and Nambisan, 2015). Hence, value propositions are an organization's "promises of value creation that build upon configurations of resources and practices" (Skålén et al., 2015, p. 144).

To access the reciprocal value creation between organizations and customers, service systems are conceptualized as the "basic abstraction of service science" (Maglio et al., 2009, p. 395). Service systems are socio-technical systems (Böhmann et al., 2014) that consist of complex networks (Barile et al., 2016) comprising actors,

technologies, organizations, and layers of shared information (Alter, 2008; Böhmann et al., 2014; Maglio et al., 2009). When actors in service systems integrate and (re-)combine their resources, innovations are being realized (Barrett et al., 2015), creating either 'new' resources or 'new means' of value creation (Akaka and Vargo, 2014). Service innovation is intertwined with service systems innovation, since the elements in a service system are mutually adapted and realigned when service systems are transformed or newly established (Alter, 2008). Service system innovation includes the design of multiple elements, such as processes, activities, technologies, and information access (Alter, 2008). Innovation in this context refers to either the establishment of an entirely new service system or the transformation of an existing one, e.g., as an adaptation to markets or to existing offerings (Gustafsson et al., 2020).

As a result of the disruption caused by new digital technologies (Vial, 2019), service system innovation is currently undergoing a radical transformation. As this change is still recent, research lacks descriptive and prescriptive knowledge on the establishment of innovative service systems in a dynamically changing environment (Gregor and Hevner, 2013), and on the convergence of design and use cycles to sustain competitive pressures (Pentland and Feldman, 2008).

Against this backdrop, this dissertation is motivated by three observations, which are elaborated in the following paragraphs. First, digital transformation not only changes but creates new challenges for service system innovation. On the one hand, tremendous new opportunities arise from the availability of data and smart products (Wessel et al., 2020) but, on the other hand, it requires grappling with the increased complexity of value creation processes (Furrer et al., 2020) and with tools such as leading-edge software and hardware, cloud computing, augmented reality, and smart devices with integrated sensors, which enable organizations to offer innovative value propositions (Böhmann et al., 2014; Lehrer et al., 2018; Wessel et al., 2020). Over the last years, the turnover of information and communication technology (ICT)-enabled services has soared by 17.2 percent (Statistisches Bundesamt, 2020). By 2030, the number of Internet of Things (IoT)-connected devices is expected to increase to about 125 billion, further fueling the opportunities for individualized and innovative services (Russo and Wang, 2019). These technological advancements facilitate the interactions between actors within and across organizations (Spohrer et al., 2014), connecting employees with customers, partners, and suppliers. It also enables value creation processes across different ge-

ographical locations, facilitating collaboration in global value networks (Lacity and Fox, 2008; Vial, 2019). In this regard, technology-enabled services can substantially improve an organization's performance, by increasing customer satisfaction by up to 60 percent, for example, through the individualization of services, and by reducing costs by about 40 percent, through e.g. self-services (Rehse et al., 2017).

However, with the availability of big data, social computing, smart devices, and real-time computing, the complexity of service systems increases as services become more context-specific, self-configurative, scalable, and increasingly preemptive (Barile et al., 2016; Beverungen et al., 2019c; Hsu and Spohrer, 2009; Wessel et al., 2019). In a digitally transforming environment in which changes are hard to predict, market volatility tends to increase (Müller et al., 2019; O'Reilly III and Tushman, 2013). Simultaneously, the lifetime of organizations steadily decreases as they are displaced by competitors. While the average life expectancy of S&P 500 companies was 90 years in 1935, this number has declined to 30 years by 1975, and to 14 years in 2010, and is estimated to continue to decrease according to recent studies (Handscomb and Thaker, 2018).

Digitalization causes the emergence of new phenomena, such as resource liquefaction, whereby information is decoupled from physical devices, and resource density, where service elements are combined and recombined to provide new value propositions (Lusch and Nambisan, 2015). Recombination refers to associating, dissociating, and adding internal and external resources in order to achieve innovation (Witell et al., 2010). Both operand resources—i.e., tangible assets, materials, and technology—and operant resources—such as capabilities and knowledge—are applied to provide innovative value propositions (Vargo and Lusch, 2004).

The dilemma between digital transformation as both an opportunity and as a challenge also impacts the innovation strategy of organizations (Wessel et al., 2020), requiring faster innovation cycles (Ojasalo and Ojasalo, 2018). On average, a service innovation project can take between six and 24 months (Van Dyke, 2017). However, to harness innovation's true potential, and ensure survival in such an intensely competitive and rapidly changing environment, innovations have to be transferred quickly and efficiently (Brynjolfsson et al., 2019).

Organizations are under pressure to have a dual innovation strategy, consisting of radical innovations, based on the *exploration* of new resources and technolog-

ical advancements (March, 1991; O'Reilly III and Tushman, 2008) and through *exploitation* activities, aimed at improving or adapting existing services through incremental innovations (March, 1991; Yu et al., 2013). Both exploration and exploitation are inherently complex efforts in themselves (Gibson and Birkinshaw, 2004). However, organizations that pursue only exploration are at risk of experiencing high uncertainty, resource costs, and extensive time requirements (O'Reilly III and Tushman, 2008), while organizations that follow only exploitation may become obsolete and lose market shares in the long term (O'Reilly III and Tushman, 2008). Hence, a combination of both may be more viable, establishing radical new service systems (exploration) to ensure future viability, and improving existing service systems through incremental innovations (exploitation) to ensure current continuation (Menor et al., 2002).

Exploration (to design radical innovations) and exploitation (to establish incremental innovations) require different structures, processes, and corporate cultures that may conflict with each other (Tushman and O'Reilly III, 1996). Hence, a new and integrated approach is needed, providing a new theoretical perspective on how the simultaneous exploration and exploitation of service systems can be achieved (Maglio and Breidbach, 2014). This view is in line with a claim by Ostrom et al. (2015, p. 136), stating that "complexity of service systems and networks requires input from disciplines and expertise outside the traditional service research arena."

To propose a solution to the conflict between exploration and exploitation activities, the theory of ambidexterity offers a promising conceptualization. Ambidexterity describes an organization's "ability to simultaneously pursue both incremental and discontinuous innovation" (Tushman and O'Reilly III, 1996, p. 24). Through ambidexterity, organizations can sense environmental issues, realize innovation opportunities, and dynamically recombine resources to stay profitable (Montealegre et al., 2019). As underlined by Lusch and Nambisan (2015), becoming ambidextrous is a key research topic in the service innovation literature. However, ambidexterity has so far been predominantly applied to product innovation (Menor et al., 2002), and the question of how to simultaneously enact exploration and exploitation activities for service system innovation has not yet been resolved (Yu et al., 2013).

> **Observation 1:** *Aligning exploration and exploitation activities for service system innovation is complex and still under-researched.*

In order to address the ambiguity about ambidextrous service system innovation, "knowledge in the two spheres of natural and artificial science" is required (Gregor and Hevner, 2013, p. 343), providing theoretical knowledge about the dynamics of innovation paths and applicable knowledge for leveraging the potential for service system innovation through digital technologies. In this regard, *descriptive knowledge* is required to discover and explain real-world phenomena in the natural and the social sciences, constituting the body of knowledge (Gregor and Hevner, 2013). In addition, *prescriptive knowledge* is required, in which IT artifacts as an invention, improvement, or exaptation to artificial science in IS research are designed (Gregor and Hevner, 2013). Knowledge growth on the phenomenon of ambidextrous service system innovation is achieved when descriptive and prescriptive knowledge inform and extend each other in multiple iterative cycles (Rothe et al., 2020).

Prescriptive knowledge can be created by developing systematic design approaches for establishing innovative service systems, e.g., through an exploration of new resources, information, and digital technologies. Design refers to a "functional-hierarchical engineering process" (Beverungen, 2013, p. 13), which comprises the identification of requirements, the purposeful creation of IT artifacts, and evaluation to ensure its usefulness (Beverungen, 2014; Hevner et al., 2004; March and Smith, 1995). It is a socially constructed process (Beverungen, 2014), which provides a clear structure for action patterns and distributes agency among actors (Glaser, 2017).

Design approaches are often top-down driven and can be linked to *service system engineering*, describing models, methods, and principles to design integrated conglomerates of services, products, and information technology (IT) (Böhmann et al., 2014, 2018; Peters et al., 2016; Spohrer et al., 2007; Tien and Berg, 2003). Traditional engineering approaches emerged from product-centric thinking and focus only on creating individual services (Ostrom et al., 2010). Most methods used to establish service systems span from idea management to offering a value proposition on the market (Yang, 2007). Modern approaches for designing new service systems suggest non-linear processes that include various activities in progressive phases of analysis, design, and transformation (Marx et al., 2020).

Organizations often follow a ‘one-size-fits-all’ approach, following the same steps for developing radical and incremental innovations (Alon and Elron, 2016). However, since service systems are complex configurations of individuals, organizations, technologies, and information (Wessel et al., 2019), distinctive design approaches are required. As service design is often limited to a new service being designed top-down from scratch, service failures are a frequent occurrence in organizations (Radu et al., 2020). Hence, prescriptive knowledge is also needed to guide bottom-up directed innovation, e.g., through a systematic exploitation of resources.

Descriptive knowledge can elucidate the mechanisms of service system innovation from an ambidexterity perspective. Besides describing how service systems can be transformed through the exploration of innovative value propositions, unofficial innovation paths may be uncovered that emerge through the exploitation of existing resources and collaboration between multiple actors in a service system. Emergence allows conceptualizing innovations as initiatives that are driven bottom-up through adaptations of work activities that diffuse in an organization (Mendling et al., 2020). More specifically, emergence is a phenomenon used to describe a unit that consists of "entities at a lower level" (Hodgson, 2007, p. 103), making “the whole entity more than the sum of its parts” (Checkland, 1999, p. 50). Emergent patterns, therefore, unfold "dynamically based on the intended and unintended consequences of the actions performed by individuals" (Beverungen, 2013, p. 5).

Emergence as a mechanism for bottom-up driven innovation is discussed in Organization Science (OS), which points out that employees can develop ideas for improvement as they exploit resources in their day-to-day work (Azad and King, 2012). Innovative solutions that are developed by employees offer a great potential to organizations since they were already implemented in daily activities and have proven to be efficient. A recent survey has shown that around 60 percent of innovations are initiated by employees (Staack and Cole, 2017). Hence, actors take an active and decisive role in the successful establishment of new service systems (Freund and Spohrer, 2013), applying their capabilities and integrating a range of resources (Vargo and Lusch, 2014). However, many organizations still ignore the potential of employees for creating innovation in their everyday work (Bradonjic et al., 2019). While the involvement of customers in a service system to achieve innovation has been widely discussed, e.g., in Gustafsson et al. (2020), Magnusson et al. (2003) or Böhmann et al. (2014), other actors, such as

employees have received little consideration. Employees can deviate consciously or subconsciously from work activities (Dunford and Perrigino, 2018), and especially workarounds—as goal-driven deviations work (Alter, 2014; Azad and King, 2012)—may constitute a viable source for bottom-up innovation (Petrides et al., 2004).

Workarounds can provide a suitable lens for examining how bottom-up innovation can be achieved through the exploitation of available resources. The concept of workarounds was established in IS literature in the mid-1980's (Gasser, 1986). Early research regarded workarounds as non-compliance, loss of control, and reduction of productivity (Koppel et al., 2008). More recently, workarounds have been considered as an important source of innovation, providing an opportunity for greater efficiency or effectiveness (Fries et al., 2016). However, the generative capacity of workarounds often remains hidden and is difficult to control (Mendling et al., 2020).

> **Observation 2:** *The ambiguity about ambidextrous service system innovation can be scrutinized through the development of, on the one hand, prescriptive knowledge to inform and guide the design of service systems and, on the other hand, descriptive knowledge to understand the emergence of innovation.*

Although 'design' and 'use' are closely connected, they are often conceptualized as distinct processes (Pentland and Feldman, 2008). However, changes often have to be achieved *on-the-fly* to meet customer demands and respond quickly to technological advancements (Dunn and Windle, 2004). Hence, in a digitally transforming environment, design and use can no longer be regarded as separate activities. While business processes and activities are consciously designed through service system engineering, they are also continuously shaped and reshaped through interactions between actors, the integration of their resources, and adaptations to customers' specific needs (Becker et al., 2009). Since processes and activities constitute the core of a service system (Alter, 2008), a process-oriented view on service system innovation can help to understand and coordinate exploration and exploitation activities between multiple actors (Chandler et al., 2019).

In business processes, multiple actors collaborate in operational sequences and structures to achieve "an outcome that is of value to at least one customer" (Dumas et al., 2018, p.6). Hence, customers—as co-creators of value—play a decisive

role in business processes, increasing the complexity of streamlining design activities across organizational boundaries (Patricio and Fisk, 2011). Business Process Management (BPM) research provides a systematic approach for structuring day-to-day work in organizations in order to achieve desired outcomes and sustain a competitive advantage (Hung, 2006; van der Aalst, 2013). In the IS discipline, BPM provides methods and technologies that support "the execution and management of processes in organizations" (Mendling et al., 2020, p. 209), following a top-down directed design approach (Mendling et al., 2020), which considers business processes as "a set of logically-related tasks performed to achieve a business outcome" (Davenport and Short, 1990, p. 4).

Besides digital transformation, organizations have to also manage internal changes that can impact value creation processes (Wessel et al., 2020). Hence, organizations are subject to both internal and external change mechanisms, requiring them to overcome inertia in their daily work practices (Wessel et al., 2020). Particularly innovation processes are becoming less bounded, open-ended, less predictable, and more fluid (Yoo et al., 2010), constituting a challenge for service systems since business processes and organizational structures are designed to provide continuity (Müller et al., 2006). So far, the BPM literature does not sufficiently address the requirement of being "permanently capable of adapting to new conditions" (Becker et al., 2003, p. 7) and reacting to unforeseen deviations that are performed by actors in service systems, including workarounds.

Organizational routines constitute an alternative theoretical lens on the performance of activities. In comparison to business processes, organizational routines apply a greater focus on the emergent character of work patterns in socio-technical systems (Dittrich and Seidl, 2018; Feldman, 2000). Most work in organizations is carried out in routinized ways (Becker and Zirpoli, 2008). Organizational routines are an established concept in the OS literature. Early conceptualizations describe organizational routines as "repetitive, recognizable patterns of interdependent actions, carried out by multiple actors" (Feldman and Pentland, 2003, p. 95). However, more recent literature considers organizational routines as dynamic "process[es] of (re)production, over time and space, through the ongoing effort of actants (people and things)" (Feldman et al., 2016, p. 505).

Organizational routines as a theoretical lens are based on structuration theory by Giddens (1984), consisting of two endogenously interacting elements that en-

able a dynamic and on-going change of work patterns, i.e., ostensive aspects and performative aspects (Feldman and Pentland, 2003). Ostensive aspects represent the organizational structure that guides an employee in their daily work activities, while performative aspects are the specific enactment of work patterns by certain actors (Feldman and Pentland, 2003). The performative aspects can vary in each instantiation and are dependent on prior actions, triggering an endogenous change process over the course of time (Pentland et al., 2012a). Thus, organizational routines inhibit both unanticipated change and the persistence of structures for an indefinite period of time (Feldman et al., 2016) through the performance of actors, e.g., in a service system.

> **Observation 3:** *The duality of exploration and exploitation of service system innovation can be approached from two converging theoretical lenses of business processes and organizational routines.*

To sum up, this dissertation is based on the observation that service system innovation is achieved through the interplay of the (intentional) design and the (unintentional) emergence of innovation in business processes and organizational routines. In this regard, as the theory of ambidexterity embodies both top-down and bottom-up driven innovation processes it constitutes a promising theoretical lens for designing and analyzing service system innovation.

1.2 Problem Statement and Research Questions

The acceleration of innovation cycles poses major challenges for organizations to survive in and adapt to a fast-changing hyper-competitive environment in which they need to constantly look out for, and respond to, emergent changes (Müller et al., 2019). In a volatile environment, where technologies have the potential to disrupt long-established structural patterns, organizations are required to maintain stability whilst also continuously having to adapt and improve their service to gain a competitive advantage (Luger et al., 2018). Still, there is a huge knowledge gap about how service organizations can balance these two requirements in order to remain successful in the long-term.

The theory of ambidexterity may be a viable approach with which to address this gap and mitigate the discrepancies between the simultaneous exploration and exploitation of resources (Raisch and Birkinshaw, 2008). Ambidexterity has been discussed in a growing body of research (O'Reilly III and Tushman, 2008) and recently permeated the IS literature as well. However, to apply the theory of ambidexterity for service system innovation an adaptation of its concepts and connotations is necessary (Yg, 1989). Hence, there is a need for new knowledge, which is maintained by the following two problems.

First, the theory of ambidexterity is rooted in new product development, in which managers need to balance the exploration and exploitation of innovation (Greve, 2007; Tushman and O'Reilly III, 1996). A profound difference between the design of products and service systems becomes apparent in the *goods-dominant logic (G-D Logic)* and *service-dominant logic (S-D Logic)* of Marketing (Vargo and Lusch, 2004). In the development of new products, a clear demarcation between a provider and customer is made (Barile and Polese, 2010). Hence, a new product is usually developed by an organization and then distributed to customers, creating value through the acquisition of tangible goods (value-in-exchange) (Vargo and Lusch, 2004). By contrast, in service system design, multiple actors (e.g., employees, customers, subcontractors, and other stakeholders) engage in *value co-creation*, integrating their resources and activities for their mutual benefit (Beverungen et al., 2019c), with value being provided through the (temporary) access to resources (value-in-use) (Vargo and Lusch, 2004). Hence, exploration and exploitation activities in service systems are more complex, requiring the engagement of many actors and the integration of multiple resources.

Second, while ambidexterity may be pursued by an organization or a corporate unit as a whole, its implementation has to be realized by the activities of actors (Gibson and Birkinshaw, 2004). An organization provides the structure and boundary conditions for the exploration and exploitation of innovations (Smith and Tushman, 2005), which enables and constrains human action (Pentland and Rueter, 1994). Individual actors, however, have the autonomy to decide which activities to engage in (Choudrie and Zamani, 2016), i.e., they have the flexibility to act otherwise, which can lead to the emergence of new social structures (Giddens, 1984). Hence, ambidexterity is rooted in both an organizational dimension that provides top-down directed guidance, and an individual dimension in which actors perform innovation activities (Raisch et al., 2009). Although these two lenses have already

been identified in the ambidexterity literature, e.g., by Gibson and Birkinshaw (2004) and Raisch et al. (2009), the interconnection and underlying mechanisms of these two dimensions have not been addressed sufficiently, to date. In particular, it remains unclear how top-down directed design and bottom-up driven innovation initiatives can be integrated. Hence, the following research problem is identified:

> **Research Problem.** *It is unclear how ambidexterity can be re-conceptualized for service system innovation. Particularly, approaches for reconciling top-down directed design and bottom-up driven emergence of innovation remain unexplored.*

To address this research problem, five research questions are derived that guide an in-depth analysis of ambidextrous service system innovation. In the following, the research questions are elaborated and justified against gaps in the current literature.

In IS research, a comprehensive understanding of the complex mechanisms of exploration and exploitation activities to achieve innovation in service systems is missing. Research on ambidexterity often assumes a top-down mandated approach for exploration that employees are expected to realize (Zimmermann et al., 2015). However, as employees are confronted with technological advancements and experience work constraints, ideas and initiatives for exploitation naturally emerge in day-to-day work (Azad and King, 2012). These emergent changes by employees can affect an organization as they diffuse bottom-up (Lapointe and Rivard, 2005). As already pointed out in current research, the diffusion of new ideas in service systems needs to be conceptualized as a recursive innovation process (Vargo et al., 2020). However, the theory of ambidexterity often takes a lopsided perspective on innovation, overlooking individuals as a source for innovation.

By taking a resource-based view on service system innovation, it becomes evident that organizations need to acquire specific capabilities to establish innovative service systems. In this regard, the availability and enactment of capabilities are regarded as a main driver for innovation (Dreiling and Recker, 2013). Capabilities are essential for transforming knowledge and ideas into new service systems, creating value for an organization and its customers (Dreiling and Recker, 2013). They "are embedded in [...] organizational routines, structures, and processes" (O'Reilly III and Tushman, 2008, p. 6-7). For this reason, capabilities constitute an

important part of service system innovation. However, little is known about which capabilities are actually needed. Therefore, the first research question is:

> **RQ1.** *How can ambidexterity reconcile conflicting views on the exploration and exploitation of capabilities and other resources for service system innovation?*

Research on the systematic design of service systems, i.e., *service system engineering* is still fragmented, lacking agile approaches that are quick-to-implement in volatile environments (Deutsches Institut für Normung e.V., 2019). Major challenges for the exploration and design of service systems are rooted in the development of new digital technologies, the involvement of multiple actors in mutual value co-creation, and high uncertainty in fast-developing environments (Grotherr et al., 2018). Disruptive technological advancements, like artificial intelligence, virtual reality, the IoT, and big data can act as both important resources and triggers for exploring innovative service systems (Höckmayr and Roth, 2017). Digital technologies, in particular, constitute an interconnecting bridge between service providers and consumers, transforming the interaction between participants in a service system and the value proposition itself, enabling the provision of services in real-time and remotely (Beverungen et al., 2019c).

Organizations frequently encounter discrepancies between two conflicting demands when designing service systems. On the one hand, service providers need to invest resources and explore new capabilities for designing innovative service systems (Duncan, 1976). On the other hand, they need to exploit an existing service and achieve incremental innovation in day-to-day business as well (Ojasalo and Ojasalo, 2018). Focusing only on the exploration of new innovative service entails a high risk of failure, while service organizations that only improve and exploit an existing service may become redundant over time (March, 1991).

Still, there is a lot of uncertainty among researchers and managers on how to achieve the balance between exploration and exploitation of innovation in service systems. This uncertainty is partly due to the issue that organizations often struggle with scarce resources for simultaneously exploring and exploiting innovation (Yu et al., 2013). In this regard, organizations are often under pressure to decide whether to deploy their resources for exploration—thereby exhausting resources for exploitation—or vice versa. An imbalance can entail economic losses for the organization in the long-term (He and Wong, 2004).

Recombination is argued to represent a promising procedure for remedying this conflict of scarce resources for ambidextrous service system innovation (Lusch and Nambisan, 2015). A recombinant design approach is based on the systematic reutilization and combination of existing resources that were previously unconnected, to achieve an innovative solution (Cecere and Ozman, 2014). However, extant methods and models do not provide sufficient guidance on how to systematically and flexibly design innovative service systems (Li and Peters, 2019). In line with the demand for prescriptive design knowledge (Gregor and Hevner, 2013; Rothe et al., 2020), the second research question is:

> **RQ2.** *How can innovative service systems be designed systematically and comprehensively through recombination?*

Service systems are complex in nature (Böhmann et al., 2014), as they incorporate a complex network of relationships between multiple actors that integrate and apply their knowledge, capabilities, and resources (Maglio et al., 2009). The mutual value creation in service systems is accordingly complex, phenomenological, and can grow beyond the sum of its constitutive parts (Demetis and Lee, 2016). This suggests that value creation is also contingent on the design of a particular service system and its constituent parts (Breidbach and Maglio, 2015). Existing methods and models for service system engineering are often implemented as a *one-size-fits-all* approach, disregarding the existing structures, business processes, and information systems of any given socio-technical system (Deutsches Institut für Normung e.V., 2019). In this regard, more dynamic, inclusive, and integrative approaches for designing service systems are required that consider all actors and inherent socio-technical structures (Vargo et al., 2020).

In commoditized markets with strong competition, organizations seek alternative ways to capture value (Schüritz et al., 2017b). Many manufacturers have acknowledged that the design of innovative service systems as complementary offers to their product portfolio can provide a great opportunity (Baines et al., 2009). This strategy is conceptualized as *servitization* (Vandermerwe and Rada, 1988). Although the trend of servitization has existed since the 1980's (Vandermerwe and Rada, 1988) and numerous success cases of servitization have been published (e.g., by Spohrer et al. (2007), Baines et al. (2009), or Matthyssens and Vandenbempt (2010)), reports show that managers still find it a challenge to transform their

business into a service organization (Industrial and Financial Services AB, 2017). Sometimes, organizations even have to reverse the servitization strategy due to internal or external obstacles (Finne et al., 2013).

In line with these identified problems, the third research question reads:

> **RQ3.** *Which challenges do organizations encounter in a top-down driven service system transformation approach?*

Service system innovation often assumes a uni-directional flow of innovation that diffuses top-down (Vargo et al., 2020), i.e., from an organization to a customer. However, they can also emerge bottom-up (Beverungen et al., 2019b) when employees, who work on a daily basis with IT artifacts such as constructs, models, methods, and instantiations (March and Smith, 1995), are confronted with a misfit (van Beijsterveld and van Groenendaal, 2016) or identify an opportunity towards greater efficiency (Dunford and Perrigino, 2018). This way, employees may either use an IT artifact in unintended ways (non-conform with the design's *spirit*), or change a service process or IT artifacts according to their individual needs—what has been termed *appropriation* (Straub, 2012). While many types of deviations have been discussed in research, such as non-compliance (Alter, 2015b), resistance (Lapointe and Rivard, 2005), fraud (Bagayogo et al., 2013), shadow IT (Fürstenau and Rothe, 2014), or workarounds (Röder et al., 2016), little is known about how these deviations emerge.

Especially the concept of workarounds may constitute an important source for bottom-up innovation as they represent goal-oriented behavior, which may lead to a higher level of efficiency or effectiveness (Ejnefjäll and Ågerfalk, 2019). Workarounds are defined as an alternative way of conducting work activities when "a path to a goal is blocked" (Koopman and Hoffman, 2003, p. 71). Workarounds can also be "creative acts, and [...] sources of future improvements" (Alter, 2014, p. 1052), and may, therefore, act as an important source for innovation (Mendel, 2017).

The detection of workarounds provides managers with the opportunity to gain a deeper understanding of the perceived value of service innovation in the context of use (Beckman and Barry, 2007). In this regard, managers can "understand why users act as they do, and how [they] make sense of what they do for themselves

and for others" (Beckman and Barry, 2007, p. 32). Accepted methods for detecting workarounds are often qualitative approaches, e.g., observations and interviews (Beerepoot et al., 2018). However, they depend on two factors. First actors have to be aware that they are performing a workaround, and second, they have to be willing to talk about them. Another drawback is the labor-intensity of these methods (Beerepoot et al., 2018). Hence, most workarounds remain unnoticed by managers unless they directly collaborate with operational staff.

In light of this, in order to leverage the innovation potential of workarounds it is important to understand work patterns by designing new methods for analyzing change (Grisold et al., 2020) and detecting workarounds in organizations (Beerepoot et al., 2018) to leverage their innovation potential. Hence, the following research question is derived:

> **RQ4.** *How do workarounds and work patterns emerge in a service system as actors deviate from organizational routines and business processes?*

Workarounds are supposed to be the "soul of innovation" (Norman, 2008, p. 48). However, managers need the ability to recognize their innovation potential (Norman, 2008). Deviance from described processes can threaten the standardization of business processes and impact an organization's performance (Pentland et al., 2012a). Hence, as managers detect a workaround, they need to devise corresponding actions, either by adopting them, (re-)designing the process and/or the IT artifacts, or by putting in place countermeasures to prevent their occurrence (Beerepoot and van de Weerd, 2018).

Workarounds are often examined in isolation, neglecting the interaction effects. Yet, it is important to understand how they manifest in organizational routines in which multiple actors are involved. Research indicates that workarounds can spread through the mechanisms of socialization (Safadi and Faraj, 2010) and, "as a particular form of organizational routines" (Beverungen, 2014, p.191), they can solidify in organizational routines and business processes, in IT artifacts, and in organizations as socio-technical systems. Still, it is unclear how workarounds emerge and diffuse in a socio-technical system.

Based on this problem statement, the following research question is raised:

> **RQ5.** *How can organizations create service system innovation through bottom-up driven transformation?*

The thesis follows the approach of "evocative theoretical boundary spanning" for radical theorizing (Nadkarni et al., 2018, p.373), as it acknowledges “the important dialectic between theory and the phenomena or practices to which it relates” (Gulati, 2007, p.780). In this regard, a *type II theory* (Gregor, 2006) is developed for providing descriptive knowledge about ambidextrous service system innovation and its interrelated concepts. In addition, a *type V theory* (Gregor, 2006) is designed that provides prescriptive knowledge by designing methods for service system engineering and workaround detection, enabling a dual-sided innovation process of exploration and exploitation.

1.3 Structure of the Dissertation and Research Contribution

The five identified research questions in Section 1.2 are forming the subject of in-depth exploration presented in several articles . The papers are contextually linked within the scope of the overall research objective. Thus, this thesis is structured into two main parts: Part A and Part B.

In Part A, the research is positioned in the context of *service system innovation* by adopting an ambidexterity perspective. The topic, relevance, and scope of the thesis are outlined. The remainder of this thesis is structured as follows: In Section 2, the theoretical foundations of service science, ambidexterity in service systems, and the design and emergence of service systems are discussed, embedding the thesis into the discourse of IS research. Section 3 justifies the multi-method approach that was applied to answer the identified research questions. In Section 4, a synopsis of the main research findings is provided and the contribution and implications are elaborated. In addition, the limitations of this research are discussed and some avenues for future research outlined.

Part B consists of eleven peer-reviewed publications—as a subset of the entire list of publications—that have been published in academic journals and conference proceedings.[1] Academic outlets include the *Information Systems Journal*, *Business and Information Systems Engineering*, Proceedings of the *International Conference on Information Systems*, the *European Conference on Information Systems*, the *Hawaii International Conference on System Sciences*, and the *International Conference on Wirtschaftsinformatik*.

The publications provide a multi-faceted view on the central concepts of ambidextrous service system innovation (Section 1—Section 5). In this regard, the research results of the publications complement each other to provide a "theoretically bold" contribution (Nadkarni et al., 2018) for describing and prescribing service system innovation from an ambidexterity perspective. The papers in Part B are arranged by topic, based on the line of argumentation.

The structure of the thesis and corresponding publications is illustrated in Fig. 1.1. Part B, Section 1, examines the status quo in research and necessary capabilities for establishing ambidextrous service system innovation (Papers P1 and P2). Section 2 conceptualizes the systematic design and (re-)design of service, including the organization as a socio-technical system as a top-down approach (Papers P3 and P4). Section 3 empirically explores the top-down driven service system transformation and its challenges (Papers P5 and P6). In Section 4, innovation through deviations in organizational routines and the emergence of workarounds are examined (Papers P7 and P8). Section 5 investigates the bottom-up driven transformation of service systems through workarounds in organizational routines and business processes, which can remedy paradoxes that have been identified in the BPM discipline (Papers P9, P10, and P11).

In the following, the main contributions of the papers in Part B are summarized, outlining the descriptive and prescriptive knowledge in order to answer the dissertation's research questions.

P1. *Ambidexterity in Service Innovation Research: A Systematic Literature Review.* Innovation in service systems is a key economic driver that also became a research priority in IS (Patrício et al., 2018). Over the last two decades, the literature

[1] The content of the publications included in Part B was not modified. However, minor adaptions have been made, including the correction of spelling errors, the standardization of labels, tables, footnotes, and abbreviations to ensure consistency with the thesis' layout. In this regard, the size and position of figures and tables may slightly differ from the original publications.

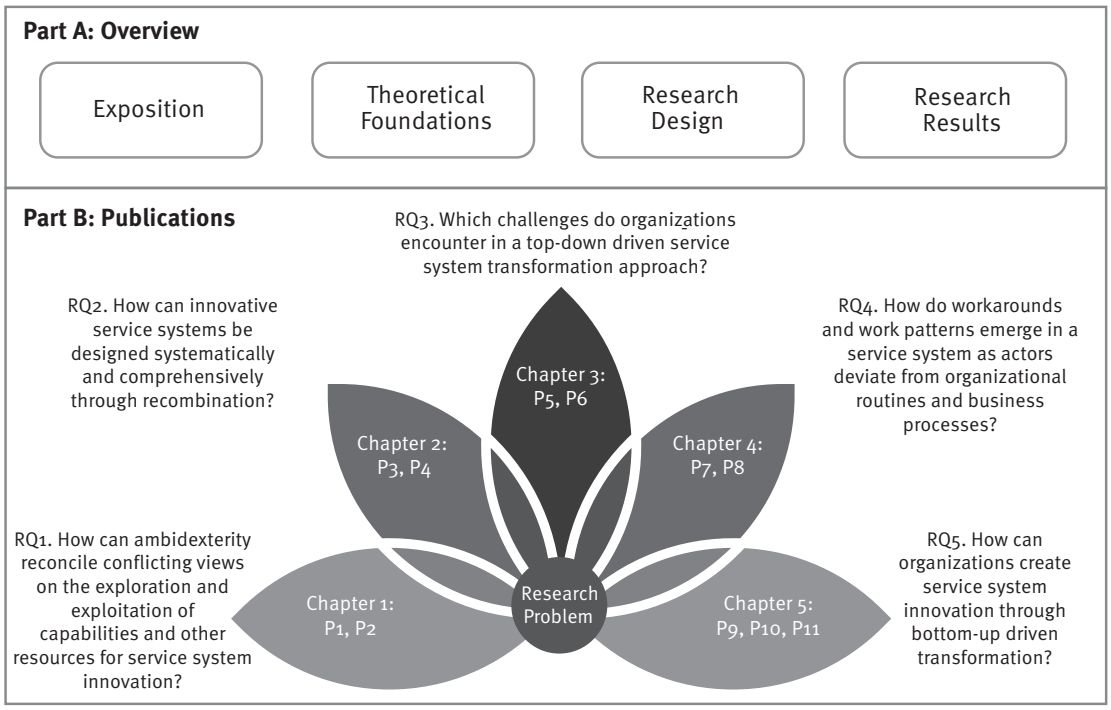

Figure 1.1: Ambidextrous Service System Innovation

on service system innovation has kept pace with this development and addressed multiple aspects, but at the cost of it having become rather fragmented (Spohrer et al., 2014). This paper takes an integrative ambidextrous view on the existing literature of service system innovation. For this purpose, a literature analysis is performed, identifying to what extent exploration and exploitation are already covered in service science. The analysis reveals that service innovation articles focus either on exploration or exploitation. A framework is developed to remedy this disconnectedness, illustrating how ambidextrous service system innovation can be achieved. The framework contributes to an advanced understanding of the dynamism and generative mechanisms involved in exploring new, and exploiting existing, resources, activities, and knowledge in order to enable ambidextrous service system innovation. With regard to digital transformation, technology is positioned as an important resource for designing new and improving existing service systems. In this paper, the gap between ambidexterity and service literature is bridged, thus partially answering RQ1.

P2. *Capabilities for Ambidextrous Innovation of Digital Service.* Exploring and exploiting an innovative service requires specific capabilities of actors in a service system. Although capabilities have been acknowledged as an important source

of innovation, it is unclear which capabilities are needed to enable ambidextrous service innovation in socio-technical systems. In this paper, a Delphi study is conducted to identify individual and organizational capabilities for exploring and exploiting a service. While organizational capabilities are embedded in the corporate structure and in organizational routines, individual capabilities are enacted by employees in their day-to-day work. Based on data collected from a panel of experts, a matrix is developed, outlining capabilities for ambidextrous service innovation, i.e. for developing and managing new services and improving existing ones. The results of the paper demonstrate that both individual and organizational capabilities are complementary and constitute necessary assets for transforming ideas into an innovative service. Hence, this article complements P1 and the two together are fully answering RQ1.

P3. *Recombinant Service System Engineering.* A range of methods published in IS research provide guidelines for systematically designing service systems. However, most approaches are complex, overengineered, resource-intense, and give little flexibility for reacting to (unforeseen) environmental changes, e.g., changes that are driven by digital transformation. The contribution of this paper is threefold: First, it provides a state-of-the-art overview of service (system) engineering methods based on the conceptual analysis of 24 existing service (system) engineering methods, at the end of which a concept matrix is developed to provide a systematic overview. Second, it proposes four design principles for a new class of methods that enable resource-efficient and flexible service system engineering through recombination. Third, based on the proposed design principles, a method for top-down driven service system engineering is designed that allows to recombine existing and new elements in a service system. The results of this article partially answer RQ2.

P4. *Understanding Smart Service System Transformation—A Socio-Technical Perspective.* The implementation of a new service system can have a significant impact on an organization, triggering a domino-effect that necessitates a (re-)alignment of the existing elements in its organizational structure (Barile and Polese, 2010). Hence, the design of service systems involves a large-scale transformation process of the organization. In the current absence of theoretical insights on how to transform a service organization, a case study is conducted, demonstrating which aspects need to be considered while designing a new service system. By taking a socio-technical perspective, six key elements are identified that can be used to

design the transformation of service organizations. Notably, organizations have to cannibalize existing structures and processes in order to support value co-creation and co-production. Thus, this article completes the answer to RQ2.

P5. *Establishing Smart Service Systems is a Challenge: A Case Study on Pitfalls and Implications.* Despite the large number of tools, methods, and models available for establishing innovative service systems, organizations still fail to implement them. This apparently contradictory observation demonstrates the gap between current research and management perspectives, which is addressed in P5. By conducting a revelatory case study in an organization that failed to establish a pay-per-use service for a smart laundry machine, several pitfalls were identified and discussed. It turns out that service system engineering is a systemic approach that goes beyond developing service-oriented value propositions. Hence, the results of this article partially answer RQ3.

P6. *The Impact of Process Automation on Manufacturers' Long-Term Knowledge.* The establishment of innovation in service systems is only possible when actors participate in knowledge-based interactions (Maglio and Spohrer, 2008). In this regard, actors integrate their resources and use their knowledge to create value-in-use (Grönroos and Gummerus, 2014). Through the digitalization and automation of processes, less human interactions take place, as information to customers is provided through technology-driven self-service or chat bots. Further, many organizations outsource processes to save costs. In this article, multiple semi-structured interviews were conducted with key personnel that were responsible for re-designing processes to achieve a higher automation rate. In non-automated processes, knowledge is embedded in the routines of employees who perform day-to-day work in business processes. The results show that outsourcing and automation will impede access to an organization's knowledge base and diminish long-term knowledge about processes, services, and technology, thereby reducing the required resources for future innovations. The insights of this article complete the answer to RQ3.

P7. *Digitalization of Work Systems—An Organizational Routines' Perspective.* Innovation in service systems can also emerge bottom-up through the actions of humans, such as employees, customers, and other stakeholders. One suitable lens for examining the behavior of actors, and deviance from described processes, are organizational routines. In this paper, a qualitative study is conducted with 14 in-

formants, holding different positions in an organization. The analysis of interview data reveals that organizational routines change endogenously as actors use IT artifacts to perform their work activities. Four atomic patterns are proposed to explain the mechanisms whereby IT artifacts are digitally transforming routines, which also consider the impact that routines might have on the design and emergence of IT artifacts. Moreover, the patterns can be concatenated to illustrate transformation trajectories, describing how deviance can lead to an unofficial (re-)design process. Accordingly, the article partially answers RQ4.

P8. *Detecting Workarounds in Business Processes—A Deep Learning Method for Analyzing Event Logs.* Workarounds are often regarded as non-conformance to prescribed business processes. However, they can also be a valuable source of innovation as they help to identify and re-structure inefficient or outdated processes in service systems. Still, many workarounds remain invisible as there are no suitable methods available for detecting them. As a result, the innovation potential of workarounds cannot be fully exploited either. In this work, a deep-learning based method is designed that enables researchers and managers to detect and analyze workarounds in event logs. The method constitutes a new application of the analysis of organizational data, leveraging the exploration and exploitation of innovation potential of workarounds. Hence, the method developed in this article completes the answer to RQ4.

P9. *Workarounds as Generative Mechanisms for Restructuring and Redesigning Organizations—Insights from a Multiple Case Study.* Although workarounds have been acknowledged as an important source of innovation, and research has pointed out antecedents and types of workarounds, the question of how they emerge and diffuse in organizations has not been addressed. Up to now, there is no research (to the best of our knowledge) on how and why workarounds can transform a socio-technical system, from the bottom-up. Based on research about workarounds in business processes and organizational routines, a multiple case study is conducted in this paper to understand the occurrence and diffusion of workarounds in organizations. The data analysis reveals that workarounds occur when the organizational structure, the individual performance of actors, and IT artifacts are misaligned. They diffuse a socio-technical system by the means of observation and communication, and in so doing they have the potential to redesign IT artifacts, establish new work practices, and trigger innovation processes. Consequently, this article partially answers RQ5.

P10. *Conceptualizing the Impact of Workarounds—An Organizational Routines' Perspective.* The theory of workarounds (Alter, 2014) has pointed out the direct effects of workarounds, e.g., that employees can continue their work activities despite misfits, burdens, or anomalies. However, workarounds have been mostly studied on an individual level, i.e., how they impact the performance of an actor's own performance of organizational routines. To gain a deeper understanding of the immediate impact of workarounds on the activities of co-workers, a multiple case study was conducted in this article. Based on empirical data, six patterns were identified that are structured in a framework, which consists of three distinct types of collaboration and two different types of handoffs. The data show that workarounds are complex phenomena that can have desired and undesired consequences. This article supplements the results from P9, as it takes a different lens on the diffusion of workarounds. Thus, it partially contributes to answering RQ5.

P11. *Seven Paradoxes of Business Process Management in a Hyper-Connected World.* In order to understand how innovation emerges bottom-up and manifests in socio-technical structures, an examination and comprehension of business processes—the main component of an organization's DNA—is necessary. From a socio-technical perspective, business processes can be considered as organizational structures that are created and re-created by human actions (Beverungen, 2013). On the one hand, workarounds can lead to the emergence of innovative service systems; on the other, organizations also need to standardize business processes—and thereby suppress the emergence of workarounds—to achieve economies of scale. In this article, seven paradoxes of BPM are identified and discussed that have occurred in a digitally transforming and hyper-connected environment. As this article relates to the results of P9 and P10, it completes the answer to RQ5.

RQ	No.	Authors	Title	Outlet	VHB JQ3	Points
RQ1	P1	Wolf	Ambidexterity in Service Innovation Research: A Systematic Literature Review	WI2019	C	1
	P2	Wolf, and Lüttenberg	Capabilities for Ambidextrous Innovation of Digital Service	WI2020	C	0.6
RQ2	P3	Beverungen, Lüttenberg, and Wolf	Recombinant Service System Engineering	BISE	B	0.3
	P4	Wolf	Understanding Smart Service System Transformation—A Socio-Technical Perspective	ECIS2020	B	1
RQ3	P5	Wolf, Franke, Bartelheimer, and Beverungen	Establishing Smart Service Systems is a Challenge: A Case Study on Pitfalls and Implications	WI2020	C	0.5
	P6	Gernreich, Bartelheimer, Wolf, and Prinz	The Impact of Process Automation on Manufacturers Long-Term Knowledge	ICIS2018	A	0.3
RQ4	P7	Wolf, Bartelheimer, and Beverungen	Digitalization of Work Systems—An Organizational Routines' Perspective	HICSS2019	C	0.45
	P8	Weinzierl, Wolf, Pauli, Beverungen, and Matzner	Detecting Workarounds in Business Processes—A Deep Learning Method for Analyzing Event Logs	ECIS2020	B	0.35
RQ5	P9	Wolf, Bartelheimer, and Beverungen	Workarounds as Generative Mechanisms for Restructuring and Redesigning Organizations—Insights from a Multiple Case Study	Working Paper	–	0.45
	P10	Wolf, and Beverungen	Conceptualizing the Impact of Workarounds—An Organizational Routines' Perspective	ECIS2019	B	0.75
	P11	Beverungen, et al.	Seven Paradoxes of Business Process Management in a Hyper-Connected World	BISE	B	0.04
Σ						**6.04**

Table 1.1: List of Publications in Part B

2 Theoretical Foundations

2.1 Service Research

2.1.1 Four Transformation Waves in Service Research

Service research is anchored in more than 24 academic disciplines (Spohrer et al., 2014), and in the last decades, it has also become a key discipline in IS (Beverungen et al., 2019a). The concept of service refers to "the application of specialized competences (knowledge and skills) through deeds, processes, and performances for the benefit of another entity or the entity itself" (Vargo and Lusch, 2004, p. 2). Over the last 40 years, service and the environment in which services are designed and experienced have undergone drastic changes (Ostrom et al., 2015), which can be summarily described by four major waves of transformation (see Fig. 2.1).

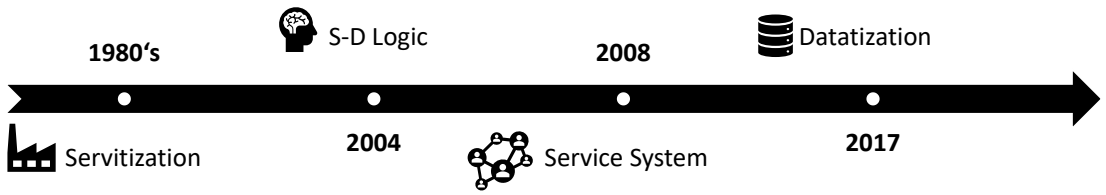

Figure 2.1: Four Transformation Waves of Service Research

Since the 1980’s service research was fueled by *servitization*—the modification of business models and organizational structures (Ostrom et al., 2015) offering integrated value bundles (Baines et al., 2009)—and *service infusion*—the process of "adding customer-centered services to a product-centric business model" (Zeithaml and Brown, 2014, p. xiv). Servitization and service infusion include the transformation of value creation processes, which build customer relationships, and the integration of new technologies to support them (Ostrom et al., 2015; Salonen

et al., 2017). Both the transformation and the integration processes have led to an increase in complexity, which in turn has radically transformed both organizations and whole economies. Over one-third of the leading manufacturing organizations have become service providers (Cavalieri et al., 2018). But innovative services have also the power to transform an entire economy. Especially in developing countries, economic progress can be accelerated despite limited access to resources (Barrett et al., 2015).

In 2004, the conceptualization of service has shifted from a firm-centric and transactional view towards a customer-oriented and relational perspective (Breidbach and Maglio, 2015; Gummesson et al., 2010). A broadly adopted conceptualization of service, which is in line with the relational view of value creation is *S-D Logic* by Vargo and Lusch (2004). In this view, the service paradigm includes a set of foundational premise (FPR) that are based on the notion that service is the foundation of all economic exchange and value creation (Vargo and Lusch, 2004). One transformative and widely adopted FPR is that organizations can only make value propositions to customers (Vargo and Lusch, 2004). Hence, the value is determined by the customers who can decide whether or not they would like to engage in value co-production through the integration of resources (Chandler and Lusch, 2015; Vargo and Lusch, 2004). In this regard, S-D Logic transforms the traditional notion of services being distinctive from goods. In fact, service is a transcending concept (Lusch and Nambisan, 2015) that can be regarded as "hypernymic to goods" (Lusch and Vargo, 2006, p. 282).

In 2008, the concept of service systems was introduced as a new theoretical lens (Vargo et al., 2008) and established as *basic abstraction in Service Science* (Maglio et al., 2009; Spohrer et al., 2008). The concept of a system is rooted in the ancient Greek word "sústēma", meaning "organized whole" (Polese et al., 2020). Service systems describe a dynamic "configuration of people, technologies, and other resources that interact with other service systems to create mutual value" (Maglio et al., 2009, p. 395). These elements are linked within and across service systems by a value proposition (Maglio et al., 2009). The boundaries of service systems cannot be delineated (Böhmann et al., 2014) because they range from a few individuals to a large groups of actors within and across entire organizations that apply and exchange resources with other systems (Vargo et al., 2008).

Besides the notion of service systems, related concepts of *product service systems*, *service ecosystems*, and *smart service systems* are frequently discussed in the service literature. To provide conceptual clarity, the concepts are delineated in Tab. 2.1. While the focus in product service system (PSS) lies on the provision of services as offerings, all other definitions, including the definition of service systems itself, share the notion that value is co-created for mutual benefit. Hence, adopting a systemic perspective on service allows a deep understanding of complex and dynamic value creation processes (Barile et al., 2016; Maglio and Spohrer, 2008). In this perspective, value emerges through the configuration of human and nonhuman actors (Wessel et al., 2019) and their resources in a service system (Vargo and Lusch, 2014).

Concept	Definition
Service system	"Configuration of people, technologies, and other resources that interact with other service systems to create mutual value" (Maglio et al., 2009, p. 395).
Service ecosystem	"Relatively self-contained self-adjusting systems of resource integrating actors connected by shared institutional logics and mutual value creation through service exchange" (Lusch and Nambisan, 2015, p. 161).
Product service system	"A product service system is an integrated product and service offering that delivers value in use" (Baines et al., 2007, p. 3).
Smart service system	"Smart service systems are service systems in which smart products are boundary-objects that integrate resources and activities of the involved actors for mutual benefit" (Beverungen et al., 2019c, p. 12).

Table 2.1: Salient Definitions of Related Concepts to Service Systems

Recent research streams acknowledge *datatization* as the next wave of service transformation (Hunke et al., 2018; Lehrer et al., 2018; Lim and Maglio, 2018; Rizk et al., 2018; Schüritz et al., 2017b). Datatization describes "an organization's capabilities and processes to change its value proposition by utilizing data analytics" (Schüritz et al., 2017b, p.4). Leveraging data analytic methods allows the contextualization (Hunke et al., 2018) and individualization of service (Beverungen et al., 2019c), reconciling spatial, temporal, and physical limitations (Nyström and Mickelsson, 2019). This way, datatization enables new data-based and data-driven business models (Schüritz et al., 2017a).

As can be inferred from these four waves of service transformation, service is subject to continuous change. As the amount and velocity of data generation and

analysis constantly increases, innovation cycles for service system innovation need to become shorter, enabling services to be provided in real-time (Lehrer et al., 2018). In this regard, new approaches are necessary to enable flexible and agile service innovation.

2.1.2 Innovation in Service Systems

Although the concept of service systems innovation has been much studied in service research in recent years it is often considered as a "black box" (Gustafsson et al., 2020; Lusch and Nambisan, 2015), in that its complex internal workings are still not readily understood. Most definitions take a service-centric innovation perspective (Ostrom et al., 2010; Patrício et al., 2018; Peters et al., 2016; Rubalcaba et al., 2012; Toivonen and Tuominen, 2009), without considering the configuration of the service system as a whole (see Tab. 2.2 for an overview on service (system) innovation definitions). In this thesis, the definition by Maglio and Breidbach (2014, p. 167) is adopted, defining service system innovation as "recombinations of the roles and relationships among service system resources, including technological resources" for which it "requires basic science and engineering."

In the service literature, the term innovation is applied to both new service systems and improved existing ones (Alter, 2008). Innovation can emerge ad hoc (through interaction), can be anticipatory (derived from abstract customer needs), or occur as a result of the formalization of standardized processes (Barrett et al., 2015; Gallouj, 2002). Several attributes impact the success of an innovation: (1) the perceived value of a novel idea, (2) its compatibility with an organization's values and beliefs, and (3) the maturity of a service (Vargo et al., 2020).

Authors	Definition
Alter (2008, p. 8)	"Service system innovation typically involves mutually algined changes in multiple elements of a service system."
Breidbach and Maglio (2015, p. 2)	"We define service innovation as service system reconfiguration, which helps to avoid the inconsistencies of existing service innovation perspectives."
Den Hertog et al. (2010, p. 494)	"A service innovation is a new service experience or service solution that consists of one or several of the following dimensions: new service concept, new customer interaction, new value system /business partners, new revenue model, new organizational or technological service delivery system."
Lusch and Nambisan (2015, p. 161)	"Service innovation can then be considered the rebundling of diverse resources that create novel resources that are beneficial (i.e., value experiencing) to some actors in a given context; this almost always involves a network of actors, including the beneficiary (e.g., the customer)."
Ostrom et al. (2010, p. 5)	"Service innovation creates value for customers, employees, business owners, alliance partners, and communities through new and/or improved service offerings, service processes, and service business models."
Chandler et al. (2019, p. 85)	"Innovation [is] a dialectical process by which viable service ecosystems emerge. In these ways, innovation is a systemic process propelled by institutional reconciliation."
Maglio and Breidbach (2014, p. 167)	"Service system innovation results from recombinations of the roles and relationships amongs service system resources, including technological resources, and also requires basic science and engineering."
Patrício et al. (2018, p. 3)	"Service innovation can be defined as a new process or service offering that is put into practice by an organization, and is adopted by, and creates value for one or more actors in a service network."
Peters et al. (2016, p. 137)	"Service innovation includes novel ways of configuring service operations and novel ways of creating customer value that often depend on using new technology and new information."
Rubalcaba et al. (2012, p. 708)	"Service innovation relates to innovations of value constellations, according to the foundational premise that all social and economic actors are resource integrators. In other words, a service innovation provides new resources, available to customers in value constellations."
Toivonen and Tuominen (2009, p. 893)	"A service innovation is a new service or such a renewal of an existing service which is put into practice and which provides benefit to the organisation that has developed it."

Table 2.2: Definitions on Service (System) Innovation

Depending on their degree of newness, service innovations can be systematized into *radical* and *incremental* innovation. Service system innovation is radical when it's both unique and novel (Carlo et al., 2012). In this regard, they significantly differ from the existing solution, particularly in terms of their structure, processes, or the business model (Carlo et al., 2012; Johnson et al., 2000). Incremental innovations, in contrast, are achieved through improvements or reconfigurations

of a preexisting service (Gallouj and Weinstein, 1997; Pagani, 2013). However, the classification into radical or incremental innovation is often less binary and, on a continuum, ranging from radical to incremental (Carlo et al., 2012).

A common assumption in service science and organizational science is that managers guide service design processes (Wessel et al., 2019), which has been termed 'naive top-down-ism' (Pentland and Feldman, 2008). However, the innovation process in service systems is recursive as it includes both the emergence and the diffusion of ideas (Vargo et al., 2020). Moreover, to leverage a service system's full innovation potential requires collective enactment and the integration of a novel idea within its social structures (Rogers, 2016). As actors in a service system interact, an existing service is re-created and transformed into a new innovative value proposition (Akaka et al., 2012). In this regard, the adoption of new ideas is a social process that cannot be considered as an isolated or subsequent process of service system innovation (Vargo et al., 2020).

Service innovation can be created in structured or loosely coupled systems (Sundbo and Gallouj, 2000). A structured system is characterized by "long-lasting relations and cooperation through contracts and accepted norms (i.e., institutions)" (Vargo et al., 2020, p. 6), while a loosely coupled system does not have "fixed behavioral patterns and traditions" and includes "in-observable elements like intuitive ideas" (Sundbo and Gallouj, 2000, p. 18) that are generated by employees whose identity often remains unknown. In this regard, structural flexibility—allowing actors to have agency to design an innovative service—and structural integrity—strengthening the relationships between actors in a value network—are needed to establish an innovative service. This duality is also reflected in the reciprocal relationship of exploration and exploitation (Lusch and Nambisan, 2015).

2.2 Ambidexterity in Service Systems

2.2.1 Theory of Ambidexterity

The theory of ambidexterity was first introduced by Duncan (1976). In general, ambidexterity describes the "ability to simultaneously balance different activities in a trade-off situation" (Rothaermel and Alexandre, 2009, p. 759). The theory

offers a viable approach to understand and explain the existing duality of exploration and exploitation despite scarcity of resources (March, 1991). Exploration focuses on the development of fundamental new service innovations (Sok and O'Cass, 2015) by searching for new opportunities, diversification, or entering new markets. However, with exploration discrepancies can arise with an existing service and organizational structures (Müller et al., 2019; Werder and Heckmann, 2019). Exploitation, on the other hand, describes improvements or minor adjustments of an existing service (Sok and O'Cass, 2015) through the efficient utilization of resources and capabilities (Müller et al., 2019).

To date, there is no consensus about the definitions and connotations of the fundamental concepts of ambidexterity (Gupta et al., 2006). While there is a shared understanding of exploration, referring to radical top-down driven innovation, long-term orientation, extension of the search scope, acquisition of new knowledge, variation, and experimentation (Gilsing and Nooteboom, 2006; Katila and Ahuja, 2002; Lavie et al., 2010; March, 1991; O'Reilly III and Tushman, 2008; Tushman and O'Reilly III, 1996), the conceptualization of exploitation is inconsistent (Gupta et al., 2006). Some scholars use exploitation to refer to control, inertia, variance reduction, stability, and deployment of existing knowledge (Andriopoulos and Lewis, 2009; Chang et al., 2009; Gibson and Birkinshaw, 2004; Lavie et al., 2010); other scholars emphasize that exploitation refers to the acquisition of new knowledge, bottom-up driven variation, improvements, and incremental innovation (Gupta et al., 2006; Katila and Ahuja, 2002; O'Reilly III and Tushman, 2008; Tushman and O'Reilly III, 1996). In order to establish an ambidextrous service organization, it is critical to provide conceptual clarity. Tab. 2.3 outlines the key properties of exploration and exploitation adopted in this thesis.

Dimension	Exploration	Exploitation
Degree of novelty (Gilsing and Nooteboom, 2006)	Radical innovation	Incremental innovation
Strategy (O'Reilly III and Tushman, 2008)	Top-down strategic intent	Bottom-up generation of variation
Focus (Lavie et al., 2010)	Long-term	Short-term
Search behavior (Katila and Ahuja, 2002)	Search scope	Search depth
Transitional process (March, 1991)	Knowledge acquisition, experimentation, flexibility, variation, discovery	Knowledge development, adaptation, efficiency, refinement, choice

Table 2.3: Properties of Exploration and Exploitation

Organizations often experience a contradictory tension between the exploration and exploitation of resources, knowledge, and activities (Montealegre et al., 2019). Three types of ambidexterity (see Tab. 2.4) are established in the literature to remedy this tension: structural, sequential, and contextual. Early research proposed *structural ambidexterity*, emphasizing the dual structure of organizations, whereby one unit concentrates on exploitation while another emphasizes exploration (Duncan, 1976). At the same time, *sequential ambidexterity* was proposed, stating that organizations can pass through two distinct temporal cycles instead of simultaneous exploration and exploitation (Lavie et al., 2010). The latest view on simultaneous exploration and exploitation is *contextual ambidexterity*, which is embedded in the actions of employees in an organization (Gibson and Birkinshaw, 2004). While structural and sequential ambidexterity have turned out to be ineffective for most organizations (Holotiuk and Beimborn, 2019; O'Reilly III and Tushman, 2013), contextual ambidexterity has been established as a viable approach for exploring and exploiting innovations simultaneously and remaining successful in a dynamically changing environment (March, 1991).

Ambidextrous organizations need to be "aligned and efficient in their management of today's business demands, while also adaptive enough to changes in the environment [in which] they will still be around tomorrow" (Gibson and Birkinshaw, 2004, p. 209). Recent approaches acknowledge that ambidexterity constitutes a steady and self-reinforcing process of orchestrating contradictory efforts by recombining different resources and assets (Göbeler et al., 2020; Jansen et al., 2009). In order

	Structural Ambidexterity	Sequential Ambidexterity	Contextual Ambidexterity
Description	Tensions between exploration and exploitation are remedied through two different sub-units in an organization, which address one of the goals.	Discrepancies between exploration and exploitation coexist in the same organizational unit but are addressed at different periods of time.	The ability of an organization to simultaneous pursue of exploration and exploitation in one business unit.
Authors	Gibson and Birkinshaw (2004), Tushman and O'Reilly III (1996), Duncan (1976)	Raisch and Birkinshaw (2008), Lavie et al. (2010), Turner et al. (2013)	Zaidi et al. (2015), Chang et al. (2009)

Table 2.4: Synopsis of Ambidexterity Types

to manage ambidextrous service system innovation, organizations need to apply complementary cycles of integration and differentiation (Göbeler et al., 2020).

The theory of ambidexterity has been applied in domains like organizational learning (March, 1991), organizational structure (Gibson and Birkinshaw, 2004), and technology innovation (He and Wong, 2004), but rarely in Service Science[2] to investigate the simultaneous design (through *service system engineering*) and emergence (through *workarounds*) of innovation in service systems. Hence, it needs to be examined how contextual ambidexterity can be achieved in service system engineering that is driven by mutually constitutive top-down and bottom-up innovation mechanisms.

2.2.2 Exploration through Service System Engineering

In order to foster service system innovation, researchers call for knowledge on the development of complex service systems and value networks (Ostrom et al., 2015). For many decades, only few methods and little design knowledge were available to support the systematic development of service systems (Alam and Perry, 2002; Böhmann et al., 2014; Bullinger et al., 2003; Yang, 2007). Organizations often relied on "a hit-and-miss approach when developing new services" (de Brentani,

[2] The theory of ambidexterity is discussed as strategic goal by Yu et al. (2013) and for New Service Development (NSD) by Menor et al. (2002).

1989, p. 239). However, in the 1980's the first models and frameworks for developing a new service were proposed (Alam and Perry, 2002). Since service research is dispersed across many disciplines (Spohrer et al., 2014), different paradigms for establishing a new service have emerged, such as *NSD*, *Service Design*, and *Service (System) Engineering*. Although these three paradigms focus on the same subject, they adopt a different perspective on how a service should be designed.

Research on NSD is rooted in the Anglo-American literature of the 1980's (Meiren and Barth, 2002) and highlights the differences between designing tangible products and a service. Publications in this research stream often adopt a service management or service marketing perspective (Papastathopoulou and Hultink, 2012). NSD describes the "overall process of developing new service offerings" (Johnson et al., 2000, p. 5). The first models, e.g., by Bowers (1987) and Scheuing and Johnson (1989), proposed linear approaches with stages from idea generation to market launch (Alam and Perry, 2002). Success factors, such as service quality, newness, or competitiveness have also been identified as critical for NSD (de Brentani, 1989). Since then, the number and scope of research articles on NSD has increased (Papastathopoulou and Hultink, 2012). Amongst others, the publications by Edvardsson and Olsson (1996), Menor et al. (2002), and Johnson et al. (2000) can be assigned to this stream of research.

At the same time, studies on Service Design established as a new and distinct research stream. In comparison to NSD, Service Design is more human-centered, yielding structured approaches for designing a new service (Blomkvist et al., 2010; Ostrom et al., 2015; Teixeira et al., 2019). Approaches that can be attributed to the Service Design literature are often concerned with the design of service elements that are visible to customers, e.g., via touchpoints or interfaces, taking a Marketing perspective, which allows for a more thorough and contextualized understanding of customer experience and of their participation in value co-creation (Teixeira et al., 2019). One of the first and often-cited publications in Service Design is the service blueprint by Shostack (1984). Other renowned publications that can be attributed to this research stream include the studies of Bitner et al. (2008), Goldstein et al. (2002), and Patrício et al. (2011), and Zomerdijk and Voss (2010).

In the 1990's, service (system) engineering manifested as another research paradigm for establishing an innovative service in the German research community (Bullinger et al., 2003). Traditional service engineering approaches are based

on product-centric thinking, featuring a structural analogy to generic guidelines for product development, such as VDI 2221 (Verein Deutscher Ingenieure, 1993). These service engineering methods often provide a linear, iterative, and phase-based approach for developing an individual service (Böhmann et al., 2014; Ostrom et al., 2010). More recent approaches adopt a systemic perspective on service engineering (e.g., Höckmayr and Roth, 2017; Johnson et al., 2000; Pöppelbuß and Durst, 2017; Yang, 2007), acknowledging the reconfiguration of resources, guidance of service interactions, and design of the service architectures, i.e., the structure and connections between the elements in a service system (Li and Peters, 2019).

Service system engineering provides actionable and "evidence-based design knowledge on service systems that enhance collaborative and contextualized value creation" (Böhmann et al., 2014, p. 74). In the service system engineering methods often either waterfall models, stage-gate processes, or spiral models are proposed (Beverungen et al., 2019b; Yang, 2007). However, digitalization transforms the process of service engineering as new technologies permeate the market, e.g., ICT or big data, which force organizations to deal with opposing demands of exploring new value propositions while exploiting an existing service to stay efficient at the same time (Menor et al., 2002). Hence, innovation is not only achieved by designing value propositions and service systems top-down but also by the emergence of innovative ideas from individuals that diffuse in the organization bottom-up (Li and Peters, 2019; Polese et al., 2020). This perception highlights the need for an effective understanding of two-sided innovation processes.

2.2.3 Exploitation through Workarounds

Workarounds are an emergent phenomenon in service system innovation (Alter, 2008). They are an important element of everyday work but still remain understudied (Alter, 2014; Pollock, 2005). Workarounds describe "conscious adaptations of work activities that are not expected or specified to be changed in this manner" (Laumer et al., 2017, p. 335). Other definitions emphasize that workarounds are performed when "a path is blocked" (Ejnefjäll and Ågerfalk, 2019, p. 347). Hence, workarounds are goal-driven (Röder et al., 2015a), i.e. they are performed to "ensure continued business operations" (Berente et al., 2019, p. 884).

As employees are faced with an obstacle, e.g., a recurrent problem in their day-to-day work, they may abandon, work around, or change them (Orlikowski, 2000). This obstacle can arise from industry-specific causes, such as regulatory guidelines or normative authorities (van Beijsterveld and van Groenendaal, 2016), company-specific constraints (Ejnefjäll and Ågerfalk, 2019), or individual problems (Choudrie and Zamani, 2016), e.g., a lack of resources which can lead to ignorance or resistance (Ferneley and Sobreperez, 2006) (see Fig. 2.2). Company-specific constraints comprise strategic misfits, i.e., issues that exist between an IS and predefined business processes (Gasser, 1986), technology misfits, i.e., obstacles that are rooted in a system's properties (Strong and Volkoff, 2010), and organizational misfits, i.e., conflicts in the alignment of top-down and bottom-up work pressures (Ejnefjäll and Ågerfalk, 2019).

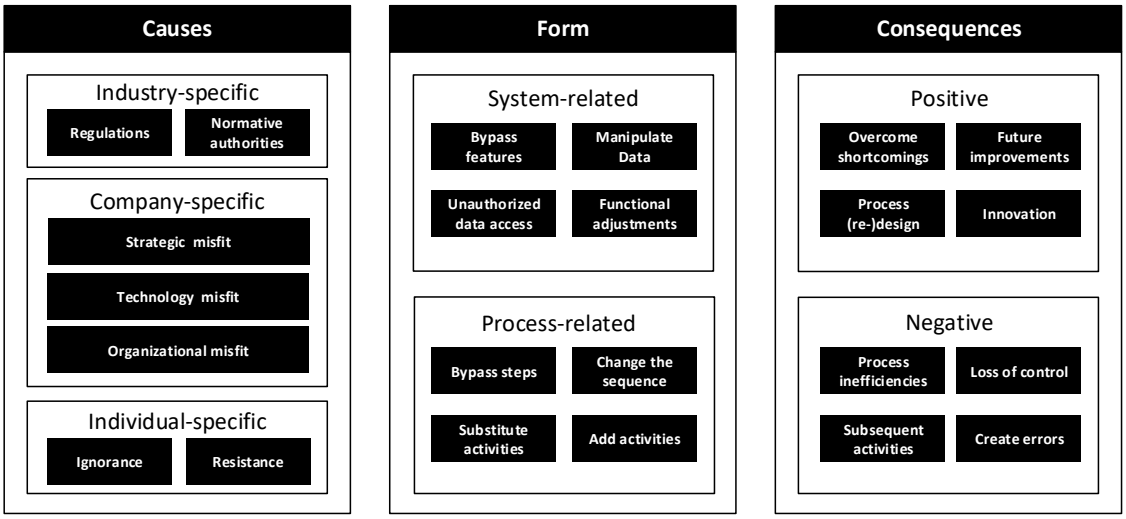

Figure 2.2: Systematization of Workarounds

To overcome misfits, employees diagnose their environment and search for possible solutions (Miller et al., 2012). This includes improvising processes and recombining existing work elements to achieve a specific goal (Malaurent and Karanasios, 2019). Thereby, employees may be "intentionally using computing in ways for which it was not designed or avoiding its use and relying on alternative means of accomplishing work" (Gasser, 1986, p .216). In this regard, actors can bypass specific features in an IS (Parks et al., 2017), manipulate data (Pinto et al., 2018), access data unauthorized (Ignatiadis and Nandhakumar, 2009), or make functional adjustments (Azad and King, 2012). In addition, workarounds can be manifested in employees' deviations from business processes (Choudrie and Zamani, 2016).

In this regard, employees may also perform work differently, i.e., bypass steps (Outmazgin and Soffer, 2014), change the sequence of steps (Zainuddin and Staples, 2016), substitute activities (Alter, 2015a), or add activities (Ejnefjäll and Ågerfalk, 2019), in each case deviating from the specifications for designing and managing a service (Alter, 2014).

Workarounds propagate bottom-up and are performed unofficially in an organization (Röder et al., 2016). While workarounds do not resolve the misfit, they provide an alternative path in pursuit of work goals (Ejnefjäll and Ågerfalk, 2019). Therefore, workarounds are often regarded as a secondary design process (Alter, 2015a), in which "functions and content emerge during interaction, modification, and embodiment of the system in use" (Germonprez et al., 2011, p. 662). Hence, workarounds can be an important mechanism for transforming an organization's processes (Alter, 2015a).

The perception of workarounds in the extant literature can be divided into two dominant views (Malaurent and Karanasios, 2019), i.e., workarounds are either considered as having negative or positive consequences (Laumer et al., 2017; Li et al., 2017; Pentland et al., 2020). They are deemed negative when they involve deviations from a standardized process, are seen to violate IS security (Arduin and Vieru, 2017), lead to process inefficiencies (Alojairi, 2017), loss of control (Lapointe and Rivard, 2005), create errors (Laumer et al., 2017), or have a negative impact on subsequent work activities (Boudreau and Robey, 2005). More positive conceptualizations are grounded on the observation that a workaround might identify a flawed system or might turn out to be functionally useful, e.g., to overcome technological shortcomings (Ferneley and Sobreperez, 2006). Thus, workarounds can also be a source of flexibility (Li et al., 2017), leading to future improvements (Choudrie and Zamani, 2016) and innovation (Mendel, 2017).

Actors reinvent service systems during its adoption in the organization (Barrett and Stephens, 2017). As new service systems are designed, not all requirements and contingencies can be identified, which leads to the realization that "there is a strong need for continuous response to changing environments" (Vicente, 1999, p. 356). Hence, workarounds can reveal insufficiently designed processes or organizational misalignment (Mendel, 2017), which is the case when actors in a service system purposefully and dynamically adapt business processes and IS in their day-to-day work to their specific needs (Beerepoot and van de Weerd, 2018). These individ-

ually performed workarounds constitute scalable solutions that can be adopted by other actors across an organization (Kelley et al., 2018). Hence, workarounds constitute a source of continuous innovation (Beerepoot and van de Weerd, 2018) that enables "change from within" (Essén and Lindblad, 2013, p. 209). Therefore, workarounds can be "conceptualized as the basic unit of analysis in analyzing this change and predicting future development" (Barrett and Stephens, 2017, p. 1011). In summary, innovation in service systems emerges when workarounds are performed frequently enough, consolidating in the organizational routines of employees and triggering a (re-)design of business processes (Outmazgin and Soffer, 2014).

2.3 Design and Emergence of Innovation in Service Systems

2.3.1 Structure in Service Business Processes

Service system innovations are established by processes that impact the quality, efficiency, and reliability of a service (Alter, 2008; Böhmann et al., 2014; Edvardsson and Olsson, 1996; Ferneley and Sobreperez, 2006). Although people have always worked in business processes and pioneers like Adam Smith (1723–1790), Frederick Taylor (1856–1915), and Henry Ford (1863–1947) have driven the establishment of processes and the division of labor (van der Aalst, 2013), it is widely acknowledged that a first comprehensive understanding on business processes is provided by the *value chain* developed by Porter (1985). Since then, many methods, models, and tools for managing business processes have been proposed, e.g., Information Technology Infrastructure Library (ITIL), supply-chain operations reference (SCOR) model, Six Sigma, or business process model and notation (BPMN) (Harmon, 2007).

Business processes can be defined as a "completely closed, timely, and logical sequence of activities which are required to work on a process-oriented business object" (Becker and Kahn, 2003, p. 4). A business process consists of events and activities (Dumas et al., 2018), providing a service system with "a structure for action" (Lindsay et al., 2003, p. 1017). An event is a record of state change

that can cause the execution of activities in a business process (Dumas et al., 2018). Activities refer to a "working step which has to be executed in order to render a service" (Becker and Kahn, 2003, p. 4), and can be executed manually or automatically by internal or external actors (Dumas et al., 2018).

The management of business processes as a strategic resource has been developed in the BPM discipline. BPM describes "a body of methods, techniques, and tools to identify, discover, analyze, redesign, execute, and monitor business processes" (Dumas et al., 2018, p. 6) in order to sustain a competitive advantage (Poeppelbuss et al., 2015). While many established definitions emphasize that the goal of BPM is to enable process control and achieve consistent results, e.g., Müller et al. (2006) and Venkatesh and Bala (2007), organizations are increasingly under pressure to adapt their business processes in order to become more flexible, agile, and to dynamically improve service levels (Badakhshan et al., 2019; Harmon, 2016; van der Aalst et al., 2016). These changed requirements can be explained by the demands arising from a decreasing time-to-customer and an increasing innovation rate of service offerings by competitors (Rosemann et al., 2008). In addition, processes tend to drift over time (Pentland et al., 2020). Hence, BPM can increasingly be understood "as an ambidextrous management discipline" (Badakhshan et al., 2019, p. 3), which unites both stability and change (Bider, 2005; Rosemann et al., 2008). In this regard, BPM constitutes a "set of practices that includes [both] incremental change and radical change in business processes" (Hung, 2006, p. 24), denoting an important capability for a service's viability in a dynamically changing environment (Lohmann and zur Muehlen, 2015). Thereby, BPM has "the power to innovate and continuously transform businesses and entire cross-organizational value chains" (vom Brocke and Rosemann, 2015, p. ix).

Business processes are generally designed as a sequence of specific (planned) activities (Mendling et al., 2020) in a top-down approach (Beverungen, 2013; Davenport, 1997). However, research is increasingly interested in the emergent character of innovation (Mendling et al., 2020) as an unfolding bottom-up process that can enable change and agility in business processes (Badakhshan et al., 2019). Emergent innovation typically occurs in an open and collaborative organizational environment, where it is facilitated by advances in ICT that offer unprecedented opportunities for sharing information and interacting with customers and other stakeholders across organizational boundaries (Kunz et al., 2019). It is important to note, however, that this form of business process redesign usually involves only

minor improvements to processes or incremental innovation (Harmon, 2016). This duality between top-down and bottom-up innovation represents a significant shift in the traditional conceptualizations in BPM, highlighting that managers increasingly need to balance process compliance with existing structures and positive deviance that emerges bottom up in value-creation networks (Mendling et al., 2020).

2.3.2 Dynamics of Organizational Routines

Innovations in service systems are established and distributed by individuals who perform day-to-day work in higher level structures, i.e., organizational routines (Vargo et al., 2020). The majority of activities in service systems is carried out in a routinized way (Becker and Zirpoli, 2008). Organizational routines have become a conceptual cornerstone in research because they "occupy the crucial nexus between structure and action" (Pentland and Rueter, 1994, p. 484). Consequently, the structure of socio-technical systems like service systems cannot exist without the activities of actors that are reproduced over time and space (Giddens, 1984). In this regard, organizational routines—as a superset of business processes (Beverungen, 2014)—represent a viable theoretical lens for observing and understanding how innovation is achieved in an organization, shifting the perspective from innovation as an outcome to innovation as a process (Mahringer et al., 2019).

In early research, organizational routines were conceptualized as mindless, stable, and predictable behavioral patterns of work (Cyert and March, 1963; March and Simon, 1958; Nelson and Winter, 1982). However, recent publications have challenged this perception (Dittrich and Seidl, 2018), adopting a more dynamic perspective on organizational routines (Danner-Schröder and Geiger, 2016). This is in line with the distinction between 'dead routines', i.e., rigid and mindless routines that are largely ignored by actors, and 'live routines', i.e., generative systems that evolve over time (Pentland and Feldman, 2008). With regard to the latter conceptualization, an organizational routine can be defined as a “repetitive, recognizable pattern of interdependent actions” (Feldman and Pentland, 2003, p. 95).

Organizational routines are collective in nature, involving multiple actors linked to each other through interaction (Becker, 2004; Gao et al., 2014). In organiza-

tions, work is often divided among actors who are jointly attempting to achieve a specific organizational goal (Miller et al., 2012). As actors collectively work in organizational routines, they integrate a heterogeneous set of skills and knowledge (Miller et al., 2012), enabling the creation of inimitable value for customers (Boe-Lillegraven, 2019).

The structure of organizational routines can be systematized into two mutually constitutive entities: ostensive and performative aspects. These two aspects were conceptually introduced in the *powers of association* by Latour (1984) and are associated with the duality of *structure and agency* in structuration theory by Giddens (1984). Ostensive aspects describe the abstract or schematic form that actors use as guidance (Feldman and Pentland, 2003). Referring to *structuration theory* (Giddens, 1984), the ostensive part of a routine embodies the *structure*. Performative aspects describe the actual performances by individual actors at a particular point in time and location (Feldman and Pentland, 2003), referring to *agency* in structuration theory (Giddens, 1984). As routines are effortful accomplishments (Deken et al., 2016), their internal structure contributes to both stability and change (Pentland and Feldman, 2005).

Similar to the concepts of structure and agency, the relationship between ostensive and performative aspects is recursive (Pentland and Feldman, 2005). Ostensive aspects enable and constrain the performance of actors, e.g., through service system engineering methods that describe activities and methods for establishing an innovative service, while performative aspects create and recreate the abstract idea of how a routine should be carried out (Pentland and Feldman, 2005).

Theoretical and conceptual frameworks, e.g., as proposed by Beverungen (2014), D'Adderio (2008), Miller et al. (2012), and Pentland and Feldman (2005) or Iannacci and Hatzaras (2012), often describe how routines are imbricated with IT artifacts (Leonardi, 2011). As actors exert human agency, they shape their interaction with IT artifacts, i.e., adapting the ostensive aspects of an organizational routine and the structure of an IT artifact (Leonardi, 2011). Likewise, designed IT artifacts can impact organizational routines by exerting material agency (Leonardi, 2011), enabling and constraining its ostensive and performative aspects (Beverungen, 2014). Thus, organizational routines can be understood as "continuously emerging systems with internal structures and dynamics" (Pentland and Feldman, 2005, p. 794).

From a top-down design perspective, service system innovation requires the adaptation of existing routines or the replacement of new ones (Howard-Grenville and Rerup, 2016). From a bottom-up perspective, innovations can emerge in each iteration of a routine in which actors deviate from the previous one (Danner-Schröder and Geiger, 2016), turning organizational routines into continuously adapting systems. More specifically, individuals can either adhere to the ostensive aspect of a routine or choose to deviate from it (Feldman and Pentland, 2003). The deviation from ostensive aspects in a routine can either occur in response to external changes or through reflexive self-monitoring (Feldman and Pentland, 2003). Especially in service systems that are primed by individual customer interactions in the co-creation and co-production of value, routines are "unlikely to unfold the same way every time" (Pentland and Rueter, 1994, p. 488).

Changes can manifest either in new means of performing work, in existing means that are used differently to achieve other goals, or in different means to achieve the same work goals (Dittrich and Seidl, 2018). As routines are interdependent (Pentland et al., 2016), the actions that are performed in one routine can impact or trigger actions in other routines (Pentland and Hærem, 2015). Thereby, changes can spread across routines within and across service systems, constructing and re-constructing them as a socio-technical system (Beverungen, 2014).

In summary, organizational routines embody both performance and patterning of day-to-day work by taking multiple dimensions into account (D'Adderio and Pollock, 2020). Each performance of a routine provides an occasion for change (Pentland and Feldman, 2008), which can trigger the transformation of an entire service system. Hence, organizational routines provide a suitable lens for explaining how ambidextrous service system innovation can be achieved through the design and emergence of innovations in day-to-day work.

3 Research Design

3.1 Research Paradigms

3.1.1 Ontological Positioning

IS is an interdisciplinary research field (Becker and Niehaves, 2007; Kroeze and van Zyl, 2015), which stipulates that a phenomenon should be examined from multiple perspectives (Becker and Niehaves, 2007). The purpose of this dissertation is to make theories in service science more actionable and to provide a new theoretical perspective that can steer the process of organizational transformation as part of ambidextrous service system innovation. In this regard, it is important to justify theoretical preconceptions (Bunge, 1996), since scientific paradigms underpin the choice of methodology (Becker and Niehaves, 2007). Thereby, the diversity of applied research methods needs to be aligned to understand phenomena from different perspectives (Niehaves, 2005), i.e., to understand how service system innovation can be re-conceptualized by applying an ambidextrous approach. Fig. 3.1 summarizes the theoretical preconceptions that characterize a research approach.[3]

Ontology describes the basic assumptions about "the form and nature of reality" (Guba and Lincoln, 1994, p. 108). It primes our view on the examined phenomena, constituting the cornerstones of research (Aliyu et al., 2015). Thereby, the fundamental question is whether the reality exists independently of humans or the realms constructed by individual cognition (Burrell and Morgan, 2019).

Ontological realism adopts the position that the real world exists autonomously from human cognition (Becker and Niehaves, 2007). In contrast, ontological ide-

[3] The framework is based on the philosophical assumptions by Hay (2002), Becker and Niehaves (2007), Reihlen et al. (2007), Aliyu et al. (2015), and Orlikowski and Baroudi (1991).

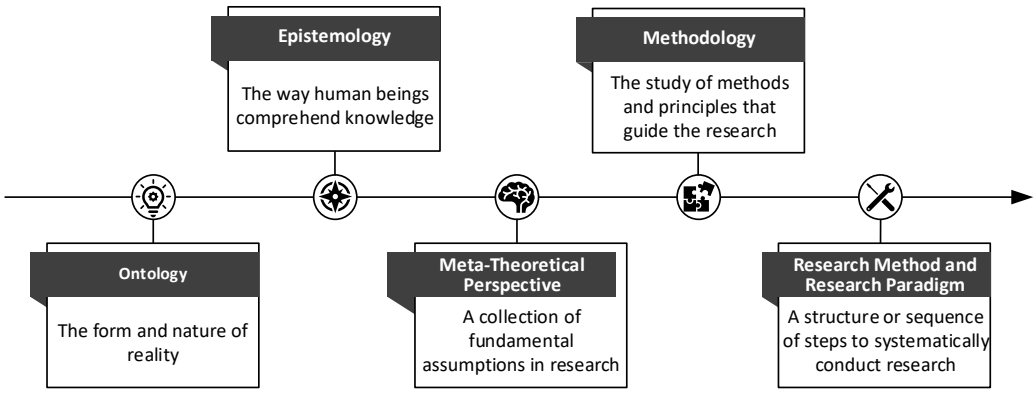

Figure 3.1: Scope of the Theoretical Preconceptions

alism affirms that the real world cannot exist without human perception (Mingers, 2001). From an ontological viewpoint, this research is based on the perception that reality exists and is self-contained, but it is also created and recreated through human action (Orlikowski and Baroudi, 1991). Accordingly, Kantianism is adopted as an ontological position, describing that entities can exist independently (noumena) and dependently (phenomena) from humans (Becker and Niehaves, 2007).

3.1.2 Epistemological Positioning

Epistemology describes the nature of knowledge and ways of gaining knowledge about reality (Hay, 2002). Epistemological assumptions establish how knowledge can be created and how a person can achieve 'true' cognition (Burrell and Morgan, 2019), and thus they provide a conclusive logic for researching the phenomenon under investigation (Becker and Niehaves, 2007).

From an epistemological viewpoint, three philosophical paradigms of cognition can be distinguished: positivism, interpretivism, and critical realism (Mingers, 2001; Wynn and Williams, 2012). Positivism refers to the assumption that "facts and values are distinct, and scientific knowledge consists only of facts" (Walsham, 1995, p. 75). In contrast, interpretivism (as subset of constructivism) describes the view that reality is constructed by human actors through social interaction (Burrell and Morgan, 2019), assuming that there is no objective reality at all (Orlikowski and Baroudi, 1991). Critical realism states that experiences that can be observed are a subset of all events that actually occur in the real world (Mingers et al.,

2013). In this research, the paradigm of critical realism is applied, recognizing that reality is created, on the one hand, by the subjective knowledges of actors and, on the other, by the independent structures that impact actors by enabling and constraining their actions (Wynn and Williams, 2012).

Another epistemological paradigm refers to the concept of truth (Niehaves, 2005), i.e., how researchers can attain true cognition of knowledge (Becker and Niehaves, 2007). Three theories of truth can be distinguished: (1) the correspondence theory of truth, which posits that truth is achieved through facts that are either true or false, (2) the consensus theory of truth, stating that, to exist, truth needs to be acknowledged by a group of actors, and (3) the semantic theory of truth, based on semantic theory, which claims that object language and meta-language are needed to achieve the correctness of statements (Becker and Niehaves, 2007). As the value that emerges through service system innovation is phenomenological (Vargo and Lusch, 2004), a consensus theory of truth is adopted as epistemological stance.

Another central question for epistemological positioning concerns the origin of cognition. Research can be conducted either through empiricism, in which experience-based or posteriori knowledge is acquired, or through rationalism, i.e., non-experience-based knowledge (Becker and Niehaves, 2007). A third source of cognition capability is rooted in Kantianism, which is also adopted in this research. This posits that cognition is achieved by combining both priori and posteriori knowledge (Becker and Niehaves, 2007).

Finally, hermeneutic cycles are performed as process for developing an understanding of ambidextrous service system engineering. Hermeneutics describes an iterative approach (Olson and Carlisle, 2001), in which "the process of gaining knowledge is influenced by a circle of (previous) understanding, gaining knowledge, and then achieving a better understanding of the [whole]" (Becker and Niehaves, 2007, p. 206). One of the principles of hermeneutics postulates the iteration between examining the system as a whole and the individual elements of the system, as well as their interdependence and coherence (Klein and Myers, 1999).

3.1.3 Meta-Theoretical Positioning

In order to understand and explain the behavior of actors in service systems, different meta-theoretical perspectives have been proposed. A meta-theory comprises "a collection of fundamental assumptions on which the investigation of research and technological problems is based" (Reihlen et al., 2007, p. 49). It provides a lens through which a phenomenon under investigation can be viewed, creating a better and more profound understanding of the theoretical insights (Bostrom et al., 2009).

Salient meta-theories include individualism, holism, and systemism. An individualist assumes that organizations are composed of autonomous individuals, and hence analyzes the individual elements of a socio-technical system to make inferences about a phenomenon (Reihlen et al., 2007). By contrast, a holist position involves examining the structures of organizations, assuming that individual behavior is the result of reflective collective attributes (Reihlen et al., 2007). However, organizations can neither be understood as "purely aggregates by individuals nor [as] holistic entities" (Reihlen et al., 2007, p. 56).

For this reason, the underlying meta-theory adopted for this research is systemism, covering both individuals and systems, i.e., individual agency—of actors who enact organizational routines—and socio-technical structures—such as service systems (Reihlen et al., 2007). This meta-theory considers the interaction of "individual (micro-level) and structural (macro-level) features of a system" (Reihlen et al., 2007, p. 56). Systemism provides a suitable theoretical position to study organizational routines, which are considered as structures that enable and constrain the activities of individuals in organizations (Bunge, 1996). Likewise, individuals have the power to influence organizational structures but are also influenced by the systems (Giddens, 1984).

The research paradigms and assumptions adopted in this dissertation are summarized in Fig. 3.2 (framework adapted and extended from Becker and Niehaves, 2007).

Ontological Positioning	Ontological Realism	Ontological Idealism	Kantianism
Philosophical Paradigms of Epistemology	Postivism	Critical Realism	Interpretivism
Concept of Truth	Correspondence Theory of Truth	Consensus Theory of Truth	Semantic Theory of Truth
Origin of Cognition	Empiricism	Rationalism	Kantianism
Reasoning Approach	Inductivism	Deductivism	Hermeneutic
Meta-Theoretical Position	Individualism	Holism	Systemism

Figure 3.2: Ontological, Epistemological, and Meta-Theoretical Positioning

3.2 Research Approach

Explaining phenomena in IS research is inherently complex (Niehaves, 2005) and challenges researchers to obtain a comprehensive reflection of reality (Morse, 2003). The ability to understand, describe, and explain certain phenomena in research is enabled and constrained by the application of research methods (Morse, 2003). Each method is designed to examine certain dimensions of a real-world phenomenon (Ahmed and Sil, 2009) and to answer a specific type of research question or solve a research problem (Morse, 2003). In this regard, each method has its strengths but also limitations and weaknesses (Hunter and Brewer, 2003). In order to cover the scope and complexity of real-world phenomena, researchers need to "combine together different research methods to gain richer and more reliable research results" (Mingers, 2001, p. 243). Hence, with regard to the research questions, the interdisciplinarity of this research, the complexity of ambidextrous service system innovation, and the positioning in terms of the research paradigms, a multi-method approach is conducted (Becker and Niehaves, 2007; Gable, 1994).

Multi-method research is an approach recommended "for overcoming each method's weaknesses and limitations by deliberately combining different types of methods within the same investigation" (Hunter and Brewer, 2003, p. 578). It consists of two or more internally consistent and rigorously conducted research studies

that are connected by one overarching research question (Mingers, 2001; Morse, 2003), with each study being carried out to answer a specific sub-question (Morse 2003). In this regard, the research results complement each other (Gable, 1994), by considering research as a "puzzle-solving process" (Morse, 2003, p. 189).

The advantages of multi-method research are based on triangulation, expansion, and creativity (Mingers, 2001). First, the findings of all individual research projects are triangulated to achieve a comprehensive understanding of the phenomenon under investigation (Morse, 2003). This way, cross-validation can be performed, increasing the robustness of the findings (Gable, 1994). In addition, the scope of the research is expanded by integrating multiple perspectives on a phenomenon (Mingers, 2001). Finally, creativity is fostered, enabling the discovery of new, congruent, or even paradoxical findings that encourage future research (Mingers, 2001).

The multi-method approach is performed throughout as a process of gradual knowledge development in which iterative cycles of research are undertaken (Mingers, 2001; Morse, 2003; Niehaves, 2005; Olson and Carlisle, 2001) to understand ambidexterity in service system innovation. A prevalent framework that acknowledges this iterative research process in IS is proposed by Hevner et al. (2004), who conceptualize knowledge generation as complementary cycles—similar to dialectic hermeneutics (Myers, 1995). In line with Hevner et al. (2004) and Goldkuhl (2016), methods of behavioral science and design science are combined to gain new knowledge and allow the comprehensive examination of ambidextrous service system innovation. This integrative perspective of the applied research methods and paradigms is visualized in Fig. 3.3 (adapted from Hevner et al., 2004, p. 80).

Empirical research provides a tool to derive constructs from the field (Orlikowski and Baroudi, 1991), constituting an important building block for building theory (Boxenbaum and Rouleau, 2011). Empirical data from the *environment*, comprising people, organizations, and technologies (Hevner et al., 2004), are collected and analyzed, providing new insights on ambidextrous service system innovation. However, to provide conceptual clarity and develop an inherent structure of an organizational phenomena, further abstraction and theoretical concepts are required (Boxenbaum and Rouleau, 2011). To meet these requirements, a *knowledge base*

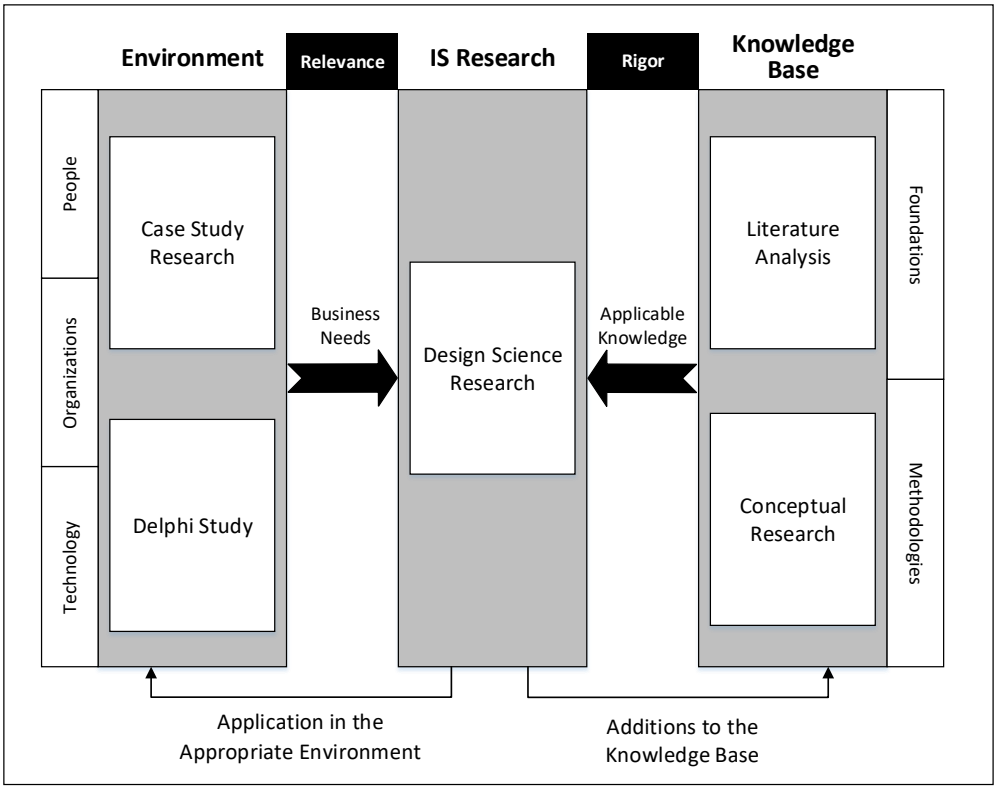

Figure 3.3: Multi-Method Research Approach

is developed (including, amongst others, theories, framework, and constructs), providing the theoretical foundations for this research (Hevner et al., 2004).

The data from the environment and the knowledge base enable both the design of rigorous and relevant IT artifacts, which in turn are applied in the environment and add knowledge to IS research (Hevner et al., 2004). Hence, research can be conceptualized as a hermeneutic cycle comprising iteration cycles of analyzing and interpreting theoretical concepts (*literature analysis* and *conceptual research*), deriving constructs from the field (*case study research* and *Delphi studies*), and designing artifacts (*design science research*). By conducting this approach, this research provides both truth and utility (Hevner et al., 2004).

There are five types of theory with different features that can be achieved by applying the described research methods: type I (analysis), type II (explanation), type III (prediction), type (IV) explanation and prediction, and (V) design and action (Gregor, 2006). Type I theories provide a description or categorization of characteristics of an examined subject by analyzing its properties. A type II theory

provides explanations for understanding how and why a phenomenon appears. Type III theories are developed to enable predictions and testable propositions regarding a specific outcome that is justified by a set of causal factors. Type IV theories provide both an understanding of causal factors that enable the prediction of certain outcomes and a description of the underlying constructs, including their relationships to other constructs. Finally, type V theories provide guiding principles for designing IT artifacts in IS. Importantly, the different types of theory can affect each other, e.g., concepts that were identified in a framework of a type I theory can have causal relationships, i.e., impacting the insights of a type IV theory (Gregor, 2006). Hence, this research is positioned as both a type II theory for explaining ambidextrous service system innovation and its interrelated concepts and a type V theory by providing design knowledge on a novel method for service system engineering and for detecting workarounds in event logs to leverage bottom-up driven innovation.

3.3 Research Paradigm and Research Methods

3.3.1 Literature Review

A literature review constitutes the foundation of a research endeavor (Baker, 2000). It is performed to synthesize and analyze the existing knowledge in a specific domain (Schryen et al., 2020), and can be defined as "a critical summary and assessment of the range of existing materials dealing with knowledge and understanding in a given field" (Blaxter et al., 2010, p 124). Service research is an interdisciplinary research area (Spohrer et al., 2014). Hence, it is important to examine the literature inside and outside of the research domain in order to achieve an appropriate scope of knowledge as the basis to advancing theory (Webster and Watson, 2002).

In order to provide new insights on the topic under investigation, a literature review's contribution has to comply with the demands for rigor and relevance of IS research (Baker, 2000; vom Brocke et al., 2009). Rigorous results are achieved through effective methods applied to reviewing the knowledge, e.g., by executing a reliable and valid search process. For this purpose, the criteria for inclusion and exclusion of literature are defined (Wolfswinkel et al., 2013). Relevance is

obtained by excluding research on phenomena that have already been extensively studied (vom Brocke et al., 2009).

A high-quality literature analysis includes both backwards and forwards search (Levy and Ellis, 2006; Schryen et al., 2020; Webster and Watson, 2002). Backwards search can be conducted through three sub-processes, respectively searching for previously used keywords, by references, and by authors (Levy and Ellis, 2006). To identify and evaluate the extant literature, a query can be performed in leading journals, peer-reviewed conference proceedings, selected books, and databases by using search phrases with Boolean operators (Okoli, 2015; vom Brocke et al., 2009; Wolfswinkel et al., 2013). In addition, the references of the already identified articles can be reviewed, gradually approaching the origin of the examined theory or phenomenon (Levy and Ellis, 2006). Finally, further publications and prior work of authors who published articles on the subject under investigation can be reviewed (Levy and Ellis, 2006). Forward search includes the examination of more recent publications that cite the identified literature in the backwards search (Webster and Watson, 2002).

To systematize the scope of a literature review, a taxonomy by Cooper (1988) has been proposed, comprising six characteristics, i.e., focus, goal, perspective, coverage, organization, and audience of research (see Fig. 3.4). Each taxonomy characteristic can be further divided into categories that can either be exclusive or combined with others (vom Brocke et al., 2009). Focus is an important aspect when classifying literature, distinguishing between research outcomes, methods, theories, or applications (Cooper, 1988). The goal of the identified literature can be on the integration, criticism, or identification of central issues (Cooper, 1988). Two different perspectives can be adopted, i.e., a neutral perspective or the espousal of a particular position (Cooper, 1988). The coverage of research comprises four different levels, namely, exhaustive, exhaustive with selective citation, representative, and central or pivotal. In the taxonomy by Cooper (1988), research can be organized historically, conceptually, or methodologically. Finally, the intended audience that will be addressed with the literature analysis needs to be considered, i.e., whether the review is written for a specialized journal, general journal, practitioners, or for the general public (Cooper, 1988).

A literature review can be performed for three different purposes (vom Brocke et al., 2009). First, it can be conducted for theory testing in a research domain with a

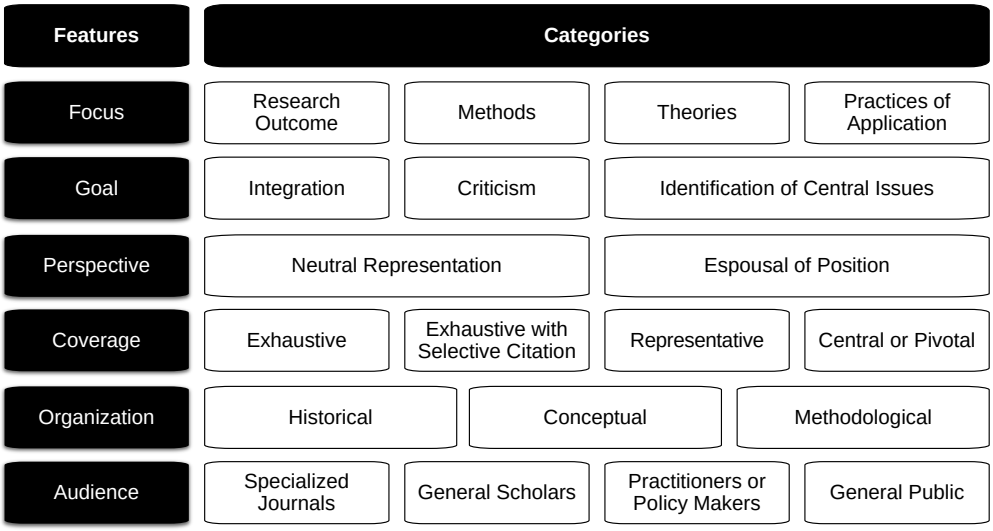

Figure 3.4: Taxonomy of Literature Reviews by Cooper (1988)

rich set of publications by deriving a hypothesis (Rowe, 2014). Second, a literature review can be performed in order to identify gaps in the extant body of knowledge for future research (Schryen et al., 2020). Third, it can serve as a vehicle for theory building to remedy previously ambiguous, contradictory, or obscure research results (Webster and Watson, 2002). In this thesis, a comprehensive literature review has been performed to examine whether a gap exists in the methods and models of service system innovation from an ambidexterity perspective.

3.3.2 Conceptual Research

Conceptual research is among the most applied research methods in IS (Mora et al., 2008). It is used to "bridge existing theories in interesting ways, link work across disciplines, provide multi-level insights, and broaden the scope of our thinking" (Gilson and Goldberg, 2015, p. 128). Hence, conceptual studies can be described as the “product of a researcher’s creative endeavor or experiences” (Poeppelbuss et al., 2011, p. 511).

Conceptual research aims to create new knowledge by selecting, analyzing, and recombining evidence from different information sources of information (Jaakkola, 2020). It focuses on the theoretical development of assumptions, premises, and axioms (Hirschheim and Newman, 1988) to understand real world phenomena

(Mora et al., 2008). When conducting conceptual research, it is important to ensure clarity, integrity, and the logical coherence of concepts (Jaakkola, 2020).

The focus of conceptual research articles lies on the synthesis of relevant concepts and constructs regarding a particular phenomenon (Gilson and Goldberg, 2015). A concept is a generic idea that is derived from specific instances of a phenomenon, such as workarounds (van der Waldt, 2020). In this regard, concepts can be divided into sub-concepts or clustered into super-concepts (Slattery et al., 2020). A construct, by contrast, has a high degree of abstraction, is often theory-laden, and cannot be observed (Meredith, 1993; van der Waldt, 2020). However, constructs are theoretical entities that can be derived from observable events, such as perceived value or resistance (Meredith, 1993).

Developing new theoretical insights is a non-empirical and iterative process, consisting of a knowledge discovery and a knowledge justification phase (Mora et al., 2008; Yadav, 2010). In the knowledge discovery phase, information and ideas are gathered, while in the justification phase, the knowledge is tested and refined (Yadav, 2010). However, there is no sharp demarcation between the two processes (Yadav, 2010).

Two general approaches of conceptual research can be distinguished. First, conceptual studies can be performed by inductively elaborating different conceptualizations and linking them to a specific phenomenon, i.e., creating complementary value (Jaakkola, 2020). Second, shortcomings of a focal theory are identified, which are addressed by integrating other theories or concepts of distinctive literature streams, i.e., providing supplementary value (Jaakkola, 2020). In this thesis, the latter approach is applied by examining the theory of ambidexterity in order to provide extended knowledge on how innovation can be achieved through exploration and exploitation.

3.3.3 Delphi Study

The Delphi method was first proposed by Dalkey and Helmer (1951) and applied in military operations (Dalkey and Helmer, 1963). In the 1980's, the method became adopted in IS (Paré et al., 2013) as a structured and rigorous approach for obtaining an opinion in a group of experts concerning a specific topic (Skinner

et al., 2015). It is an iterative process for collecting, aggregating, and prioritizing knowledge (Paré et al., 2013) in order to approach complex phenomena (Linstone and Turoff, 1975).

In multiple survey rounds, a panel of experts receives a series of questionnaires about a specific topic to gradually develop a consolidated opinion (Fletcher and Marchildon, 2014). In the course of theory development, the insights obtained from the questionnaires are reflected by experts until mutual convergence is achieved (Linstone and Turoff, 1975). Thereby, experts can receive feedback from other experts that encourage them to think and re-think their answers (Schmidt, 1997). The study can be performed in a paper-and-pencil version, in which experts meet physically in a room, or online, which is especially suited for handling larger and geographically dispersed groups of experts (Linstone and Turoff, 1975).

In a Delphi study, statistical samples that represent a population are not necessary (Okoli and Pawlowski, 2004). Rather, it is important to identify qualified experts who have extensive knowledge or experience about a phenomenon or topic (Okoli and Pawlowski, 2004). The experts are ranked by their expertise and categorized into panels of different stakeholder groups with regard to their disciplinary background or knowledge (Skinner et al., 2015). While heterogeneous groups provide more creativity and a higher validity than homogeneous groups (Linstone and Turoff, 1975; Okoli and Pawlowski, 2004), it also complicates the process of reaching consensus among the experts (Alarabiat and Ramos, 2019).

There are four different types of Delphi studies, namely *classical Delphi*, *policy Delphi*, *decision Delphi*, and *ranking-type Delphi* (Okoli and Pawlowski, 2004; Paré et al., 2013; Rauch, 1979; Schmidt, 1997; Turoff, 1970). While the classical Delphi aims to create consensus by consulting unbiased experts (Rauch, 1979), the policy Delphi seeks to define and differentiate the views of lobbyists on social and political issues (Paré et al., 2013). The decision Delphi method is used to support decision-making in a real-life context (Rauch, 1979). The ranking-type Delphi is frequently applied to identify and rank insights about a specific topic (Okoli and Pawlowski, 2004). This latter type of Delphi study is a suitable method for theory building because it can be used to identify concepts to develop propositions, strengthen the theoretical basis of knowledge, provide a high construct validity, and understand the causal relationship between concepts (Okoli and Pawlowski, 2004). Hence, a ranking-type Delphi is adopted as one of the research methods in this thesis.

3.3.4 Case Study Research

Case study research is a widely applied research strategy for gaining insights into service innovation (Verleye, 2019). Case studies as a method allow to investigate "a contemporary phenomenon (the 'case') in its real-world context" (Yin, 2014, p. 2). A case study is a phenomenon-driven research approach that allows to gain rich insights about contemporary events in a specific context (Benbasat et al., 1987; Dubé and Paré, 2003; Verleye, 2019; Yin, 2014). The phenomenon itself is embedded in a *bounded context* (Miles and Huberman, 1994), constituting the environmental and organizational environment of a case (Hartley, 2004).

The focus of a case is on the "examination of an instance in action" (Simons, 2009, p. 20), highlighting the fact that case studies are never generalizable to populations, only to theoretical propositions (Yin, 2014). The unit of analysis of a case can comprise individuals, organizations, project, events, or processes (Verleye, 2019). Depending on the unit of analysis, research can be conducted as either a holistic or an embedded case study, each having two different variants (single or multiple case design) (Yin, 2014). Single case designs are feasible approaches when the case is "critical, unusual, common, revelatory, or longitudinal" (Yin, 2014, p. 51). Interesting insights in single case studies are achieved by elaborating contrasts, identifying patterns, or highlighting interesting findings within the case (Miles and Huberman, 1994). A multiple case design has a higher robustness (Yin, 2014) and offsets imbalances between consistency and variation, providing a firm base for building theories (Verleye, 2019).

Case studies aim to answer the *'how'* and *'why'* of research questions in under-researched areas (Yin, 2014). Hence, they are a suitable research approach for the exploration and theory development of new or emerging phenomena (Hartley, 2004) that cannot be examined outside their context (Dubé and Paré, 2003). In addition, they provide the flexibility to be adapted to emergent or changing properties in the unit of analysis (Hartley, 2004).

Both qualitative (e.g., descriptions and statements) and quantitative (e.g., numbers) data can be included as data sources (Eisenhardt, 1989; Hartley, 2004). In case study research, a number of data collection methods are combined, e.g., interviews, observations, focus groups, questionnaires, time series, and archival documents (Dubé and Paré, 2003; Eisenhardt, 1989; Verleye, 2019). The data

collection takes place over a specific period of time in one or more units of analysis (Hartley, 2004). Importantly, "no experimental controls or manipulations is used" (Benbasat et al., 1987, p. 370) in case study research.

Each of the different data collection methods in case study research entails both advantages and disadvantages. For instance, interviews provide rich data but can also be biased as an interviewee (IV) reflects experiences retrospectively (Verleye, 2019). Hence, it is important to conduct "triangulation from multiple sources of evidence" to overcome these restrictions (Yin, 2014, p. 120). Triangulation thus improves the robustness of research results and of construct validity (Verleye, 2019).

Case study research can be structured into three distinct types: descriptive, explanatory, and exploratory case studies (Yin, 2014), whereas explanatory cases are conducted to describe a phenomenon in a specific context (Yin, 2014). Explanatory cases can reveal operational links between variables and provide explanations of events that yield a specific result (Benbasat et al., 1987). Exploratory cases, in turn, investigate phenomena in-depth to deepen the understanding of a complex phenomenon, e.g., such as in a pilot study (Ogawa and Malen, 1991).

In line with the multi-method approach (Gable, 1994) adopted in this research to generate knowledge, and with the hermeneutic research paradigm, exploratory case studies constitute the main building block for developing a 'type II theory' (Gregor, 2006) in this thesis. To complete the cycle of theory building, an inductive process of theory building was performed in which the emergent theory was deductively compared with new empirical data (Eisenhardt and Graebner, 2007).

3.3.5 Design Science Research

IS research is positioned at the intersection of people, technology, and organizations (Hevner et al., 2004). The creation of knowledge in the discipline is dominated by two distinct and complementary paradigms, i.e., behavioral science and design science (Goldkuhl, 2016; Hevner et al., 2004). The previously described research methods used for the study of phenomena and the development of theory are associated with the behavioral science paradigm. The paradigm of Design Science Research (DSR) addresses "questions relevant to human problems via the creation

of innovative artifacts, thereby contributing new knowledge to the body of scientific evidence" (Hevner and Chatterjee, 2010, p. 5) and complements the thesis' knowledge creation process by solving real organizational problems (Deng and Ji, 2018).

Design refers to both processes and products (Hevner et al., 2004). From a process perspective, the aim of DSR is to understand and solve a problem domain by *building* and *evaluating* novel IT artifacts in a structured form (Hevner et al., 2004; March and Smith, 1995), with the overarching goal of achieving utility (Hevner et al., 2004). The design process comprises iterative cycles, guided by heuristics to search for a solution to an identified class of problems (Hevner et al., 2004). Thus, DSR is enacted through "learning through building" (Kuechler and Vaishnavi, 2011, p. 126).

From a product perspective, DSR focuses on IT artifacts, which can be classified as constructs (symbols and vocabulary of concepts), models (set of propositions or abstract representations of relations), methods (algorithms and guidelines), and instantiations (implemented systems or prototypes) (March and Smith, 1995). IS research sees IT artifacts as extending human and organizational boundaries of problem solving (Hevner et al., 2004), enabling a "transformation from the 'present situation' to a 'desired situation'" (Deng and Ji, 2018, p. 2). As such, they must be coherent and internally consistent (Hevner et al., 2004). In addition to the design of an IT artifact, IS research also develops more abstract design theories, ranging from design principles to kernel theories, to provide novel and unique value (Baskerville et al., 2018) and advance knowledge on IS design and action (Baskerville et al., 2018; Gregor and Hevner, 2013).

A research contribution in DSR can be classified according to the maturity of the solution and the problem context (Gregor and Hevner, 2013). Thus, a knowledge contribution may be positioned as either invention, improvement, exaptation, or routine design (Gregor and Hevner, 2013). Invention is the most radical form of new knowledge, describing an innovative solution for a new class of problems. Achieving an improvement refers to a novel solution to an already-known and important application context. The third type of DSR knowledge concerns exaptation, which refers to already known solutions in related research areas being adapted or transferred to a new class of problems. Finally, routine design constitutes the least innovative form, offering only a marginal contribution to knowledge as exist-

ing solutions are adopted for known problems (Gregor and Hevner, 2013). One of the contribution of this thesis is the design of prescriptive knowledge, which is positioned as exaptation by adapting process mining methods to address the problem of detecting the innovation potential in the day-to-day work of employees, thereby enabling ambidextrous service system innovation (type V theory) (Gregor, 2006).

4 Research Results

4.1 Synopsis of Findings

The results of the publications in Part B are outlined from two perspectives, as proposed by Weber (2012): in parts and as a whole. This distinction is important because the individual results of the publications make up the theory and, therefore, impact the quality of the overall theoretical contribution. Nevertheless, high quality of publications is "a *necessary* but not *sufficient* condition for a high-quality whole" (Weber, 2012, p.4). Therefore, a theory is designed to explain how service system innovation is achieved through ambidexterity, i.e., through the simultaneous performance of exploration and exploitation activities.

Service system innovation can be considered as an infinite loop of design and emergence. On the one hand, service systems are designed through engineering processes, which then transform the organization top-down and manifest in the organizational routines of employees and in business processes. On the other hand, employees may face unforeseen obstacles in their routines, which can lead to the emergence of, inter alia, tweaking, sabotage, or workarounds (Alter, 2014). Especially workarounds can be a viable source for improvement. Since organizational routines are generative systems, they can transform a socio-technical system bottom-up and provide an impetus for designing or redesigning a service system, thereby complementing the loop of ambidextrous service system innovation, as visualized in Fig. 4.1.

In accordance with the framework in Fig. 4.1 and the research questions proposed in Section 1.2, five subareas of ambidextrous service system innovation are examined in more detail: ambidextrous innovation, the (re-)design of innovative service systems, top-down transformation of service systems, emergence of workarounds in organizational routines, and the bottom-up transformation of service systems.

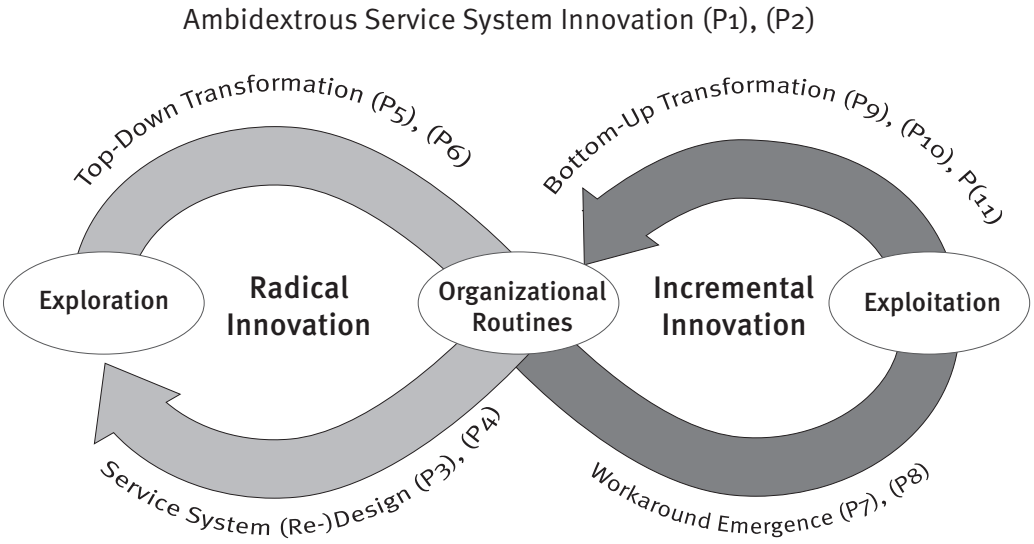

Figure 4.1: Ambidextrous Service System Innovation

These five areas provide a meso-perspective on the research topic and provide a framework with which to fill the identified research gap of limited research on the application of ambidexterity in a service system context.

> **RQ1.** *How can ambidexterity reconcile conflicting views on the exploration and exploitation of capabilities and other resources for service system innovation?*

As proposed in the theory of ambidexterity, organizations need to balance their activities of exploring and exploiting new service systems simultaneously. In order to achieve this, organizations have to adapt their structures and acquire specific capabilities. The publications *P1.* "*Ambidexterity in Service Innovation Research—A Systematic Literature Review*" in Section 1.1 and *P2.* "*Capabilities for Ambidextrous Innovation in Digital Service*" in Section 1.2 of Part B address these two organizational demands and, thereby, provide a theoretical basis for understanding service system innovation from an ambidexterity perspective.

In P1 a systematic literature analysis and conceptual analysis has been conducted, from which three propositions were derived. First, service system innovation can be considered to be on a continuum between exploration and exploitation of resources, capabilities, and processes. The exploration of innovative value propositions provides the foundation for their efficient implementation and management into a

service. Hence, exploration enables and constrains the exploitation of innovation in day-to-day business. P1 reveals that exploitation of service innovation, which is performed by actors in a service system, creates and recreates the mechanisms and patterns for exploring an innovative service. Considering this reciprocal relationship between the two innovation directions, it becomes apparent that service systems are subject to endogenous change.

Second, technology provides an opportunity for offering new value propositions, as it can be an enabler and a trigger for service innovation. In order to explore a radically new service, actors engage in searching for and acquiring mainly disruptive technologies. To exploit an existing service and adapt a value-proposition, established technologies are selected, integrated, and reconfigured.

Third, taking a systemic perspective on service innovation provides a suitable research perspective, acknowledging the inherent dynamics of convergence and divergence. Value is created as resources are integrated in a service system, comprising people, technology, organizations, and shared information (Breidbach and Maglio, 2015).

Based on these three insights, a framework is developed that considers the exploration of new and the exploitation of existing resources, activities, and knowledge in a mutually constitutive relationship. The framework provides an integrative view of service system innovation that is in line with ever-accelerating innovation cycles (Brynjolfsson and McAfee, 2014).

In order to realize an ambidextrous innovation approach, organizational and individual capabilities need to be acquired and applied. By conducting a Delphi study in P2 with a panel of service experts from research and management, an extensive set of capabilities has been identified. Among the most important *individual* capabilities to establish ambidextrous service innovations are complexity handling, integrated thinking, economic thinking, and networking, while highly relevant *organizational* capabilities include knowledge transfer, innovation encouragement, flexible structures, and the co-existence of dual structures.

Depending on the phases of the innovation process, i.e., analysis, design, transformation, or management, some specific capabilities are more important than others. However, a customer focus and (project) management skills are indispensable capabilities required for all phases. Some capabilities have been found as

particularly relevant for the exploration of an innovative service, such as agility, open-mindedness, and readiness to fail. In contrast, other capabilities, like adaptability, reflectivity, or freedom of action have been identified as relevant for the exploitation of an existing service to achieve incremental innovation.

> **RQ2.** *How can innovative service systems be designed systematically and comprehensively through recombination?*

The systematic (re-)design of value propositions is a viable approach for exploring an innovative service and gaining a competitive advantage. Service system engineering is a complex venture that comprises multiple aspects, secondary design activities, and an organizational transformation process. In the publications *P3.* "*Recombinant Service System Engineering*" in Section 2.1 and *P4.* "*Understanding Smart Service System Transformation—A Socio-Technical Perspective*" in Section 2.2 of Part B a socio-technical perspective is adopted to enable the successful establishment and transformation of a service system.

As a conceptual analysis in P3 reveals, existing engineering methods often focus only on the design of a value proposition instead of an entire service system, thus ignoring to take into account the socio-technical context in which actors integrate their resources to co-create value. Further, a design of a service is often disconnected from physical goods, which, however, constitute an important resource for value co-creation. Two other drawbacks of existing service engineering approaches are identified as being either linear or iterative and failing to acknowledge recombination as an innovation mechanism.

To remedy these shortcomings, a new method for recombinant service system engineering is designed. The method is based on the concept of recombination, in which existing resources and solutions are reused and newly combined to achieve an innovative service system. There are different types of recombination that can be applied to establish new service systems: association, dissociation, and addition to existing internal and external resources.

The method comprises three sub-processes, namely service system analysis (1), service system design (2), and service system transformation (3), which are connected by a decision point to enable an agile engineering process. In the first phase, it is important to develop and select innovative ideas as well as identify

and analyze requirements, resources, and viable value-propositions. As soon as the decision point is reached, the manager has to decide whether to repeat the first phase, proceed with the design of the service system, or continue with the service system transformation phase. In the service system design phase, a cyclic prototypical approach is pursued to design a business model and a service concept. After each design cycle the prototype is evaluated. Subsequently, the manager can continue with further design cycles to improve or refine the prototype, or begin the service system transformation phase, in which the service concept is implemented. To enable continuous improvement, the learning should be formalized and the feedback loops should be integrated, in the spirit of exploitation of service system innovation.

In order to fully leverage the potential of service system innovation, it is necessary to (re)-align all the elements in a service system, which is elaborated in P4. As already stated in the socio-technical theory by Bostrom and Heinen (1977), socio-technical systems consist of multiple elements that affect each other. In this regard, a change of one element will result in the alteration of another. Besides structure, processes, people, and technology that shape social and technical systems, the management and culture also substantially impact a service system.

For organizations to fully realize the innovation potential of designing a new service, they need to undergo a transformation phase to ensure the (re-)alignment of all the elements in the service system. It is important that organizations cannibalize old structures, abandon established processes, and eliminate obsolete activities, and build synergies with actors in value networks. These findings confirm that the systematic design of service systems goes beyond organizational boundaries and is inherently complex, as the processes of value co-creation and resource integration of multiple actors need to be considered.

> **RQ3.** *Which challenges do organizations encounter in a top-down driven service system transformation approach?*

The top-down driven transformation of service systems can be challenging as mangers may need to overcome internal or external barriers. Moreover, the designed structures need to be manifested in the organizational routines of employees to take advantage of newly designed service systems and reinforce their innovation potential. The two publications *P5. "Establishing Smart Service Systems is a*

Challenge—A Case Study on Pitfalls and Implications" in Section 3.1 and *P6.* "*The Impact of Process Automation on Manufacturers Long-Term Knowledge*" in Section 3.2 of Part B outline pitfalls, guidelines, and implications for organizations that adopt new ways of value creation.

The transformation into innovative service systems is particularly challenging for organizations that follow a servitization strategy as identified in P5. Not realizing the complexity of the servitization process, many organizations fail to achieve this transformation successfully. It requires a mind-shift from value-in-exchange, i.e., in which the ownership of products is transferred to the customer, to value-in-use, i.e., in which value is co-created in interaction with the customer (Vargo and Lusch, 2008). Typical pitfalls include the design of product-centered value propositions, the limited awareness and high complexity of service system engineering methods, the unclear role of customers in the value creation process, the retention of organizational structures, decoupling the service system, and incongruous goals of managers in different departments.

Based on these pitfalls, guidelines for research and management were derived. Using pre-existing products as basis for the design of a value proposition can cause a prejudicial and ambiguous perception of value. Further, the integration of (smart) products and services as value bundle requires that its life-cycle needs to be considered, i.e., the disposal or replacement of a (smart) product after its lifetime. Hence, one implication is that integrative engineering approaches are required that consider all elements and the life cycle of a service system. Methods for service system engineering need to be agile and with a hands-on focus since managers often have neither the time nor the necessary resources to familiarize themselves with complex approaches.

While the conception of customers as co-creators and co-producers of value has been established in service science, it still has not been generally accepted in organizations. Therefore, service system engineering methods need to be extended to clarify the roles, functions, and responsibilities of actors in value networks. The transformation brought about by the establishment of an innovative service system is often so fundamental that it can conflict with existing value propositions or organizational structures. Often service systems are established by using a greenfield approach, neglecting existing structures and value-propositions that can have unexpected side-effects for the organization. To remedy this conflict, methods

for service system engineering need to be complemented with a transformation and management phase.

Smart service systems are inherently complex, featuring a smart product with actuators, sensors, interfaces, back-stage analytics, and front-stage use (Beverungen et al., 2019c) that need to be considered when establishing a value proposition. Even with full awareness of these elements, there is no single approach for holistically designing all parts of a smart service system. Hence, a method is needed to design front-stage and back-stage activities so that they are aligned, including the smart product itself. Ultimately, service system innovation is a challenging endeavor that is influenced by management decisions and other environmental requirements (laws, social norms, public opinions, etc.). Therefore, formal guidelines are needed to align the goals of various stakeholders in a service system.

P6 points out that innovative technologies, such as artificial intelligence, enable new ways of resource bundling and value creation processes, e.g., an automated service provision. For example, social bots enable an automated customer care service, which is available to customers 24/7. However, as machines rather than humans interact with customers, knowledge about the processes, customers, and integrated technology may diminish over time.

Knowledge is an important resource that underpins both service system innovation and the individualization of service (Barile et al., 2015). Knowledge in this context is a “fluid mix of framed experience, values, contextual information, and expert insights, that provides a framework for evaluating and incorporating new experiences and information” (Davenport and Prusak, 1998, p. 5). Over time, knowledge is accumulated through experience and embedded in repositories, processes, and organizational routines of actors, providing a main competitive advantage. Knowledge, therefore, is often bound to individuals.

Managers frequently decide to outsource activities, processes, or even entire divisions to access additional external resources. Especially activities that involve the adoption of complex and fast developing digital technologies are outsourced (Maglio and Spohrer, 2013). Hence, knowledge is also transferred across organizational boundaries, and changing access rights to organizational resources. Semi-structured interviews with managers revealed that the decision to outsource resources can lead to increased efforts in seizing knowledge and, thereby, reduce the knowledge base of an organization in the long-term. Hence, it is important to

embed a new service into the organizational routines of employees to enable the continued accumulation and maintenance of knowledge as an important resource for exploring and exploiting future service innovations.

> **RQ4.** *How do workarounds and work patterns emerge in a service system as actors deviate from organizational routines and business processes?*

Organizational routines feature both stability and dynamism as they can exhibit changing patterns of action (Pentland et al., 2012b). The implementation and diffusion of innovative technologies both enables and constrains the structure and enactment of an organizational routine. Hence, the interplay between activities in organizational routines and IT artifacts reveals how new behavioral patterns emerge in an organization while an innovation is being established in a service system. This interplay is examined in the two publications *P7*. "*Digitalization of Work Systems—An Organizational Routines' Perspective*" in Section 4.1 and *P8*. "*Detecting Workarounds in Business Processes—A Deep Learning Method for Analyzing Event Logs*" in Section 4.2 of Part B.

By conducting a qualitative research approach with interviews in multiple organizations, four patterns could be identified in P7 that illustrate the interplay between organizational routines and IT artifacts. An IT artifact not only reflects new digital technologies but also comprises constructs, models, methods, and instantiations (March and Smith, 1995), including new innovative services and service system engineering methods.

In the first pattern of actions it is shown how an IT artifact is established in an organization by management and how this transforms ostensive aspects, i.e., the schematic form of an organizational routine in a service system. This contrasts with the second pattern, where an IT artifact diffuses in a service system as it is adopted by employees, transforming the performative aspects, i.e., the enactment of a routine in a service system.

Organizational routines can also lead to an adaptation or the emergence of new IT artifacts. Hence, changes in the ostensive aspects of an organizational routines can impact the form and function of new IT artifacts, as described in pattern three. Finally, pattern four shows how the performative aspects of an organizational routine can trigger a bottom-up design process through demand pull. These four patterns

can be concatenated into transformation trajectories to describe and examine the emergence of bottom-up innovation initiatives.

P8 points out that the emergence of deviant behavior is difficult to detect because employees avoid telling managers about their deviant behavior. Workarounds—as a common form of noncompliant or anomalous behavior in organizational routines and business processes—can be directed towards changing either an information system or a business process. They can occur without being noticed or steered by management. In order to easily and automatically detect them in day-to-day business operations, a method for detecting and analyzing different types of workarounds was designed.

Based on machine learning and process mining, a deep-learning-based method was designed that can detect workarounds in event logs of digitalized business processes. It constitutes a new application of data analysis methods that can be adopted in organizations in order to explore and exploit the innovation potential of workarounds. The method enables an automatic detection for each process instance, regardless of whether a workaround of a specific type actually exists.

For standardized processes that have enough process instances to train the deep neural network, the method achieves a high predictive accuracy and precision. This empowers managers to detect the emergence of workarounds and helps them decide whether to prevent or adopt them as innovation potential in a socio-technical system.

> **RQ5.** *How can organizations create service system innovation through bottom-up driven transformation?*

Workarounds can be considered as an important source of bottom-up innovation because they have already proven their practicability in day-to-day work by having affected the routines of co-workers, IT artifacts, and the organization as a social structure. As explored in the publications *P9*. "*Workarounds as Generative Mechanisms for Restructuring and Redesigning Organizations—Insights from a Multiple Case Study*" in Section 5.1 and *P10*. "*Conceptualizing the Impact of Workarounds—An Organizational Routines' Perspective*" in Section 5.2 of Part B, workarounds emerge on an individual level through perceived misfits and diffuse through communication and observation in the whole socio-technical system, leading to organizational

change. Therefore, they can constitute a viable source of innovation that remedies the challenges and paradoxes as identified in *P11*. "*Seven Paradoxes of Business Process Management in a Hyper-Connected World*" in Section 5.3 of Part B.

In P9, a multiple case study is performed, which revealed that workarounds emerge as actors perceive either a technological, organizational, or strategic misfit that interferes with their goal achievement. To alleviate this misfit, employees adapt a malfunctioning IT artifact or alternate the activities in a business process, which manifests in the performative aspects of an organizational routine. An actor might adopt a workaround if its innovative potential is great enough, e.g., if it enables a better or faster, i.e., more effective performance of an organizational routine.

Workarounds diffuse through observation or (verbal or non-verbal) communication with other actors in a service system, either in the same spacial sphere or virtually. As soon as the extent of a workaround, the number of actors who perform the workaround, or the number of workarounds surpasses a certain threshold, it can trigger a top-down driven innovation process, through which IT artifacts, processes, and organizational routines are restructured, redesigned, and innovated, leading to the resolution of a perceived misfit.

Routines are conducted by multiple actors that collaborate by using one or more IT artifacts to perform their tasks in service systems. In P10, six patterns were identified that show how and why workarounds are transferred from one to another organizational routine. All patterns represent different ways of how workarounds are conveyed across routines, thus leading to endogenous change in service systems.

The patterns are systematized in a conceptual framework, which allows to examine workarounds from a multi-dimensional perspective. It considers two forms of handoffs—i.e., directly by person or indirectly via an IT artifact—and three ways of collaboration—i.e., uni-directional, bi-directional, or multi-directional.

The six patterns show that the diffusion of workarounds is complex in nature and can lead to both desired and undesired consequences. As the workarounds are exploited, new ostensive patterns emerge that have the power to alter the whole service system. The patterns also emphasize that the transformation of organizational routines in service systems progresses always differently, as each organization is unique and has its own structures.

While workarounds constitute "first-order solutions to problems" (Röder et al., 2015b, p. 483), they can also trigger a secondary (re-)design of business processes to improve their performance (Alter, 2015a). In this regard, workarounds are an omnipresent phenomenon in business processes.

Business processes are a central element of service systems, representing social structures that are enacted by employees and enabled by technology. They are networked to other elements in a service system and to their environment, including customers, suppliers, and other business partners (Alter and Recker, 2017). Besides the emergence of workarounds, constantly new digital technologies are launched, which provide opportunities for performing business processes completely differently, including processes for the co-creation of value. Hence, as digital technologies trigger the re-design of business processes, other elements in a service system also need to be transformed to achieve an alignment of organizational structures. Hence, digital technologies also increase the complexity of managing business processes and service systems.

Four main technological trends are currently reshaping service systems and their underlying business processes, which are discussed in P11: social computing, smart devices, big data analytics, and real-time computing. These transformative technologies and other disruptive IT create challenges for the strategy, modeling, implementation, and analysis of business processes.

Some challenges are mutually impacting each other; while others counteract each other. This leads to seven paradoxes that need to be solved by establishing new theories and designing innovative IT artifacts. In order to manage these paradoxes, organizational structures need to be realigned and traditional roles of process managers and process participants redesigned to establish both efficient and flexible processes. Further, customer data and other contextual data need to be integrated from different sources, ensuring data analysis results of higher quality to provide an innovative service. Finally, IT artifacts and theories must have a higher level of abstraction, allowing managers to remain efficient throughout standardization and exploitation while at the same time creating business value through the individualization and exploration of an innovative service.

4.2 Contribution to Research and Management

This thesis contributes to both research and management by explaining how service system innovation can be established through simultaneous exploration and exploitation processes, i.e., through an ambidextrous innovation strategy. The contribution is structured in a 2x3 matrix, as visualized in Fig. 4.2. Some publications in this thesis (P1, P3-P4 and P9-P11) specifically provide insights on the ideal or schematic form of how an innovative service system can be established (*ostensive aspects*), contributing to the body of knowledge. Other publications (P2, P5-P8) examine more closely the enactment of service system innovation (*performative aspects*), providing hands-on knowledge and thereby, a substantial contribution to management. In this regard, research on specific aspects allows an in-depth analysis of ambidexterity in the service system context. In addition, the constituent mechanisms of exploration and exploitation are uncovered by explicitly investigating how innovation can be achieved through ambidexterity.

The sum of all research results provides a comprehensive base of both descriptive and prescriptive knowledge on how an ambidextrous service system innovation strategy can be established (Rothe et al., 2020). In this regard, the overall research objective is achieved by developing a theory for explaining (type II theory) and designing (type V theory) (Gregor, 2006) ambidextrous service system innovation and its interrelated concepts.

A theoretical contribution is achieved in form of a substantially new logic that unites concepts and how they interrelate in a theoretical model (Whetten, 1989). The research results of this thesis comply with all four criteria of a value-added theoretical contribution by (Whetten, 1989) and (Dubin, 1969).

First, a theory was developed that outlines the *concepts and constructs* that enable the dynamic development of ambidextrous service system innovation. This theory is the first to combine the view of top-down and bottom-up transformation for service system innovation, thereby fulfilling the requirements of *comprehensiveness*—by including relevant concepts—and of *parsimony*—by providing a viable explanation on how ambidextrous service system innovation can be achieved (Whetten, 1989). As a top-down approach for exploring a new innovative service, recombinant service system engineering was identified and conceptualized. This crucially requires organizations to transform their service system as a whole,

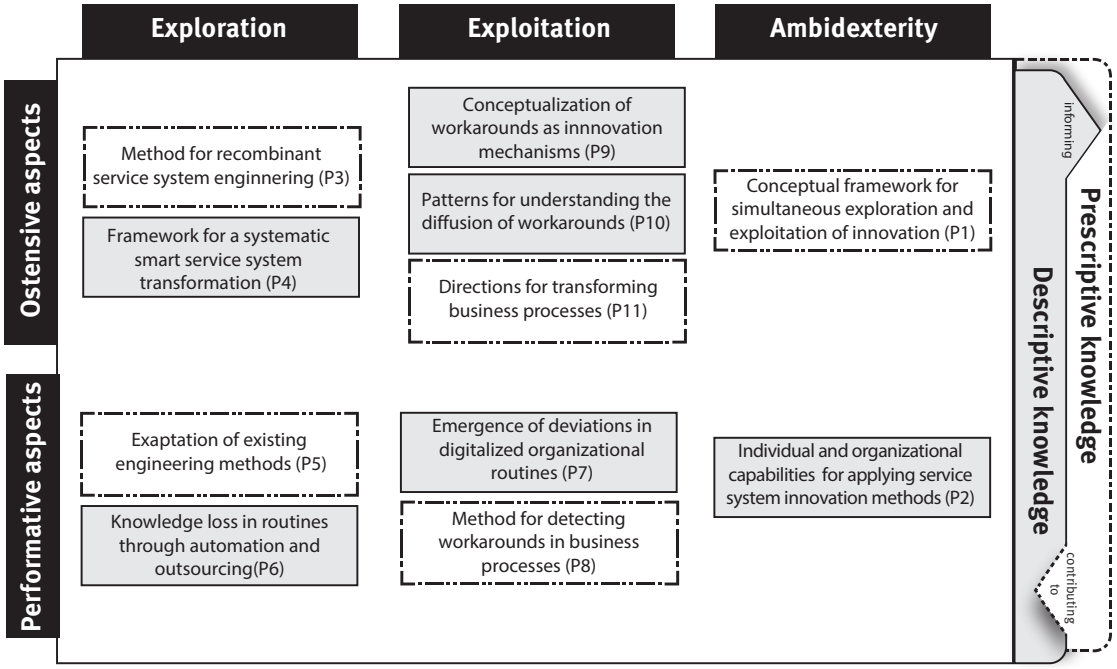

Figure 4.2: Contributions to Research and Management

including its structure and processes. To exploit service systems, organizational routines were identified as a central concept, to understand how service systems are adapted and improved by actors in their day-to-day work. Especially workarounds constitute a viable source of incremental innovation and efficiency.

Second, the *relationship* between top-down and bottom-up innovation of service systems is delineated as the mutually constitutive interplay of exploration and exploitation. In this regard, new links were established that show how the simultaneous design and emergence of service systems can be managed. More specifically, ambidextrous service system innovation is conceptualized as an infinite innovation loop of exploration, i.e., through a top-down driven design process and exploitation, i.e., through a bottom-up driven innovation process, as workarounds emerge in day-to-day work.

Apart from the meso-perspective of ambidextrous service system innovation, a micro-perspective is adopted that explains the sub-processes and related concepts, and through which innovation patterns were identified that can be used to describe trajectories of service system transformation. As service systems are designed

and implemented, they transform the organizational routines of employees from the top down. When an employee perceives a misfit in her work performance, workarounds can emerge that manifest in organizational routines, thereby, transforming the structure of a service system bottom-up. In this regard, workarounds have the power to trigger the (re-)design of service systems.

Third, with regard to the socio-economic challenges in a digitally transforming environment, the requirements for fast and flexible adjustments of service systems are intensifying. By applying the theory of ambidexterity as *underlying logic* to service science, the challenges arising from simultaneous design and the emergence of innovation can be resolved. With regard to the extant literature in IS, the disconnection between dispersed research areas of service system engineering and organizational routines is allayed. Further, prevalent theories on service system engineering and management are extended by adopting bottom-up transformation as an additional mechanism for service system innovation. Finally, the theory of ambidexterity is extended as it is applied to a new context and research domain.

Fourth, the theoretical contribution is embedded in temporal and contextual *boundaries* (Whetten, 1989). The contextual boundaries are set by the theoretical lens on service systems, which means that if an innovative service is designed or emerges outside of the system's boundaries, it lies beyond the scope of this theory. Moreover, service systems are nested in a culture in which factors like power distance or uncertainty avoidance (Hofstede et al., 2005) have an effect on the emergence and acceptance of workarounds, constituting further boundaries of the research results. As the theoretical contribution of this thesis constitutes both a type II theory that can be applied to explain how simultaneous exploration and exploitation is achieved, and a type V theory, in which novel design knowledge for ambidextrous service system innovation is developed, the predictability of bidirectional innovation mechanisms is out of scope. With regard to temporal boundaries, the theory assumes synchronicity or near-synchronicity, neglecting a potential coordination delay or inconsistencies that can arise from simultaneous top-down and bottom-up innovation processes.

4.3 Outlook

In line with the rapid development of new digital technologies, innovation cycles keep accelerating, constantly requiring new methods and tools for establishing service systems. The thesis provides a new theory on the establishment of new service systems and improvement of existing ones through the mutually constitutive mechanisms of exploration and exploitation.

Researchers can use this new perspective on service system innovation as conceptual basis for extending service engineering methods with a subsequent transformation and management phase. This could include the restructuring of an organization and its processes, remedying potential conflicts with existing elements of a socio-technical system. Further, methods can be designed to allow both radical innovations and incremental improvements that are implemented in a fast and agile manner. This way, both directions of innovation, i.e., bottom-up and top-down, can be incorporated.

While workarounds constitute an emergent source of innovation that needs to be detected by managers, other concepts for exploiting service systems can be identified. One promising avenue for extending the framework on ambidextrous service system innovation is through *guided bottom-up innovation*, e.g., as already attempted by managers who establish innovation labs, brown-bags, or hackathons. Thereby, managers encourage and guide the development of innovative ideas from actors in a service system. As researchers examine guided innovation, insights on the environment, infrastructure, and organizational climate can be provided to foster service system innovation.

In line with the requirements for a value-adding theory (Whetten, 1989), concepts in the theoretical framework for ambidextrous service system innovation can be operationalized and tested with respect to their causal relationships. In this regard, moderating variables, e.g., specific characteristics of actors, innovation climate, or external variables like time-pressure can be added to advance the explanatory character of the proposed theory in this thesis.

Finally, organizations rely more and more on the acquisition and integration of external resources to establish innovative value propositions and to remain competitive. Hence, service systems need to interact with other service systems, providing

new opportunities but also increasing the complexity of innovation mechanisms. Future research could adopt a perspective of *service ecosystems* to extend the theory of ambidexterity to a broader context and design artifacts that can be harnessed to realize the advantages of an ambidextrous innovation approach.

Part B
Included Publications

1 Ambidextrous Service System Innovation

1.1 Ambidexterity in Service Innovation Research: A Systematic Literature Review

Title	**Ambidexterity in Service Innovation Research: A Systematic Literature Review**	
Publication Type	Conference Proceedings	
Publication Outlet	14th International Conference on Wirtschaftsinformatik	
VHB JOURQUAL3	C	
Authors	**Name**	**Contribution**
	Verena Wolf	100%
Presentation	Verena Wolf	100%
Status	Published	
Awards	–	
Full Citation	V. Wolf 2019. "Ambidexterity in Service Innovation Research: A Systematic Literature Review," in *Proceedings of the 14th International Conference on Wirtschaftsinformatik,* (Siegen, Germany).	

Table 1.1: Fact Sheet of Publication P1

1.2 Capabilities for Ambidextrous Innovation of Digital Service

Title	**Capabilities for Ambidextrous Innovation of Digital Service**	
Publication Type	Conference Proceedings	
Publication Outlet	15th International Conference on Wirtschaftsinformatik	
VHB JOURQUAL3	C	
Authors	**Name**	**Contribution**
	Verena Wolf	60%
	Hedda Lüttenberg	40%
Presentation	Verena Wolf	100%
Status	Published	
Awards	–	
Full Citation	V. Wolf and H. Lüttenberg 2020. "Capabilities for Ambidextrous Innovation of Digital Service," in *Proceedings of the 15th International Conference on Wirtschaftsinformatik,* (Potsdam, Germany).	

Table 1.2: Fact Sheet of Publication P2

2 (Re-)Design of Innovative Service Systems

2.1 Recombinant Service System Engineering

Title	**Recombinant Service System Engineering**	
Publication Type	Journal Article	
Publication Outlet	Business & Information Systems Engineering	
VHB JOURQUAL3	B	
Authors	**Name**	**Contribution**
	Daniel Beverungen	40%
	Hedda Lüttenberg	30%
	Verena Wolf	30%
Presentation	Hedda Lüttenberg	50%
	Verena Wolf	50%
Status	Published	
Awards	Best Paper Nominee at WI2017	
Full Citation	D. Beverungen, H. Lüttenberg, and V. Wolf 2018. "Recombinant Service Systems Engineering," *Business & Information Systems Engineering* (60:5), pp. 377–391.	

Table 2.1: Fact Sheet of Publication P3

2.2 Understanding Smart Service System Transformation—A Socio-Technical Perspective

Title	**Understanding Smart Service System Transformation—A Socio-Technical Perspective**	
Publication Type	Conference Proceedings	
Publication Outlet	28th European Conference on Information Systems	
VHB JOURQUAL3	B	
Authors	**Name**	**Contribution**
	Verena Wolf	100%
Presentation	Verena Wolf	100%
Status	Published	
Awards	–	
Full Citation	V. Wolf 2020. "Understanding Smart Service Systems Transformation – A Socio-Technical Perspective," in *Proceedings of the 28th European Conference on Information Systems (ECIS),* (Marrakech, Morroco).	

Table 2.2: Fact Sheet of Publication P4

3 Top-Down Transformation of Service Systems

3.1 Establishing Smart Service Systems is a Challenge: A Case Study on Pitfalls and Implications

Title	**Establishing Smart Service Systems is a Challenge: A Case Study on Pitfalls and Implications**	
Publication Type	Conference Proceedings	
Publication Outlet	15th International Conference on Wirtschaftsinformatik	
VHB JOURQUAL3	C	
Authors	**Name**	**Contribution**
	Verena Wolf	50%
	Alena Franke	20%
	Christian Bartelheimer	20%
	Daniel Beverungen	10%
Presentation	Verena Wolf	50%
	Alena Franke	50%
Status	Published	
Awards	–	
Full Citation	V. Wolf, A. Franke, C. Bartelheimer, and D. Beverungen 2020b. "Establishing Smart Service Systems is a Challenge: A Case Study on Pitfalls and Implications," in *Proceedings of the 15th International Conference on Wirtschaftsinformatik,* (Potsdam, Germany).	

Table 3.1: Fact Sheet of Publication P5

3.2 The Impact of Process Automation on Manufacturers Long-Term Knowledge

Title	**The Impact of Process Automation on Manufacturers Long-Term Knowledge**	
Publication Type	Conference Proceedings	
Publication Outlet	39th International Conference on Information Systems	
VHB JOURQUAL3	A	
Authors	**Name**	**Contribution**
	Chris Gernreich	30%
	Christian Bartelheimer	30%
	Verena Wolf	30%
	Christopher Prinz	10%
Presentation	Chris Gernreich	100%
Status	Published	
Awards	–	
Full Citation	C. C. Gernreich, C. Bartelheimer, V. Wolf, and C. Prinz 2018. "The Impact of Process Automation on Manufacturers Long-Term Knowledge," in *Proceedings of the 39th International Conference on Information Systems (ICIS),* (San Francisco, California, USA).	

Table 3.2: Fact Sheet of Publication P6

4 Emergence of Workarounds in Organizational Routines

4.1 Digitalization of Work Systems—An Organizational Routines' Perspective

Title	**Digitalization of Work Systems— An Organizational Routines' Perspective**	
Publication Type	Conference Proceedings	
Publication Outlet	52th Hawaii International Conference on System Sciences	
VHB JOURQUAL3	C	
Authors	**Name**	**Contribution**
	Verena Wolf	45%
	Christian Bartelheimer	35%
	Daniel Beverungen	20%
Presentation	Verena Wolf	100%
Status	Published	
Awards	–	
Full Citation	V. Wolf, C. Bartelheimer, and D. Beverungen 2019. "Digitalization of Work Systems—An Organizational Routines' Perspective," in *Proceedings of the 52nd Hawaii International Conference on System Sciences (HICSS),* (Maui, Hawaii, USA). (doi: 10.24251/HICSS.2019.724)	

Table 4.1: Fact Sheet of Publication P7

4.2 Detecting Workarounds in Business Processes—A Deep Learning Method for Analyzing Event Logs

Title	**Detecting Workarounds in Business Processes–A Deep Learning Method for Analyzing Event Logs**	
Publication Type	Conference Proceedings	
Publication Outlet	28th European Conference on Information Systems	
VHB JOURQUAL3	B	
Authors	**Name**	**Contribution**
	Sven Weinzierl	40%
	Verena Wolf	30%
	Tobias Paul	10%
	Daniel Beverungen	10%
	Martin Matzner	10%
Presentation	Sven Weinzierl	50%
	Verena Wolf	50%
Status	Published	
Awards	Invitation for re-submission in the Journal of Business Analytics	
Full Citation	S. Weinzierl, V. Wolf, T. Pauli, D. Beverungen, and M. Matzner 2020. "Detecting Workarounds in Business Processes—A Deep Learning Method for Analyzing Event Logs," in *Proceedings of the 28th European Conference on Information Systems (ECIS),* (Marrakech, Morroco).	

Table 4.2: Fact Sheet of Publication P8

5 Bottom-Up Transformation of Service Systems

5.1 Workarounds as Generative Mechanisms for Restructuring and Redesigning Organizations—Insights from a Multiple Case Study

Title	**Workarounds as Generative Mechanisms for Restructuring and Redesigning Organizations —Insights from a Multiple Case Study**	
Publication Type	Working Paper	
Publication Outlet	Paderborn University Faculty of Business Administration and Economics	
VHB JOURQUAL3	–	
Authors	**Name**	**Contribution**
	Verena Wolf	45%
	Christian Bartelheimer	35%
	Daniel Beverungen	20%
Presentation	N/A	
Status	Published	
Awards	–	
Full Citation	V. Wolf, C. Bartelheimer, and D. Beverungen 2020a. "Workarounds as Generative Mechanisms for Restructuring and Redesigning Organizations—Insights from a Multiple Case Study," *Working Paper Series, Paderborn University, Faculty of Business Administration and Economics* (No. 68).	

Table 5.1: Fact Sheet of Publication P9

5.2 Conceptualizing the Impact of Workarounds—An Organizational Routines' Perspective

Title	**Conceptualizing the Impact of Workarounds—An Organizational Routines' Perspective**	
Publication Type	Conference Proceedings	
Publication Outlet	27th European Conference on Information Systems	
VHB JOURQUAL3	B	
Authors	**Name**	**Contribution**
	Verena Wolf	75%
	Daniel Beverungen	25%
Presentation	Verena Wolf	100%
Status	Published	
Awards	Best Paper Nominee	
Full Citation	V. Wolf and D. Beverungen 2019. "Conceptualizing the Impact of Workarounds—An Organizational Routines' Perspective," in *Proceedings of the 27th European Conference on Information Systems (ECIS),* (Stockholm and Uppsala, Sweden).	

Table 5.2: Fact Sheet of Publication P10

5.3 Seven Paradoxes of Business Process Management in a Hyper-Connected World

Title	**Seven Paradoxes of Business Process Management in a Hyper-Connected World**	
Publication Type	Journal Article	
Publication Outlet	Business & Information Systems Engineering	
VHB JOURQUAL3	B	
Authors	**Name**	**Contribution**
	Daniel Beverungen	8%
	et al.	4%
	Verena Wolf	4%
Presentation	N/A	
Status	Published	
Awards	–	
Full Citation	D. Beverungen, J. C. Buijs, J. Becker, C. Di Ciccio, W. M. P. van der Aalst, C. Bartelheimer, J. vom Brocke, M. Comuzzi, K. Kraume, H. Leopold, M. Matzner, J. Mendling, N. Ogonek, T. Post, M. Resinas, K. Revoredo, A. del-Rio-Ortega, M. La Rosa, F. M. Santoro, A. Solti, M. Song, A. Stein, M. Stierle, V. Wolf, J. C. A. M. Buijs, A. del-Río-Ortega, and F. M. Santoro 2020. "Seven Paradoxes of Business Process Management in a Hyper-Connected World," *Business & Information Systems Engineering* (Forthcoming). (doi: 10.1007/s12599-020-00646-z).	

Table 5.3: Fact Sheet of Publication P11

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