Digital Service System Transformation: Socio-Technical Reflections on the Prospects and Constraints of Design

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Foreword

Few of our international colleagues know that Paderborn is home to one of Germany's more exciting football clubs: The SC Paderborn 07. In its history, the club has seen its ups and downs, but little compares to the exhilarating events of recent years. In 2013/2014, the club ranked second in Germany's 2nd Football League, letting them climb into the nation's prestigious top league (Bundesliga). However, this leap in prestige came with a high price: The club was soon relegated two seasons in a row (2014/2015 and 2015/2016), and only another club going bust saved them from falling further (2016/2017). Astonishingly, the club's turnaround for the better was equally impressive, allowing them to make a direct ascent (2017/2018), followed by re-entering the Bundesliga (2018/2019). After yet another relegation (2019/2020), they recently remained in the Second Football League. What a thrill!

Maybe, the eventful history of Paderborn's top football club reflects some properties that also constitute the digital transformation of our economy and society. First, an appreciation for local events can be a surprisingly refreshing experience to complement a global perspective on digital transformation. Second, unexpected events—positive and negative—keep shaking our views of the world, while there are always opportunities to change for the better, to make the best of a situation, and to keep going ahead. Finally, new vistas invite us to question, extend, and update our taken-for-granted perceptions of the world, enabling us to create something new. I believe that all three aspects are invaluable to guide both our personal development and the digital transformation at large.

In his dissertation, Christian Bartelheimer (implicitly) takes up these aspects, providing fresh insights on how service science and information systems research can interplay to develop new knowledge. Three results stand out. First, Christian reports on new design knowledge on engagement platforms used in the physical setting of local high street retail to establish interactive shopping experiences that

might help preserve the quality of life in cities. Second, he investigates the role and consequences of workarounds in organizations, highlighting their potential to foster process innovation. Third, he builds on service science's concepts to update task-technology fit theory, contributing new ideas on using digital technologies for value co-creation.

Besides its scientific contribution, the dissertation reports core results of diverse research projects, including smartmarket² and DIGIVATION (funded by the German Federal Ministry of Education and Research) and RISE_BPM (funded by the European Commission), making the results accessible to a general audience.

I see Christian's dissertation as essential reading for establishing new services and actor engagement on digital platforms and using workarounds as a source for process innovation. Indeed, I expect to see future breakthrough ideas that build on the results provided here. May the reading inspire your views on digital transformation and provide first-hand insights that help you implement your ideas. I trust the digital transformation will remain a challenging and an (at least) equally rewarding thrill for us all.

Paderborn, September 2021 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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Part A

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List of Abbreviations

ADR	Action Design Research
AST	Adaptive Structuration Theory
BDA	Big Data Analytics
BLE	Bluetooth Low Energy
BPM	Business Process Management
CRM	Customer Relationship Management
DOIS	Design-Oriented Information Systems Research
DSML	Domain-Specific Modeling Language
DSR	Design Science Research
DSRM	Design Science Research Methodology
DSST	Digital Service System Transformation
EDT	Explanatory Design Theory
EoD	Extent of Digitization
ERP	Enterprise Resource Planning
FEDS	Framework for Evaluation in Design Science
G-D logic	Goods-Dominant Logic
HSJML	High Street Journey Modeling Language
ICT	Information and Communication Technology
IS	Information Systems
ISDT	Information Systems Design Theory
LBA	Location-Based Advertising
MES	Manufacturing Execution System
QCA	Qualitative Content Analysis
RoD	Range of Digitization
S-D Logic	Service-Dominant Logic of Marketing
SME	Small- and Medium-Sized Enterprizes
SSE	Service Systems Engineering
SSME	Service Science, Management, and Engineering
STS	Socio-Technical System
STSE	Socio-Technical System Engineering
STT	Socio-Technical Theory

Part A
Research Overview

1 Exposition

1.1 Introduction and Motivation

By virtue of exchanging a service, all actors in a service ecosystem continuously integrate resources with other actors in order to co-create value for the benefit of at least one of the involved actors (Vargo and Lusch, 2016). Impacted by institutional arrangements, actors constantly review and adapt their resource integration activities, which in turn shape and reshape the context of value co-creation activities (Lusch and Nambisan, 2015). The continuous and unpredictable modification of activities, however, leads to uncertainty for other actors in the ecosystem and its environment (Lusch and Nambisan, 2015). The so-called information revolution (Rust and Huang, 2014), driven by pervasive digital technology (Yoo et al., 2012) that permeates service systems in various ways (Coreynen et al., 2017), fundamentally transforms service systems (Rust and Huang, 2014) at all aggregation levels (Edvardsson et al., 2010), disrupting business models, markets, and society (Iansiti and Lakhani, 2014).

Rapid advancements in information and communication technology (ICT) enable innovative resource configurations that occur at an ever-accelerating speed (Beverungen, Breidbach, et al., 2019). While in the first decades of their existence computers were employed to perform simple tasks faster and more efficiently than humans, the doubling of computational power every 18 months—predicted by Moore's law (Moore et al., 1975)—has increased so much so that computers are now capable of solving structured and unstructured problems which previously had been the preserve of humans (Demirkan et al., 2016). Hence, pervasive digital technology (Yoo et al., 2012) can serve not only as an enabler and facilitator of service, or provide the service context, but it can itself be applied as a service (Huang and Rust, 2013).

Digital technology consists of a layered modular architecture that affords its basic characteristics *reprogrammability* and *data homogenization* (Yoo et al., 2012), both of which equip digital technology with inherent adaptability (Tilson et al., 2010). It capitalizes on the availability of virtually limitless computational power that can be realized at relatively marginal costs (McAfee et al., 2012) but that has had the effect of fundamentally transforming the engagement practices between actors in service systems (Rust and Huang, 2014). It allows for the adding, modifying, and withdrawing of digital touchpoints from the servicescape ad-hoc, enabling organizations to implement solution-based business models (Brax and Jonsson, 2009). Simultaneously, organizations are increasingly required to transform their organizing logic (i.e., altering their organizational and operational structure; Hess et al., 2016) to make use of such technology (Yoo et al., 2010). Technological advancements, in combination with the speed at which customer demands evolve, has led to organizations innovating in a sometimes disruptive manner (Schwab, 2016).

The pervasiveness of service systems by digital technologies brings forth trends like datatization (Schüritz et al., 2017), whereby massive amounts of (customer) data become available for analysis. These data can be contextualized, and integrated as resources in value co-creation processes (Ardolino et al., 2018), enabling individualized service experiences with high efficiency at low costs (Barrett et al., 2015). Hence, digital technology fundamentally transforms service systems, providing them with the ability to offer better and more personalized services, aiming to strengthen the relationships between service customers and service providers (Rust and Huang, 2014). Additionally, digitalized service systems become "increasingly more *automated, interactive, open,* and *learning* systems" (Böhmann et al., 2018, p. 373).

Moreover, the emergence of digital technology facilitates the digital decoupling of information (Lusch and Nambisan, 2015), i.e., digitizing information and decoupling it from technology. Digital decoupling fosters resource liquefaction and enables resource density. Resource liquefaction refers to the ability to decouple resources from their context, and resource density describes the ability to ad-hoc mobilize resources context- and situation-dependent—and at low costs (Lusch and Nambisan, 2015). The broad application of these phenomena in socio-technical systems enables generativity (Tilson et al., 2010), which allows for manifold (service) innovation opportunities through the recombination of exist-

ing resources (Arthur, 2009; Beverungen et al., 2018). In most cases, this resource recombination involves new technology (Peters et al., 2016), transforms multiple elements of a service system (Alter, 2008), rebundles diverse resources for a benefit (Lusch and Nambisan, 2015), and often results in new service systems (Chandler et al., 2019). It is often referred to as *service innovation* (Alter, 2008; Breidbach and Maglio, 2015; Lusch and Nambisan, 2015; Chandler et al., 2019). This dissertation, however, coins the delineated phenomenon as *Digital Service System Transformation (DSST)*, which emphasizes a design and continuum perspective and is in line with Breidbach and Maglio (2015, p. 2), who define "service innovation as service system reconfiguration, which helps to avoid the inconsistencies of existing service innovation perspectives."

Drawing on the tripartite view of service innovation, as proposed by Lusch and Nambisan (2015), DSST deals with the transformation of service ecosystems (network-centric focus), service platforms (information-centric focus), and value co-creation activities (experience-centric focus). One way of enabling DSST is by facilitating access to resource bundles—and to enable their configuration—to create (innovative) value propositions through digital technology, which is characterized by a modular architecture (Yoo et al., 2010) that inherently provides structural flexibility and integrity (Tilson et al., 2010). Flexibility and integrity are both crucial to a service system's digital transformation, allowing for the dynamic configuration of value propositions that can be offered to a broad and location-independent spectrum of potential customers who might engage in service exchange, if they expect to benefit from such an exchange (Lusch and Nambisan, 2015). However, the flexibility and integrity inherent in digital technology must be equilibrated and codified to achieve DSST. The technology must provide actors with the option of integrating resources while constraining their behavior sufficiently so that the desired outcomes (i.e., engaging in resource integration and co-creating value) are more likely to occur than undesired outcomes (i.e., failure to engage in resource integration, resulting in a "co-destruction" of value; Echeverri and Skålén, 2011; Plé et al., 2010).

From a resource perspective, knowledge represents the primary operant resource in service. Furthermore, knowledge is a critical resource for developing innovative digital technology and is, hence, embedded in technology (Lusch and Nambisan, 2015). In DSST, digital technology can take two roles in value co-creation. First, digital technology can act as an operand resource that facilitates or enables

resource integration among actors in service ecosystems and, second, it can act as an operant resource that integrates and configures other resources (Lusch and Nambisan, 2015). As an operand resource, employing digital technology aims to facilitate resource integration interactions among a service ecosystem's actors. Given the emergent nature of digital technology as an operant resource, the design and actions of digital technology can trigger and impact other actors' behavior and vice versa. Consequently, developing new technology is a constituent of DSST because "technology is the practical application of knowledge; thus, technology, innovation, and service are interlinked" (Lusch and Nambisan, 2015, p. 159).

Service systems that employ digital technology become more robust and able to adapt to changes in their environment (Lusch and Nambisan, 2015). Hence, organizations aim to leverage digital technology with a view to achieving positive transformational impact, and to implement innovative business models based on pursuing service transformation enabled by technology (Demirkan et al., 2016; Rust and Huang, 2014). However, dynamically adding and withdrawing additional touchpoints to a servicescape alters the context of an implemented digital technology as an IT artifact (March and Smith, 1995). The new context then imposes new technology affordances and constraints (Majchrzak and Markus, 2012) to an IT artifact's form and function (Alexander, 1964; March and Smith, 1995), resulting in a decreasing fit between an IT artifact and its context. Whilst the innovations enabled by digital technology have mainly been associated with positive transformational impact, and related societal developments, the fast pace with which pervasive digital technology has been emerging over the last twenty years (Yoo et al., 2012) has put pressure on technology providers to continuously enhance and reconfigure existing digital technology (Asadullah et al., 2018).

Given that actors' resource integration activities (Lusch and Nambisan, 2015), digital technology (Yoo et al., 2012), and service providers that employ the technology (Asadullah et al., 2018) unprecedently—and partially radically—change at an ever-increasing speed, the complexity of the environment for individuals, organizations, and society also continuous to increase. Consequently, DSST is accompanied by high uncertainty, which can result in undesirable outcomes (Vial, 2019; Lember et al., 2019). However, the relationship between pervasive digital technology and service system transformation has only been sparsely investigated and described in the scientific literature (Akaka and Vargo, 2014; Ardolino et al., 2018). Currently, "technology-enabled value co-creation processes remain largely

unexplored, and understanding the performance implications of ICT remains a key challenge for service research" (Breidbach and Maglio, 2016, p. 73). Hence, one central research path for studying DSST is to examine how digital technology ought to be designed to enable maximum liquefaction and density of resources, fostering resource integration and value co-creation (Lusch and Nambisan, 2015). However, such a design cannot be comprehensively achieved and is impacted by both continuous technological progression and the steady altering of the resource integration activities of actors. Consequently, it is assumed that the design goal of DSST pursues to make desired outcomes more likely to occur than undesired outcomes.

Service system design has become "a means for societal transformation" (Sangiorgi, 2011, p. 29), which can only be achieved through "transformation design" (Burns et al., 2006). Hence, the design of a service system's transformation needs a more holistic approach that transcends organizational boundaries, holistically transforms service ecosystems, and is human-centered (Schwab, 2016; Sangiorgi, 2011). In order to create fundamental change, transformative service system design considers the changing behavior of humans, because "[service system design] projects can initiate a lasting transformation process" (Sangiorgi, 2011, p. 31). Thus, the design of a digital service system's transformation requires the perspective of "seeing every use situation as a potential design situation" (Ehn, 2008, p. 96). Consequently, digitally transformed service systems need to result in systems that enable flexibility and agility for future evolution and adaption—and designers need to become reflexive, and to incorporate new skills and tools into their practices to understand both emerging change and the impact of their design decision (Sangiorgi, 2011). The ultimate aim of DSST, then, is to yield a system that enables continuous monitoring and adaption of its design to reach desired outcomes in the long-term.

Consequently, analyzing, explaining, and prescribing both the nature of digital technology and the consequences of its implementation for the behavior of actors in service systems should be a key research priority for future research in Information Systems (IS). In particular, we need to understand how digital technology ought to be designed to enable resource integration and value co-creation, while simultaneously examining how and why implementing new technology induces behavioral and structural changes in service systems. Since these changes result from actors who adapt to new technology, altering behavior over time, it is an-

other critical priority to describe and understand their actions on a micro-level. Moreover, the changing behavior of actors affords new demands over time that not only generate additional requirements for an IT artifact's form and function but also need to be anticipated in the technology's initial design.

1.2 Research Problem and Research Objectives

The importance of studying the DSST for its role in shaping the digital service revolution (Rust and Huang, 2014) has been underlined by the fact that digital technologies have been mentioned at the highest level, i.e., at a recent G20 forum. More specifically, in 2019 the G20 ministers for trade and digital economy have stated that, to realize a sustainable and innovative global society should involve "making full use of digital technologies [...] [in order to] harness the benefits of technological transformation" (G20, 2019). The Japanese government has published similar developmental goals for their country proposed in the *5th Science and Technology Basic Plan*. The plan envisages Japan to become "a human-centered society that balances economic advancement with the resolution of social problems by a system that highly integrates cyberspace and physical space" (Government of Japan, Cabinet Office, 2020). Following on from the information society (Society 4.0), the transformation into a Society 5.0 is seen as the next frontier of societal development, with the ultimate goal of enabling service tailored to "individual and latent needs" (Government of Japan, Cabinet Office, 2020).

Moreover, Klaus Schwab, founder and executive chairman of the World Economic Forum describes the DSST as the fourth industrial revolution or "digital revolution" (Schwab, 2016), which is characterized by innovation based on the (re-)combination of technology (Schwab, 2016). The speed of technological change, its transformative nature for all industries, and its global impact force organizations to transform their business models and corresponding structures by rapidly developing and implementing new technology. Organizations need to adapt to a world in which "customer experience, data-based service, and asset performance through analytics [...] requires new forms of collaboration" (Schwab, 2016). According to Schwab, continuing the revolution can result in two scenarios: either in an increase of global income levels and quality of life, or in greater inequality (Schwab, 2016; Brynjolfsson and McAfee, 2014). However, while it is

impossible to predict which of these scenarios DSST might bring about, the revolution itself is unstoppable. Hence, Schwab argues that "we should [...] grasp the opportunity and power we have to shape the Fourth Industrial Revolution and direct it toward a future that reflects our common objectives and values" (Schwab, 2016).

Drawing on the necessity to consciously shape DSST for desired future developments, the research problem can, in principle, be approached from two mutually complementary perspectives: a behavioral-oriented perspective that starts with analyzing and explaining observable phenomena, and a design-oriented perspective that obtains prescriptive knowledge on IT artifacts, aimed at shaping the DSST in a particular context. This dissertation opts for the latter, approaching the following research problem.

> ***Research Problem.*** *Comprehensive knowledge about how to shape the Digital Service System Transformation to achieve positive transformational impact is scarce in the IS knowledge base. More specifically, the literature lacks descriptive and prescriptive knowledge with which to describe, explain, and prescribe the digital transformation of service systems.*

In response to calls for action which emphasize the need to overcome "narrow conceptions that separate technological aspects of innovation from processes of diffusion or adoption" (Vargo et al., 2020, p. 526), the research problem is approached by pursuing three interrelated research objectives concerning the prospects, constraints, and consequences of design in the DSST, respectively. The structure of these three objectives is inspired by the process of digital innovation in organizations (Fichman et al., 2014), undertaken in pursuit of the discovery, development, diffusion, and impact of digital technology as IT artifacts in service systems. To gain more in-depth insights into the DSST and to understand its very nature, one has to consider that "specific technologies will probably affect co-production and co-creation in different ways, in different contexts" (Lember et al., 2019, p. 1666). Consequently, it is advisable to focus on the design (constraints) of a particular digital technology in a particular context to investigate the DSST at this early stage of academic inquiry.

Digital (technology) platforms are a game-changing digital technology and, since "the most prominent growth strategy involves the use of digital platforms" (Ver-

hoef et al., 2021, para. 4.3), they are seen as lying at the very heart of digital innovation (Yoo et al., 2012; Schwab, 2016). Digital innovation that is based upon and emerges from platforms has become manifest in many aspects of daily life and has profoundly impacted social habits (Fichman et al., 2014). Organizations aiming to evolve from service providers to platform providers (Beverungen, Kundisch, et al., 2021) do so by leveraging digital platforms to build engagement ecosystems (Breidbach and Brodie, 2017) that comprise physical and virtual customer touchpoints. While platform providers such as Apple, Google, Microsoft, Amazon, and Facebook are the top five most valuable brands in the world 2020 (Swant, 2020) and these famous examples illustrate the infinite growth options that the design of digital platform ecosystems opens up to organizations aiming to develop digital innovation, "it is important to realize, however, that successful [multi-sided digital platforms] are the exception rather than the norm" (Hagiu, 2015, p. 11). The main reason for this development is that the design of digital platforms is only one element of accomplishing (platform-based) DSST. The aim of developing and implementing digital platforms is to establish two- or multi-sided markets in the platform ecosystem (Gawer, 2014). These markets, however, are subject to direct and indirect network effects. Direct network effects refer to effects that occur within one group of actors (e.g., sellers and buyers), and indirect network effects refer to cross-group effects in platform ecosystems (e.g., more sellers attract more buyers) (Beverungen, Kundisch, et al., 2021). How strong these effects are is based on different factors including, among others, the degree of openness that a platform (ecosystem) provides for different groups of actors (Ondrus et al., 2015).

What has followed, and is still an ongoing development, is that a few successful platform ecosystem providers have become quasi-monopolists in their environment and markets, due to what Iansiti and Lakhani (2017, p. 87) refer to as the "digital domino effect." In this network effect, the resulting value is concentrated among a few "hub firms that capture a growing share of the overall economic value created" (Iansiti and Lakhani, 2017, p. 87), while the platform providers benefit from the resource integration activities of all of the service ecosystem's actors. Such "winner-take-all dynamics" (Eisenmann et al., 2006, p. 99) are highly problematic from a market perspective (Schwab, 2016). In recognition of this view, the question of whether near-monopolist tech-conglomerates should be broken up has been considered by, not least, the U.S. government (Federal Trade Com-

mission, 2020). Nevertheless, from a research point of view, digital platforms represent a highly relevant digital technology because it is on these platforms and ecosystems that the limitations and consequences of design seem to be eminently observable, e.g., by studying the direct and indirect network effects that relate to a specific decision on a platform's design.

One domain massively affected by the development of "winner takes all" markets is high street retail—with platform-based online retail currently appearing to emerge as the winner. Recent studies have outlined that more Europeans buy online than in-store and that smartphones have already become the primary device for online shopping (Arnoldy et al., 2019). High street retail in Germany—characterized by a large proportion of Small- and Medium-Sized Enterprizes (SME)[1] (Bollweg et al., 2016)—is trapped in so-called *digital Darwinism* (Goodwin, 2018). Digital Darwinism describes an evolutionary phenomenon that emerges if society (i.e., customer demands) and technology evolve faster than organizations can adapt to, resulting in a natural selection that will only allow the fittest to survive (Goodwin, 2018). Consequently, and according to the digital domino effect, the vast majority of businesses will vanish (Iansiti and Lakhani, 2017). Moreover, it can be assumed that few high street retailers—as SME's—have the resources and capabilities to constantly adapt to a highly competitive and fast-changing environment.

One worst-case scenario assumes what has been observed in the last decade in the United States—and especially in shopping malls—described as the *retail apocalypse* (Townsend et al., 2017). In the US it reached its peak in 2019 with 9,302 store closures, up by 59 % jump compared to 2018 (Meyersohn, 2019). A survey of the German retail association stated that in 2020, e-commerce and loss of city center attractiveness are two of the most important issues for retail, with marketing and customer engagement prioritized as the most critical areas for future investment (HDE, 2020a). The importance of these topics is hardly surprising given the strong interconnection between high street vacancies and a city center's attractiveness. Hence, a decrease in high street retail causes decreasing numbers of high street visitors and vice versa (Hart et al., 2013). Moreover, the already problematic

[1] According to the European Union (2020), three categories of SME exist, depending on staff headcount, and turnover or balance sheet total: Medium-sized SME (staff headcount < 205; turnover ≤ 50 million Euro; balance sheet total ≤ 43 million Euro), small SME (< 50; ≤ 10 m; $\leq$10 m), and micro SME (< 10; ≤ 2 m; ≤ 2 m). In this dissertation, the term SME refers to those businesses belonging to the micro SME group.

situation of high street retail has been aggravated by the COVID-19 pandemic, which has placed additional pressures on retailers—and is expected to trigger a second retail apocalypse (Peterson, 2020). In the U.K., in the first half of 2020, 11,120 high street retail stores closed down, which doubled closures in 2019 (The Guardian, 2020), while the German retail association estimates that every ninth local store, which equals some 50,000 in total, is threatened by the crisis and might be forced to close down (Süddeutsche Zeitung, 2020). Thus, supporting high street retail to transform into physical *and* digital service ecosystems, on the one hand, promises to gain in-depth insights for research because the consequences of digitalization and servitization strongly impact this domain and, on the other hand, it could support high street retailers at a time when they are under massive pressure to last-minute herald the start of the DSST, fearing to be outdated unless they manage to digitally mature.

For SME in high street retail, a path out of the crisis, overcoming the current adverse developments and revitalizing high streets' attractiveness for the benefit of all stakeholders, is to adapt to the evolving customer demands toward digital, individualized real-time services (Piotrowicz and Cuthbertson, 2014). Even though SME retailers are aware of customers' altering expectations shifting toward e-commerce, they simultaneously underestimate customer's potential for service innovation, while the capabilities and resources to innovate continuously are not at their disposal, and most have not yet decided whether or not to initialize DSST (Bollweg et al., 2016). Understanding customers and analyzing customer data are premises on which e-commerce builds its success. Digital platforms are one means of adapting these strategies to local high street retail, enabling SMEs to benefit from network effects by "considering consumers as both recipients and resources of value" (Hänninen et al., 2018, p.162). Hence, digital platforms represent one of the key technologies for accomplishing DSST in high street retail (Hänninen et al., 2018).

Recent studies suggest that adopting strategies from e-commerce offers a promising path for the future development of high street retail (Demko-Rihter and ter Halle, 2015). Especially the combination of digital platforms and corresponding mobile applications seem to serve customer expectations for multichannel shopping trips (Demko-Rihter and ter Halle, 2015). Moreover, such technologies, which enable adding personalized features like loyalty programs, and value-adding services like delivery, are appreciated by users and positively impact customer

experience (ter Halle and Weber, 2014). However, research has not developed prescriptive design knowledge that describes how digital platforms and related IT artifacts for high street retail ought to be designed so far. The current IS knowledge base only provides few exceptions for the development and evaluation of digital platforms (e.g., Spagnoletti et al., 2015; Otto and Jarke, 2019; Venkatesh et al., 2017; Tura et al., 2018; Hönigsberg, 2020). However, recent research has re-emphasized the lack of design knowledge on digital platforms (Hönigsberg, 2020). One particular agenda-setting paper furthermore postulates that scholars and practitioners still struggle to analyze, conceptualize, and design multi-sided digital platforms (de Reuver et al., 2018) due to a lack of knowledge-dimensions—especially conceptual and prescriptive dimensions. Hence, the first research objective is formulated as follows.

> ***Research Objective 1 (RO1).*** *To conceptualize, design, and implement digital platforms and related IT artifacts for the Digital Service System Transformation in high street retail.*

The IS discipline offers research paradigms and methods for designing IT artifacts and developing prescriptive design knowledge to shape the DSST in particular contexts. On the other hand, the literature provides evidence that technological change leads to emerging behavior through actors' responses to this change. Thus, it is essential to design IT artifacts *and* to understand and explain the consequences of their implementation in service systems. However, SME high street retailers are laggards in regard to digital transformation (especially regarding the transformation of business processes). Hence, implementations with broad implications and consequences are rare to find. Consequently, the scope is broadened at this point by encompassing the understanding and explaining of the consequences and limitations of designing and implementing IT artifacts regarding DSST at the aggregation level of organizations.

Early studies concerning the adaption of technology in organizations in the IS discipline argued that many implementations failed because of only considering the technical facets while neglecting a much-needed comprehensive socio-technical view (Lucas, 1975). Further efforts confirmed these insights, outlining that "technical system intervention can actually facilitate social systems change" (Bostrom and Heinen, 1977a, p. 27) by causing an "unfreezing force" (ibid) on actors' behavioral patterns. The use of technology induces new behavioral patterns as people

try to employ the new technologies (Bostrom and Heinen, 1977a). Recent studies confirmed these findings, and scholars concluded that digitalized processes tend to drift more than their analog counterparts (Pentland et al., 2020). Moreover, technological advancements transform organizations into "variety-increasing system[s]" (Trist, 1981, p. 36) that require increased adaptive flexibility. In an organization, only humans have capacity for self-regulation and thus to incorporate the required flexibility for transforming service systems. Hence, humans, not technology, transform service systems through adaptive behavior. Consequently, humans' emerging behavior lies at the core of digitally transforming service systems and hence needs to be investigated to fully understand the consequences and the limitations of design in the DSST.

Reflecting on the occurrence of second- and higher-order change, the IS discipline has brought forward strategies for *secondary design processes*, "where functions and content emerge during interaction, modification, and embodiment of the system in use" (Germonprez et al., 2011, p. 662). This strategy accounts for the fact that design cannot prescribe human behavior but only triggers a behavioral change in response to particular design decisions (Germonprez et al., 2011; Pentland and Feldman, 2008). Humans incorporate the agency that enables organizations to implement and manifest planned changes through technological interventions. Simultaneously, inherent to human agency is the opportunity to "do otherwise" (Giddens, 1984)—including the ability to unfaithfully appropriate IT artifacts and deviate from organizational structures (DeSanctis and Poole, 1994). Consequently, research reflecting on this issue argues that organizational change is not equal to the enactment of planned change and thus can be better described as organizational *drift* (Quattrone and Hopper, 2001). Quattrone and Hopper (2001, p. 429) elaborate that "organizations are conceived as in a continuous state of flux where multiple activities of categorization intersect to create different notions of 'best'. The path of this drift [...] cannot transcend the contingent praxis in which it is constructed." Even though DSST implies that service systems are socio-technical systems and that their successful transformation urges a comprehensive systemic view to avoid negative outcomes (Bostrom and Heinen, 1977a), a "large amount of research points to this longtime research lack of integrated focus on both the social and technical subsystems in an organizational work system" (Bostrom et al., 2009, p. 18). Instead, a substantial part of the research contributions in IS focus on particular constructs, "often addressing either

the technical or social subsystems in isolation, that only explain/predict empirical results in a narrow context" (Bostrom et al., 2009, p. 19). However, to understand, explain, and shape DSST, it is essential to explore the micro-dynamics of IT-induced organizational change.

New behavioral opportunities enabled by digital technology need time to emerge, if at all (DeSanctis and Poole, 1994), to change value co-creation practices among actors in service systems. Vice versa, reconfigured value co-creation processes impose new technology affordances and constraints on the form and function of IT artifacts in the long-term (Majchrzak and Markus, 2012; Effah et al., 2020). However, Adaptive Structuration Theory (AST) suggests that this long-term change is observable from early on in single actors' micro-practices (i.e., appropriations of technology) before diffusing in an organization by reproduction through multiple actors (DeSanctis and Poole, 1994). Hence, by aiming to investigate DSST, this thesis assumes that focusing on "technology use as a key determinant of technology impacts" (DeSanctis and Poole, 1994, p. 143) can support research objective two.

> ***Research Objective 2 (RO2).*** *To describe and explain the limitations and the consequences of design in the Digital Service System Transformation.*

The first two research objectives approach the design of IT artifacts for high street retail and study the limitations and the consequences of design in specific contexts in which organizations seek to digitally transform to co-create enhanced value with customers. DSST is defined as an iterative process of designing IT artifacts and observing their consequences in context, which is in line with the duality of technology's structure that shapes and reshapes social structures by design and in action (DeSanctis and Poole, 1994). More specifically, particular transformative digital phenomena concerning the design and emergence, as well as the interrelatedness of these concepts with other phenomena related to the DSST does, on the one hand, unveil the IS discipline's delay in describing, explaining, and prescribing these phenomena, resulting in digital Darwinism where only a few hub firms will survive in the long-term. On the other hand, it emphasizes the task for academia to revisit underlying theories, constructs, and concepts that need to be revised, enhanced, or withdrawn, to fit with observations made in the real-world during DSST.

From a managerial standpoint, it needs to be investigated why a limited number of digital hub organizations become quite so successful in co-creating value by integrating resources with customers, whereas the vast majority of servitization projects fail (Valtakoski, 2017; Benedettini et al., 2015). Moreover, the fact that the majority of projects fail provides an eminently interesting subject for in-depth investigation because it is postulated that, in principle, any service system innovation (i.e., DSST) is achieved through recombining existing resources (Beverungen et al., 2018; Arthur, 2009). Hence, if all resources required to accomplish DSST exist and are, in principle, available to organizations to accomplish their transformation, without first conducting fundamental research projects to 'invent' new resources, the question arises why a large number of projects still fail. This might explain why the association between the ever-increasing complexity of digitalized service systems and the arduousness of realizing the underlying fundamental transformation of the organizing logic remains so elusive.

From a theoretical perspective, the IS discipline's body of knowledge is gradually maturing, and has become better equipped to describe transformative digital phenomena occurring in DSST. A more nuanced close-up view, however, reveals that assumptions observed in and abstracted from particular phenomena and their underlying contributions in the IS knowledge base might not thoroughly reflect the phenomena currently observable. Thus, to re-validate underlying theories, constructs, and concepts, IS research must relinquish some traditional taken-for-granted assumptions. To achieve this in a natural evolution process, it seems appropriate to start updating the premises in sub-disciplines that lie at the heart of DSST. It seems appropriate, then, to start with the Business Process Management (BPM) discipline, which investigates the design and emergence of organizational change through a process perspective. The view that BPM lies at the heart of DSST is in line with Pentland et al. (2020, p. 39) who conclude that "incremental drift can lead to dramatic changes in process structure. This possibility has implications for process design, management and control," and, hence, is investigated in the third research objective.

> ***Research Objective 3 (RO3).*** *To discuss the prospects for and the implications of the Digital Service System Transformation in relation to established theories and concepts.*

1.3 Structure of the Dissertation

Information Systems is an interdisciplinary discipline in which service-related research has become one of the prominent research topics (Rai and Sambamurthy, 2006; Böhmann et al., 2014; Brust et al., 2017). However, heretofore, IS researchers from different sub-disciplines foremost try to investigate phenomena related to DSST in isolation, not interrelating insights on related transformative digital phenomena (Rai, 2016). Two observations underpin this shortcoming. First, although we are in the middle of the fourth industrial revolution that emerges unprecedentedly since the middle of the last century (Schwab, 2016), the related body of knowledge in the IS discipline lacks in all five types of theory (Gregor, 2006). Second, the theoretical contributions made to the IS knowledge base are often not integrated, yet (Brust et al., 2017), but represent distinct contributions, hence, neglecting the "twin goals of explanation and prediction" (Gregor, 2006, p. 617). To sum up, conducting full research cycles comprising the design and evaluation of IT artifacts and investigating their transformational impact in service systems will provide essential insights for developing a consistent body of knowledge in IS. The gained knowledge on critically important consequences of emerging phenomena can enable other researchers and practitioners to shape the digital transformation of service systems with a positive outcome (i.e., co-creation of value) by dismissing misconceptions of IT artifacts that inhibit unfaithful appropriations of these artifacts (DeSanctis and Poole, 1994), which can lead to adverse outcomes (i.e., the co-destruction of value).

Following calls in IS for intradisciplinary and interdisciplinary research to yield fresh theoretical lenses, the identified research problem is approached by pursuing three interrelated research objectives which, together, bring new perspectives to the study of transformative digital phenomena (Rai, 2016). The overarching goal is to offer a comprehensive investigation of DSST. The three research objectives are studied in-depth in the 13 research articles included in Part B, each adding a distinct contribution to the IS knowledge base. The overall contribution of the articles is described in Part A, which focuses on the prospects and limitations of design and their implications for DSST in the wider IS research context. Figure 1.1 depicts the overall structure of the dissertation.

The remainder of Part A is structured as follows. Section 2 provides the theoretical background that underpins all parts of the dissertation. It outlines the

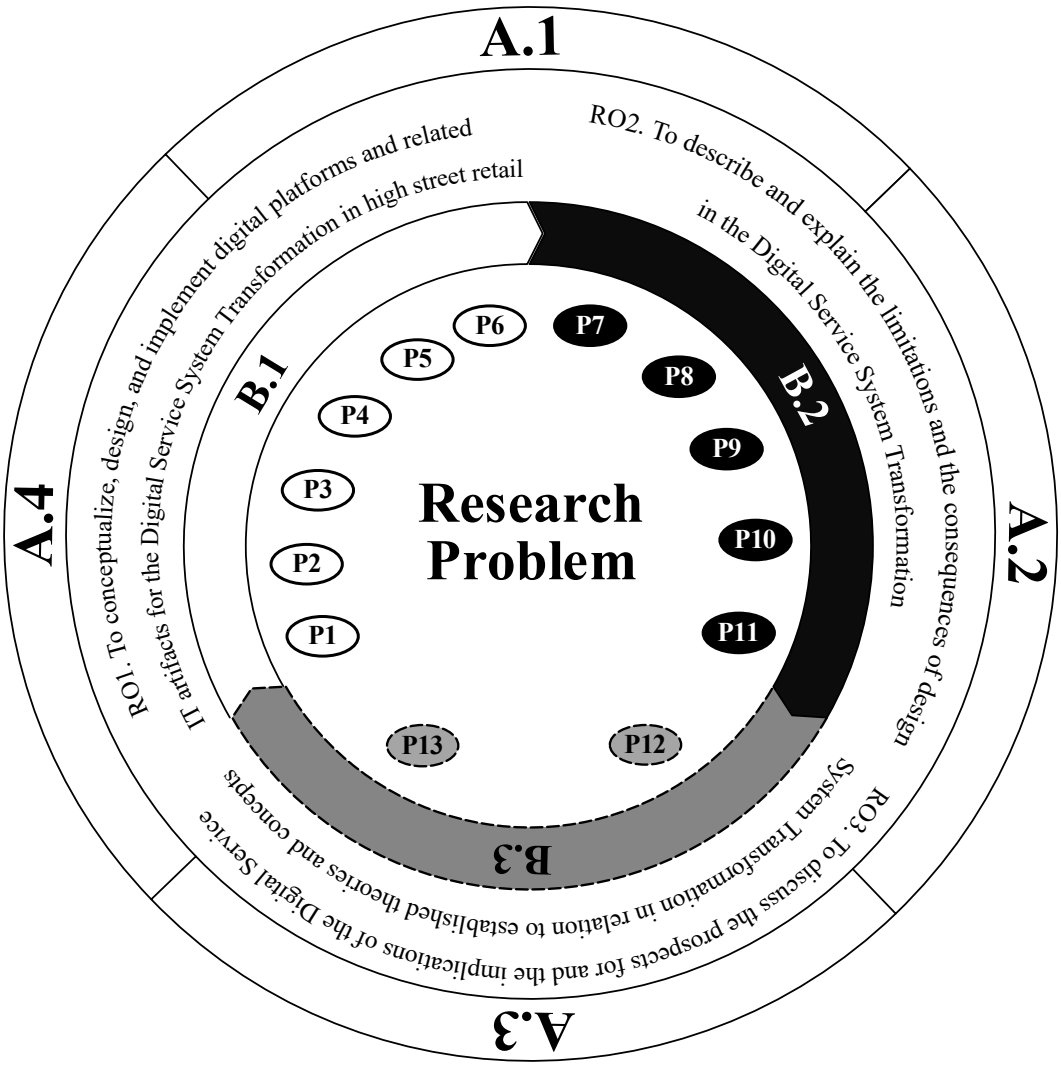

Figure 1.1: Structure of the Dissertation.

fundamentals of digital platforms, emphasizing different perspectives on platforms in IS research, and describes the digital transformation of service systems as socio-technical systems. This Section also analyzes the current state of the IS literature regarding structural and emergent technology-induced organizational change. Section 3 expounds on the ontological and epistemological preconceptions concerning the Design Science Research (DSR) paradigm and the behavioral research paradigm in IS. Furthermore, it describes and justifies selected research methods of both paradigms and elucidates the research approach of the dissertation. Section 4 concludes Part A, elaborating on the individual contributions of each of the 13 papers included in Part B while providing an integrated discussion of the prospects and limitations of design in DSST in the backdrop to the seminal

work on design by Alexander (1964) and Simon (1996). Furthermore, this Section outlines the dissertation's theoretical and managerial contribution before concluding with observations on its limitations and prospects for future research.

Part B consists of 13 double-blind peer-reviewed publications published in IS outlets ranked A–C in the VHB-JOURQUAL3 ranking for *Wirtschaftsinformatik*[2] or currently under review for publication[3]. The publications represent a subset of the comprehensive list of all publications of the author. The IS outlets targeted in this dissertation comprise the *Information Systems Journal (ISJ), Journal of the Association for Information Systems (JAIS), Business & Information Systems Engineering (BISE), Electronic Markets (EM)* and the conference proceedings of the *International Conference on Information Systems (ICIS), European Conference on Information Systems (ECIS), International Conference on Wirtschaftsinformatik (WI), Hawaii International Conference on System Sciences (HICSS),* and the *International Conference on Design Science Research in Information Systems and Technology (DESRIST)*.

In the following, for each of the papers included in Part B, a brief outline stating their respective motivation, research design, and contribution to the IS knowledge base is provided. Additionally, it is discussed how integrating the papers on an abstracted level in Part A adds another contribution to the knowledge base, in relation to the three research objectives.

P1. *Systematizing the Lexicon of Platforms in Information Systems: A Data-Driven Study*. Studies regarding (digital) platforms are prevalent not only in IS research but also in many related scientific fields. The intensive study of platforms by IS scholars from different perspectives has resulted in a plethora of contributions that implicitly or explicitly contribute to the knowledge base on platforms. However, the ambiguity of contributions has also led to a variety of conceptualizations of platforms that are fragmented and rarely acknowledge others' work. This inhibits the advancement of our discipline's knowledge on platforms. This paper takes up the call by de Reuver et al. (2018) for conceptual clarification of the digital platform concept. Eleven thousand forty-nine (11,049) peer-reviewed papers are collected from the most influential IS journals and conference proceedings, representing

[2] https://vhbonline.org/vhb4you/vhb-jourqual/vhb-jourqual-3/tabellen-zum-download.

[3] The publications in Part B have not been modified content-wise, except for minor corrections regarding typos and references. Furthermore, to enable consistency within this dissertation, the papers' formatting was adapted to the dissertation's layout by standardization of labels, tables, footnotes, and abbreviations. Hence, the position and representation of figures and tables might slightly differ from their original versions.

95 % of all papers ever published in IS on the topic of platforms. Subsequently, a data-driven analysis of the entire body of knowledge is performed. This approach reveals four unique data-driven insights on the body of knowledge on platforms, regarding (1) decoupled research strands in IS, (2) *service* as an overarching concept to reconnect these streams, (3) the layered architecture of platforms as IT artifacts, and (4) the urge for reintegrating research on platform analysis and platform design to obtain prescriptive theory on platforms. The synthesis and systematization of platform research in IS provides a conceptual foundation for further research and contributes to RO1 with a much-needed conceptualization and structuration of the platform vocabulary in IS, which are imperative, among others, for obtaining design knowledge on digital platforms in future studies.

P2. *Designing Multi-Sided Community Platforms for Local High Street Retail*. In high street retail, many businesses suffer because of the growing popularity of online retail. Meanwhile, high street retailers aim to co-create an improved digital customer experience by integrating and configuring physical and digital resources with their customers, to prevent the ongoing decline of their business. However, especially SMEs often fall short because of lacking operand and operant resources (Bollweg et al., 2016). This paper follows the DSR paradigm by designing and conceptually evaluating a digital community platform for local high street retail that adds digital touchpoints to the high street servicescape. These touchpoints enable resource integration processes, bringing together retailers with groups of customers to co-create digital customer experience. The results are abstracted from the application context and a nascent design theory for a new class of IT artifacts *multi-sided community platforms for local high street retail* is sketched by delineating the eight components of an IS design theory proposed by Gregor and Jones (2007). The paper's results support the pursuit of RO1 as one of the first contributions in the IS literature to add design knowledge on digital platforms to the knowledge base in the context of high street retail.

P3. *Designing Digital Community Service Platforms for Crowd-Based Services in Urban Areas*. City centers have been the flagship of every city for hundreds of years, representing an important means for building and keeping its residents' *sense of community* (Jeffres et al., 2009). The decline in high street retail caused by customers preferring online retail negatively impacts a city center's attractiveness. Declining high streets cause residents to rarely visit city centers, which diminishes the sense of community. Counteracting this development, in this paper, a proto-

type of a digital community service platform that enables retailers (as sourcers) and customers (as workers) to engage in resource integration to carry out micro-tasks in co-creation processes is designed and instantiated. The platform fosters online-offline relationships among residents and retailers, facilitating an online-offline (sense of) community. The ultimate goal of employing the platform is to revitalize urban areas by increasing their overall attractiveness. Conducting a DSR study, the paper contributes to both theory and practice by instantiating a prototype of the platform for the domain of high street retail and by prescribing a nascent design theory (Gregor and Jones, 2007) for a new class of IT artifacts *digital community service platforms for crowd-based services in urban areas*. Thus, the results of this paper partially contribute to RO1 in form of prescriptive design knowledge on digital platforms for the domain of high street retail.

P4. *Data-driven Customer Journey Mapping in Local High Streets: A Domain-Specific Modeling Language*. The interplay between digital platforms and other technologies (e.g., smartphones) enables different types of venues (e.g., retailers, entertainment venues, civic services) to acquire, process, analyze, and mobilize data which is integrated in value co-creation processes. Among others, these technologies transform customer journeys in local high streets into online and offline experiences for customers (Haugstveit et al., 2016). The use of technology by customers visiting a high street produces massive data traces. Using advanced data analytic techniques, retailers can transform and mobilize these data to offer individualized and context-specific value propositions to their customers. However, current IT artifacts for data-driven customer journey mapping are not available in the literature. In line with the dual mission of DSR, in this paper, a domain-specific modeling language is developed to depict online-offline customer journeys in high streets. Subsequently, the artifact is conceptually compared with rival artifacts. The resulting *High Street Journey Modeling Language (HSJML)* can be employed to conceptualize customer journeys a priori as well as to map, analyze, and predict online-offline customer journeys in high streets. Thus, this paper contributes to RO1 by adding design knowledge on IT artifacts related to digital platforms for the domain of high street retail.

P5. *Governance of Platform Ecosystems—Designing Understandable Processes for Digital High Street Retail*. Employing digital platforms to add digital touchpoints to a high street ecosystem comes at the cost of increasing the ecosystem's complexity. Moreover, because high street retail is a traditional brick-and-mortar business

consisting mostly of SMEs, the ecosystem's actors lack resources needed to transform and govern the ecosystem digitally. The current IS literature falls short of providing prescriptive design knowledge on the high street's digital transformation, especially concerning governance during transformation. Consequently, in this paper, the role of governance mechanisms in platform-based ecosystems is examined and, subsequently, governance processes for the digital transformation of high street ecosystems are designed and evaluated. Due to the aforementioned lack of resources in high street retail, the context has been identified as being a non-supportive culture of BPM (vom Brocke et al., 2016). Hence, the designed processes focus on understandability in the representational aspects of the IT artifact. This paper contributes to RO1 by adding design knowledge on IT artifacts to the IS knowledge base that prescribes how to govern the digital transformation of high street ecosystems.

P6. *Designing Digital Actor Engagement Platforms for Local High Streets: An Action Design Research Study*. High street retailers suffer from decreasing market shares and customers' preferences for digital market places, resulting in store closures that lead to reduced high street visitors—and vice versa—triggering a downwards spiral (Hart et al., 2013). Digital platforms combined with other digital technologies (e.g., smartphones) enable physical retail stores to foster engagement with their customers via digital channels (Frow et al., 2015). In this paper, a digital platform for local high street ecosystems is designed, developed, implemented, and evaluated in an action design research (ADR) study conducted over 18 months in a German high street, with strong stakeholder involvement. The IT artifact is abstracted and a design theory for a new class of IT artifacts (Gregor and Jones, 2007) *Digital Actor Engagement Platforms for Local High Streets* is developed. In the longitudinal field study, in-depth insights on how digital platforms that enable Location-Based Advertising (LBA) impact actor engagement in local high streets are obtained. This study is the first to analyze unbiased, real-world customer responses to the implementation of digital actor engagement platforms in context. Furthermore, it enhances the scientific literature on actor engagement. Moreover, our study emphasizes the importance of ADR as a much-needed research approach in the IS discipline, as it allows to connect design decisions to their consequences in context, indicating that strong second- and higher-order effects exist in DSST. Hence, this paper contributes to RO1 by gaining design knowledge on digital platforms in high street retail and emphasizing that design

should always involve iterative interventions in context to reveal second- and higher-order effects that impose additional requirements on an IT artifact's form and function.

P7. *Digitalization of Work Systems—An Organizational Routines' Perspective*. The current literature describes digitalization as an interplay between the design and diffusion of digital technology and all other elements of an organization, with digital technology imposing a transformative force (Brynjolfsson and McAfee, 2014; Fichman et al., 2014). While the IS discipline is ideally placed to examine this interplay thoroughly, digitalization currently lacks explicit references to domestic IS theories, constructs, and concepts that reveal the fundamental mechanisms of digitally transforming organizations. In this paper, a qualitative study to investigate the micro-dynamics of technology-induced change in work systems is performed. The organizational routines of actors on the micro-level of daily work practices were analyzed. The study reveals the existence of four atomic patterns that describe and explain the technology-induced transformation of organizational routines and, vice versa, the routines' impact on the form and function of IT artifacts. The paper presents a conceptual framework which contrasts these identified patterns and that can be used to analyze the trigger of digitalization in organizations and to describe transformation paths by concatenating several patterns. This paper contributes to RO2 by outlining that, on the one hand, the digital transformation of organizations can be triggered by purposeful design actions, while on the other, individuals' behavior can trigger unplanned transformation processes.

P8. *Workarounds as Generative Mechanisms for Restructuring and Redesigning Organizations—Insights from a Multiple Case Study*. IT artifacts can be designed and implemented to enable and constrain the behavior of employees in organizations. However, human agency enables employees to "do otherwise" (Giddens, 1984). If employees are confronted with misfits that impede their daily work practices, they can deviate from their routines and implement workarounds to overcome occurring obstacles (Alter, 2014). While these consequences have been observed in previous research, the current literature lacks knowledge on how and why workarounds diffuse and transform organizations as socio-technical systems in spontaneous, organic (and therefore unplanned) bottom-up processes. In this paper, a multi-case study that reveals that workarounds emerge as responses by actors to technological, organizational, and managerial misfits that become crit-

ical obstacles in their organizational routines is conducted. These workarounds become established in actors' organizational routines and diffuse in organizations through communication and observation. Workarounds can unfold the power to redesign IT artifacts, establish new work practices, and trigger bottom-up innovation processes. This paper describes and explains how and why misfits lead to workarounds as emerging actors' responses that can redesign and restructure organizations as a second- and higher-order effect of design, thus contributing to RO2.

P9. *The Impact of Process Automation on Manufacturers' Long-Term Knowledge*. Organizations digitally transform to stay ahead of the competition, fostering technology-based innovation (ServiceNow, 2017). In manufacturing, digital transformation often induces process automation. The IS literature and related fields decisively discuss the short-term effects of process automation on knowledge management, while its long-term effects are neglected in current scientific studies. In this paper, a qualitative study is performed to obtain process automation effects on manufacturers' long-term knowledge in three scenarios: manual manufacturing, automated manufacturing, and outsourced automation. Our analysis reveals that the different automation scenarios impact the location of knowledge, the carrier of knowledge, the knowledge base, and access to knowledge in varying degrees. The results suggest that especially outsourcing of automation will cause high efforts to access knowledge a posteriori. If opting for this strategy, organizations must subsequently establish new structures to regularly access and update the outsourced knowledge, impeding an organization's ability to foster future innovation. Hence, this paper partially contributes to RO2 by describing and explaining the loss of knowledge as an unintended consequence of digitalization that leads to a high degree of automation in manufacturing.

P10. *Quantifying the Impact of Geo-Spatial Recommendations: A Field Experiment in High Street Retail*. Employing digital technology can support high street retailers in their efforts of reconnecting with customers that favor shopping via digital channels. Acquiring and analyzing customers' data traces enables high street retailers to provide individualized, context- and location-dependent recommendations to their customers, including products, services, and events. While the provision of data-driven value propositions is one of the main reasons for the success of online retail, the effects of similar strategies adapted to the physical high street environment have not yet been studied (Gavalas et al., 2014). In this

paper, a geo-recommendation system (Liu and Wang, 2016) is instantiated and a field experiment in a German high street is conducted to identify, analyze, and quantify the effects that geo-recommendations have on customer behavior in high streets and on the high street's overall attractiveness. The results indicate that geo-recommendations positively impact value-in-use for both customers and retailers, increasing the high street's competitiveness compared to online retail. In this regard, this paper is considered to contribute to RO2 analyzing the direct consequences of a designed IT artifact in context.

P11. *Conceptualizing Task-Technology Fit for Technology-Pervaded Value Co-Creation*. Digital technology pervades service systems in almost all domains, digitally transforming value co-creation processes among its actors, with a foremost positive impact on value-in-use. However, digital technology's enhancement of resource integration processes increases their complexity, too (Echeverri and Skålén, 2011). IS and service researchers have repeatedly urged scholars to holistically study technology-pervaded value co-creation processes to overcome narrow conceptions that often overemphasize the peculiarities of technology or specific activities carried out in value co-creation processes (Ostrom et al., 2015; Barrett et al., 2015; Wünderlich et al., 2015). However, a unified theoretical knowledge base has not yet emerged. In this conceptual paper, the relationship between pervasive digital technology and the value co-creation processes, which consist of multiple tasks conducted by individual actors in a service system, is deconstructed. The resulting task-technology fit model for technology-pervaded value co-creation provides a holistic lens that can be employed to prescribe value co-creation processes or to evaluate and quantify the impact that task-technology fit has on resource integration activities and perceived value-in-use. Hence, this paper contributes to RO2 by explaining the interrelationships between technology, tasks, and actors' characteristics and their impact on the created value. Furthermore, it outlines that service-oriented IS research not only needs to revisit current theories and concepts, but also to reassess the underlying assumptions, in order to accommodate the nature of technology-pervaded value co-creation processes in service systems.

P12. *Establishing Smart Service Systems is a Challenge: A Case Study on Pitfalls and Implications*. While many organizations undertake or plan steps to become service system providers, the increasing speed with which innovative digital technology emerges and disrupts established structures and capabilities increases the complexity of servitization for organizations (Schüritz et al., 2017). Currently, aca-

demic studies almost exclusively report successful servitization projects while not studying how and why the vast majority of servitization projects in the real-world still fail. In this paper, a single case study to explore the causes of the failure of organizations to establish smart service systems in-depth is conducted. In particular, we analyze how and why a manufacturer's efforts to establish pay-per-use services based on smart laundry machines failed. The case reveals that pitfalls in practice exist due to insufficient methodological support from academia. The identified gaps in the knowledge base urge the need to update concepts and methods in IS research to better align with the current real-world requirements of DSST. Hence, this paper contributes to RO3 by, on the one hand, identifying the current status of the DSST in the real-world and, on the other, by giving impetus to future research in IS concerned with the enhancement and reassessment of service system engineering methods.

P13. *Seven Paradoxes of Business Process Management in a Hyper-Connected World* BPM is a fundamental subdiscipline of IS that deals with the structured identification, discovery, analysis, redesign, implementation, and monitoring and controlling of business processes in various contexts (Dumas et al., 2018). The ongoing digital transformation brings forth a hyper-connected world in which human actors, information systems, and smart products interact via multiple channels, resulting in manifold opportunities for the digital transformation of organizations. This brings about increasing complexity as a key challenge for the future development of the BPM discipline. Thus, this research note acknowledges and assesses the implications of selected transformative trends on the future development of the field, implying the necessity of updating theories and concepts as well as (re-)designing IT artifacts. The results contribute to the current knowledge base by unveiling seven paradoxes that emerge from phenomena related to the DSST and its impact on the BPM discipline, identifying the implementation of holistic views that integrate the design and execution of business processes as one of the main challenges for advancing the field. In this regard, this paper contributes to RO3 by debating the prospects and implications of the DSST for the BPM discipline.

No.	Authors	Title	Outlet	VHB JQ3	Points
		Research Objective 1			
P1	Bartelheimer, C. zur Heiden, P. Lüttenberg, H. Beverungen, D.	Systematizing the Lexicon of Platforms in Information Systems: A Data-Driven Study	Working Paper	B	0.3
P2	Bartelheimer, C. Betzing, J. H. Berendes, C. I. Beverungen, D.	Designing Multi-Sided Community Platforms for Local High Street Retail	ECIS 2018	B	0.4
P3	Bartelheimer, C. Wolf, V. Langhorst, N. Seegers, F.	Designing Digital Community Service Platforms for Crowd-Based Services in Urban Areas (Prototype Paper)	DESRIST 2020	C	0.7
P4	Berendes, C. I. Bartelheimer, C. Betzing, J. H., Beverungen, D.	Data-Driven Customer Journey Mapping in Local High Streets: A Domain-Specific Modeling Language	ICIS 2018	A	0.35
P5	Bartelheimer, C. Cappelli, C. Revoredo, K. Santoro, F. M.	Governance of Platform Ecosystems—Designing Understandable Processes for Digital High Street Retail	WI 2020	C	0.7
P6	Bartelheimer, C. Berendes, C. I. zur Heiden, P. Beverungen, D.	Designing Digital Actor Engagement Platforms for Local High Streets: An Action Design Research Study	Working Paper	A	0.3
		Research Objective 2			
P7	Wolf, V. Bartelheimer, C. Beverungen, D.	Digitalization of Work Systems—An Organizational Routines' Perspective	HICSS 2019	C	0.35
P8	Wolf, V. Bartelheimer, C. Beverungen, D.	Workarounds as Generative Mechanisms for Restructuring and Redesigning Organizations—Insights From a Multiple Case Study	Working Paper	A	0.35
P9	Gernreich, C. Bartelheimer, C. Wolf, V. Prinz, C.	The Impact of Process Automation on Manufacturers' Long-Term Knowledge	ICIS 2018	A	0.3

P10	Betzing, J. H. Bartelheimer, C. Niemann, M. Berendes, C. I. Beverungen, D.	Quantifying the Impact of Geospatial Recommendations: A Field Experiment in High Street Retail	ECIS 2019	B	0.25
P11	Bartelheimer, C.	Conceptualizing Task-Technology Fit for Technology-Pervaded Value Co-Creation	ECIS 2020	B	1
		Research Objective 3			
P12	Wolf, V. Franke, A. Bartelheimer, C. Beverungen, D.	Establishing Smart Service Systems is a Challenge: A Case Study on Pitfalls and Implications	WI 2020	C	0.2
P13	Beverungen et al.	Seven Paradoxes of Business Process Management in a Hyper-Connected World	BISE	B	0.04
Σ					**5.24**

Table 1.1: List of Publications in Part B.

2 Theoretical Background

2.1 Digital Platforms

2.1.1 Fundamentals of Digital Platforms

Digital platforms are mediators or intermediaries that orchestrate indirect and direct interactions and facilitate the efficient resource integration among two or multiple groups of actors in service ecosystems (van Alstyne et al., 2016). Digital platforms foster the digitalization of existing or the establishment of new service ecosystems which are set up to offer superior value propositions to heterogeneous customers who stand to benefit from both direct and indirect network effects (van Alstyne et al., 2016). Through the emergence of external social communities and networks, at the periphery of digital platforms, positive network and spillover effects are generated (van Alstyne et al., 2016; Beverungen, Kundisch, et al., 2021). These "help platforms rapidly increase the volume of interactions" (van Alstyne et al., 2016, p. 61), by generating value-adding resources (e.g., product reviews) that attract additional actors to affiliate with the platform (van Alstyne et al., 2016). Due to the network effects that typically occur in platform ecosystems, the impact and magnitude of digital platforms on all socio-technical systems are far more substantial than traditional ICT (Sørensen and Landau, 2015). Moreover, external networks affiliated with a digital platform that orchestrates resource integration in its own, newly created "innovation ecosystem" (Nambisan and Sawhney, 2011) enable manifold opportunities for innovation through recombining resources (Beverungen et al., 2018; Arthur, 2009).

Digital platforms are digital artifacts that are editable, interactive, open/re-programmable, and distributed (Kallinikos et al., 2013), constituting self-referential/reflexive dynamics "through which digital artifacts qua objects come to exist and develop" (Kallinikos et al., 2013, p. 366). Digital platforms build

on the fundamental architecture of any platform (McIntyre and Srinivasan, 2017) that comprises "a set of 'core' components with low variety and a complementary set of 'peripheral' components with high variety" (Baldwin and Woodard, 2009, p. 19). This inherent *duality* of the technology is based on a layered modular architecture (Constantinides et al., 2018; Adomavicius et al., 2008; Gawer, 2009; Baldwin and Woodard, 2009; Yoo et al., 2010), with flexible and stable components that enable digital technology and, in the case of digital platforms, provide both control and flexibility (Tilson et al., 2010). Due to this superior characteristic, systems that draw upon digital platforms become *generative systems* (Henfridsson and Bygstad, 2013). Zittrain (2006, p. 1980) defines that "generativity denotes a technology's overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences." Hence, generative systems are evolving systems capable of dealing with the paradoxical nature of change in DSST, which requires both flexibility and stability (Ciborra et al., 2000). Zittrain (2006, p. 1981) further explains that in such complex contexts "a technology that offers hundreds of different additional kinds of uses is more adaptable and, all else [being] equal, more generative than a technology that offers fewer kinds of uses. Adaptability in a tool better permits leverage for previously unforeseen purposes." Unsurprisingly, then, digital technology is proliferating and replacing traditional technology at an ever increasing rate (Tiwana et al., 2010) because it enables users to exchange and integrate resources in unforeseen appropriations of the technology.

Digital platforms and their emerging ecosystems frequently outperform other ecosystems because the modular layered architecture enables various options for decomposition (Alexander, 1964). Hence, if an element's complexity becomes unmanageable, it can be decomposed into less complex structures connected via simple and standardized interfaces (Baldwin and Woodard, 2009). Thereby, "the abstraction hides the complexity of the element; the interface indicates how the element interacts with the larger system" (Baldwin and Woodard, 2009, p. 64). Depending on design choices and management decisions, access to digital platforms is managed by their degree of openness (Gawer, 2014; Hanseth and Lyytinen, 2010), i.e., the ability of third-parties to integrate, access, and configure resources. Openness can refer to both the overall platform level and to its individual parts, restricting a platform's potential evolution paths (Hanseth and Lyytinen, 2010) and the ability to innovate through the recombination of resources (Gawer, 2014; Beverungen et al., 2018). The innovative potential of platform ecosystems is strongly

impacted by decentralized—and often less strict—governance mechanisms enabled by the modular architecture of digital platforms. By being less strict, these control mechanisms allow for more complex behaviors of actors, which enhances the probability of emergent change in such platform ecosystems (Tilson et al., 2010; de Reuver et al., 2018). The emergence of change is propelled by the fact that users can switch roles in platform ecosystems (Gawer, 2014).

2.1.2 Complementary Perspectives on Digital Platforms

Research on digital platforms in the IS discipline is focused either on technical/engineering aspects or on social/economic aspects, and takes place in research strands that remain little integrated (Gawer, 2014; Asadullah et al., 2018). Research that addresses digital platforms from a technical and engineering perspective is based on the definition that digital platforms consist of an "extensible codebase of a software-based system that provides core functionality shared by the modules that interoperate with it and the interfaces through which they interoperate"(Tiwana et al., 2010, p. 676). This view emphasizes that the modularity inherent in digital platforms enables (software) developers to design and implement semi-independent modules in a platform's periphery that connect with the stable core technology stack and other modules via standardized interfaces—e.g., an app store in which independent third-party providers publish applications that connect to the stable core technologies (e.g., smartphone, operating system, cloud services etc.) via standardized interfaces. Hence, a design perspective enables IS researchers to study how digital platforms ought to be designed with a view to fostering resource integration and value co-creation among affiliated actors.

Platform research in IS that is focused on technical/engineering aspects addresses the design (e.g., Spagnoletti et al., 2015; Otto and Jarke, 2019; Venkatesh et al., 2017; Hönigsberg, 2020), evolution (e.g., Fu et al., 2018; Tiwana et al., 2010; Asadullah et al., 2018; Tiwana, 2015a; Staykova and Damsgaard, 2017), third-party development and integration (e.g., Ghazawneh and Henfridsson, 2013; Karhu et al., 2018; Tiwana, 2015b; Eaton et al., 2015), and architecture (e.g., Baldwin and Woodard, 2009; Yoo et al., 2010; Blaschke et al., 2019) of platforms. At closer inspection, however, it becomes apparent that from a design perspective—the central focus of this dissertation—the current IS knowledge base only provides a few studies that elaborate on the design and evaluation of digital platforms (Spagnoletti et al., 2015;

Otto and Jarke, 2019; Venkatesh et al., 2017; Tura et al., 2018). However, Otto and Jarke (2019) conducted a case study to analyze the evolution paths of multi-sided platforms while Venkatesh et al. (2017) developed an auto-ID enabled shopping app to theorize about the effects of such IT artifacts on technology adoption, security beliefs, and shopping behavior—neither are contributing design knowledge to the IS literature. Two notable exceptions come in the work of Spagnoletti et al. (2015), who present a theoretical design framework for digital platforms supporting online communities, and of Tura et al. (2018), who contribute insights about the platform design process. Even more recently, as of December 2020, an ADR study was published that proposed design principles for digital value-co-creation platforms in SME networks in the textile industry. The same study re-emphasized the lack of design knowledge on digital platforms (Hönigsberg, 2020).

IS researchers investigating economic effects that occur in digital platform ecosystems are primarily studying (in-)direct networks effects. In particular, research focuses on the leveraging of network effects (McIntyre and Srinivasan, 2017; Evans, 2003; Rochet and Tirole, 2006; Anderson Jr. et al., 2014), competition (Mantena and Saha, 2012; Armstrong, 2006), establishing networked ecosystems and platform launch strategies (Hazlett et al., 2011; Kazan and Damsgaard, 2016; Stummer et al., 2018), and analyzing platform adoption and desertion (Katz and Shapiro, 1986; Tiwana, 2015b). From a managerial perspective, by employing digital platforms as (inter-)mediating entities, platform providers can establish two- or multi-sided markets (Rochet and Tirole, 2003; Eisenmann et al., 2006; Hagiu and Wright, 2015) that enable transactions among different groups of actors affiliated with the platform (see Figure 2.1; Beverungen, Kundisch, et al., 2021). Direct network effects occur within a group of actors on the same side of the digital platform, or market. In contrast, indirect network effects are cross-group effects that arise if the number of actors in one group impacts that in another group (Gawer, 2014; Beverungen, Kundisch, et al., 2021), generating "a self-reinforcing feedback loop of adoption 'from both sides', that has the effect of reinforcing incumbent platform owners' early installed base advantages" (Gawer, 2014, p. 1241). Hence, adopting an economic perspective helps to understand why some platform ecosystems become incredibly successful while the vast majority fail (Gawer, 2014). Consequently, studying platform adoption by distinct actor groups is one crucial research topic in the economic realm of platform research in IS (Gawer, 2014; Beverungen, Kundisch, et al., 2021).

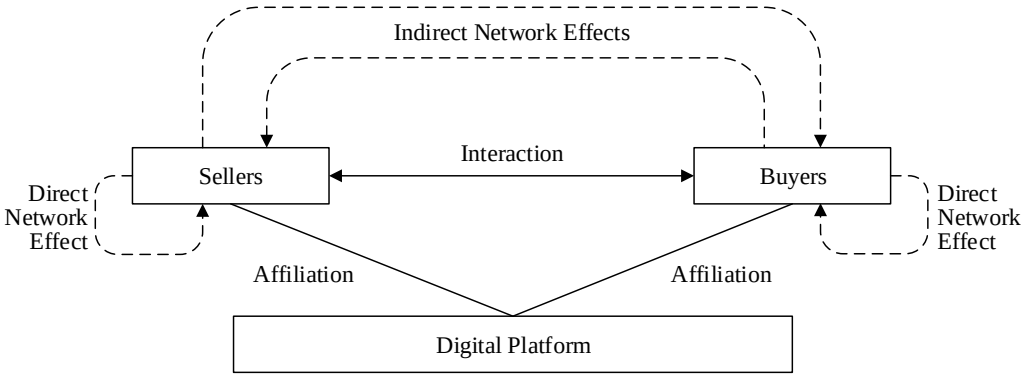

Figure 2.1: Selected Roles and Core Concepts of Digital Platforms (Adapted From Beverungen, Kundisch, et al., 2021).

While both the economic and the engineering perspective on digital platforms in IS represent distinct but inherently interrelated research strands that provide valuable insights into particular phenomena related to digital platforms, only a few studies have taken an integrative approach, holistically addressing and relating both economic and technical aspects of digital platforms (e.g., Gawer, 2009; Gawer, 2014; Asadullah et al., 2018; Spagnoletti et al., 2015). Yet others have taken a meta perspective by analyzing how the concept of platforms has developed over time (Porch et al., 2015) or by setting research agendas for digital platforms (de Reuver et al., 2018; Sutherland and Jarrahi, 2018).

One phenomenon that is intensively studied from both perspectives is platform 'openness' (Benlian et al., 2015; Ondrus et al., 2015; Ghazawneh and Henfridsson, 2013; Tiwana et al., 2010; Parker and van Alstyne, 2018). Openness refers to the degree to which access to a platform's resources is restricted to third-parties and strongly impacts platform adoption (Ondrus et al., 2015). The degree of openness of a platform ecosystem can be implemented either on the demand-side or on the supply-side by limiting access to particular user groups, or by technically codifying resource access restrictions into the digital platform's source code (Ondrus et al., 2015). Moreover, openness is managed by governance structures whose implementation is either centralized or decentralized in the platform's ecosystem (de Reuver et al., 2018). Research referring to platform openness is concerned with the governance of digital platforms and their ecosystems (Song et al., 2018), the design of governance mechanisms (Schreieck et al., 2016; Hein et al., 2016), practicing ecosystem-wide government mechanisms (Huber et al., 2017), and the evolution

of governance structures in relation to platform architecture and environmental dynamics (Tiwana et al., 2010).

Modular layered architecture and established governance structures that manage openness make digital platforms become mutable systems that evolve by adapting to changes in context (Gawer, 2014) while continuously enabling the core interactions that constitute the platform's strategic superiority (van Alstyne et al., 2016). However, siloed research strands in IS on economics and digital platform design limit the ability to understand platform evolution. From a design perspective, once a digital platform is implemented, network effects are taken for granted as exogenous phenomena continually occurring in the same way. Vice versa, from an economic perspective, the existence of a digital platform as an endogenous IT artifact that does not evolve is taken for granted (Gawer, 2014). Consequently, while both views provide valuable insights into particular phenomena occurring on or related to digital platforms, it is sometimes hard to know which of these contribute to the knowledge base on digital platforms and which do not, despite being related (yet distinct) phenomena (de Reuver et al., 2018).

Consequently, in platform research, IS scholars have repeatedly called for integrative studies in future research to be conducted to integrate design knowledge with, and align it to economic effects and behavioral studies (Gawer, 2014; de Reuver et al., 2018; Beverungen, Kundisch, et al., 2021). Among others, design-oriented research prospects include the design of digital platforms as IT artifacts that constitute socio-technical service systems (Beverungen, Buijs, et al., 2021; de Reuver et al., 2018). In particular, future research should study how digital platforms ought to be designed to establish networked relationships among distinct user groups by enabling low-effort interactions, how to implement and balance control and openness by design, and how to design digital platforms that facilitate actors' long-term commitment to it, leveraging network effects (Beverungen, Kundisch, et al., 2021). From a behavioral perspective, critical research avenues refer to the question of how and why platform (ecosystems) and actors' behavior emerge and why only a few platform providers become profitable and successful while the vast majority of DSST projects fail (de Reuver et al., 2018). Thus, future research should integratively investigate the impact of contextual change that places requirements on an IT artifact's form and function and, vice versa, how design decisions impact the context (i.e., service systems) in the long-term (Beverungen, Kundisch, et al., 2021; de Reuver et al., 2018).

2.2 Service Research in Information Systems

2.2.1 Fundamentals of Service Science

Service science is one key research area in the IS discipline (Böhmann et al., 2018; Brust et al., 2017), which "was amongst the first to adopt [the Service-Dominant Logic of Marketing (S-D Logic)] to inform its inquiries" (Brust et al., 2017, p. 1225). The service research strands in IS comprise two separate but weakly delimited strands of research, referring to either service systems' design-time, or runtime. Service system engineering (Böhmann et al., 2014; Böhmann et al., 2018) deals with the a priori design of service systems. Service management and marketing foster a customer-focused management approach for continuous customer management in service processes (Grönroos, 1990). This inherent segmentation in service research is also observable in the discipline's original terminology *Service Science, Management, and Engineering (SSME)*, which later on evolved to Service Science (Spohrer and Maglio, 2008). The two research strands mostly consider service-related issues as a service provider's internal tasks, which still need to be solved within the organizations[4].

Initiated by IBM in the early 2000s, *Service Science* was established as an independent research discipline to study service-related phenomena, integrating, among others, Service Marketing, IS and other disciplines (Chesbrough and Spohrer, 2006; Maglio and Spohrer, 2008). Service researchers agree that the service system, defined as "a configuration of people, technologies, and other resources that interact with other service systems to create mutual value" (Maglio et al., 2009, p. 395), is the basic unit of abstraction within the discipline (Maglio et al., 2009). As the discipline's agreed-upon theoretical lens, S-D Logic enables scholars to describe and explain social and economic exchanges in terms of an exchange of service (Vargo and Lusch, 2004; Vargo and Lusch, 2008; Vargo and Lusch, 2016; Vargo and Lusch, 2017). For conceptual clarity, it is important to note that service research distinguishes between the single word *service*, which is the co-production process that "involves the participation in the creation of the core offering itself," (Lusch and

[4] Service management and marketing is described "as an outside-in management task" (Grönroos, 1990). Hence, it focuses on the customer as positioned outside the firm but representing an essential part of any service process. However, an outside-in management approach also assumes that the firm has the power of any decision-making processes, including outsourcing particular decisions and tasks to the customer.

Concept	Definition
Service	"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).
Services	"The plural 'services' [is] implying units of output. [...] S-D logic considers the relationship between service and a good – that is, a good is an appliance used in service provision" (Lusch and Vargo, 2006, p. 282).
Operand Resources	"Operand resources are resources that an actor acts on to obtain support (i.e., they enable or facilitate). Thus, operand resources are often tangible and static (e.g., natural resources)" (Lusch and Nambisan, 2015, p. 159).
Operant Resources	"Operant resources are resources that act on other resources to produce effects—that is, they act or operate on other things rather than being operated on. Operant resources are often intangible and dynamic (e.g., a human skill, both physical and mental)" (Lusch and Nambisan, 2015, p. 159).
Co-creation	"Value can only be created with and determined by the user in the 'consumption' process and through use or what is referred to as value-in-use. Thus, it occurs at the intersection of the offerer and the customer over time: either in direct interaction or mediated by a good" (Lusch and Vargo, 2006, p. 284).
Co-production	"Involves the participation in the creation of the core offering itself. It can occur through shared inventiveness, co-design, or shared production of related goods, and can occur with customers and any other partners in the value network" (Lusch and Vargo, 2006, p. 284).
Value-in-Use	"Value in use is the evaluation of the service experience, i.e. the individual judgment of the sum total of all the functional and emotional experience outcomes. Value cannot be predefined by the service provider, but is defined by the user of a service during the user consumption" (Sandström et al., 2008, p. 120).
Service System	"A dynamic value-cocreation configuration of resources, including people, organizations, shared information (language, laws, measures, methods), and technology, all connected internally and externally to other service systems by value propositions" (Maglio et al., 2009, p. 399).
Service Ecosystem	"A relatively self-contained, self-adjusting systems of mostly loosely coupled social and economic (resource-integrating) actors connected by shared institutional logics and mutual value creation through service exchange" (Lusch and Nambisan, 2015, p. 161).
Institutions	"Institution—humanly devised rules, norms, and beliefs that enable and constrain action and make social life predictable and meaningful (Scott 2001; see also North 1990)—and higher-order, institutional arrangements—sets of interrelated institutions (sometimes referred to as "institutional logics")—and the process and role of institutionalization are the keys to understanding the structure and functioning of service ecosystems" (Vargo and Lusch, 2016, p. 11).

Table 2.1: Fundamental Concepts in Service Research.

Vargo, 2006, p. 284) and the term *services*, which is the unit of output, with a good being an output that represents "an appliance used in service provision" (Lusch and Vargo, 2006, p. 282). Actors in service systems continuously integrate resources because resources cannot create value in isolation (Lusch and Nambisan, 2015) and furthermore because only the recombination of resources can yield innovation (Arthur, 2009; Beverungen et al., 2018). Table 2.1 elucidates fundamental concepts in service research.

According to S-D Logic, any social and economic exchange is, in essence, a service-for-service exchange (Vargo and Lusch, 2004; Vargo and Lusch, 2008; Vargo et al., 2008; Vargo and Lusch, 2016), since "the creation of value is the core purpose and [the] central process of economic exchange" (Vargo et al., 2008, p. 145). S-D logic contrasts with the previously predominant Goods-Dominant logic (G-D logic) by constituting a shift from tangible outputs and discrete transactions to intangible exchange processes and relationships (Vargo and Lusch, 2004; Lusch and Vargo, 2006; Vargo and Lusch, 2008; Vargo and Lusch, 2016; Vargo and Lusch, 2017). It provides researchers with the theoretical constructs and principles with which to analyze value-co-creation practices in service systems (Maglio and Spohrer, 2008). It is based on three core notions: "(1) service is the fundamental basis of exchange, (2) service is exchanged for service, and (3) the customer is always a co-creator of value" (Vargo and Lusch, 2008, p. 6). Thus, according to S-D Logic, value is always co-created by at least two actors in a service system who engage with one another by integrating resources through exchanging a service to the benefit of at least one of these actors (Vargo and Lusch, 2004; Lusch and Vargo, 2006; Vargo and Lusch, 2008; Vargo and Lusch, 2016; Grönroos and Gummerus, 2014). The dynamic resource integration activities of and interactions among actors (i.e., service providers and service customers) occur alongside value co-creation processes in service systems (Spohrer et al., 2007). Thereby, the resulting value, coined *value-in-use*, is determined by a beneficiary during consumption, and, hence cannot be determined beforehand based on units of output (Sandström et al., 2008). Consequently, actors can only offer value propositions that aim to attract other actors to engage in value co-creation by voluntarily integrating resources (Chandler and Lusch, 2015). In a nutshell, S-D Logic is based on eleven foundational premises comprising five axioms (see Table **??**) and provides a theoretical lens that enables (service) researchers to explore the digital service economy (Sandström et al., 2008). Since its inception some 15 years ago, service researchers have

repeatedly called for the need to disentangle the complex relationship between technology and service (Froehle and Roth, 2004; Beverungen, Breidbach, et al., 2019), and have outlined the usefulness of employing S-D Logic for the study of transformative digital phenomena (Rust, 2004; Böhmann et al., 2014; Ostrom et al., 2015; Barrett et al., 2015).

Found. Premise	Axiom Status	Explanation
FP 1	X	Service is the fundamental basis of exchange.
FP 2		Indirect exchange masks the fundamental basis of exchange.
FP 3		Goods are distribution mechanisms for service provision.
FP 4		Operant resources are the fundamental source of strategic benefit.
FP 5		All economies are service economies.
FP 6	X	Value is co-created by multiple actors, always including the beneficiary.
FP 7		Actors cannot deliver value but can participate in the creation and offering of value propositions.
FP 8		A service-centered view is inherently beneficiary oriented and relational.
FP 9	X	All social and economic actors are resource integrators.
FP 10	X	Value is always uniquely and phenomenologically determined by the beneficiary.
FP 11	X	Value co-creation is coordinated through actor-generated institutions and institutional arrangements.

Table 2.2: Foundational Premises of Service-Dominant Logic (Adapted From Vargo and Lusch, 2016).

Maglio and Spohrer (2008) promote the understanding that "service science is the study of service systems" (Maglio and Spohrer, 2008, p. 18). Service science identifies service systems at various aggregation levels, e.g., humans, organizational departments, organizations, cities, and nations (Maglio et al., 2009; Vargo and Lusch, 2017). Value co-creation processes in service systems involve actors who voluntarily integrate operant resources (i.e., knowledge and competencies) that are applied to operand resources (e.g., tangible resources) (Vargo and Lusch, 2004). Furthermore, service systems integrate resources with other service systems in service interactions by offering value propositions that other systems might agree

to, realizing the proposal by integrating resources (Maglio et al., 2009). Beyond providing services, if the interaction between service systems is successful, it can co-create new service systems or implement a new instance of an existing service system (Maglio et al., 2009). Moreover, zooming-out and applying a service ecosystem view enables service scholars to investigate interactions in networks of interrelated service systems (Vargo and Akaka, 2012). This view is important since it "explicates the complex and dynamic nature of the social systems through which service is provided, resources are integrated, and value is cocreated" (Vargo and Akaka, 2012).

2.2.2 Digital Servitization

While any service system is assumed to be a socio-technical system (Böhmann et al., 2014; Böhmann et al., 2018), the proliferation and matureness of digital technology transform service systems fundamentally at an ever-increasing speed, converging the physical and the digital world (Acatech, 2014). This convergence implies that at least two actors can co-create value via physical, virtual, or mental contact (Grönroos and Voima, 2013), not necessarily involving face-to-face interaction (Rust and Huang, 2014). Not surprisingly, service scholars call for disentangling the complex relationship between technology and value co-creation processes as long as the service science discipline exists (Froehle and Roth, 2004).

Compared to earlier waves of technological development, digital technology's superior characteristics and its proliferation have led to the megatrend of *digitalization* (Yoo et al., 2012; Brynjolfsson and McAfee, 2014). This megatrend builds upon the phenomenon of *digitization*, which describes the conversion of analog source material into a digital format, and into binary digits (Hess et al., 2016; Tilson et al., 2010), and is used to refer to the socio-technical process of applying digitization techniques to a broader context at the individual, institutional, and societal level (Tilson et al., 2010; Legner et al., 2017). As a result of this trend, we can observe the process of ongoing digital transformation in organizations (Ganguly, 2015; Henriette et al., 2015). This transformation is a fundamental change process (Goerzig and Bauernhansl, 2018) with a view to improving the utilization of resources (integration) through the fundamental transformation of their properties (Vial, 2019). However, such transformation often involves profound structural changes being made to an organization (Vial, 2019). Organizations use

the transformation to leverage the characteristics of digital technologies to offer improved value propositions to their customers (Porter and Heppelmann, 2015) by enhancing accessibility and availability of resources in service systems (Breidbach et al., 2019). However, while innovation is generally framed as the key element of sustainable economic growth and is hence associated with positive impact (Solow, 1957; Romer, 1990), organizations' profitability does not necessarily increase, due to the greater complexity caused by digitization (Gottfredson and Aspinall, 2005).

Alongside the digitalization trend, a second megatrend that has been ongoing for almost 200 years across all developed economies, is *servitization* (Vandermerwe and Rada, 1988). Servitization has led to a significant shift of employment from manufacturing to the service sector (Rust and Huang, 2014). It is also seen as a paradigmatic shift because, with servitization, organizations change their value creation processes from offering only products and services, without any customer involvement, to co-creating value by the exchange of service with their customers (Ostrom et al., 2015; Brax and Jonsson, 2009), seen as providing additional value to customers. Organizations consider servitization as an opportunity for differentiation and service-led growth (Sklyar et al., 2019; PricewaterhouseCoopers LLP, 2018). Servitization is customer-driven (Vandermerwe and Rada, 1988) and, since digital technology—and IT in general (March and Smith, 1995)—is pervasive and consequently affects customers (Yoo et al., 2012), customer expectations are likewise shifting towards digital real-time services, and corresponding business models (Cusumano, 2012; Piotrowicz and Cuthbertson, 2014; Henriette et al., 2015). Rust and Huang (2014, p. 219) conclude that the "service revolution [...] is irreversible and will only become more pronounced with time." In their efforts of staying ahead of the competition, organizations have come under pressure to mobilize and integrate resources ad-hoc in order to cater to their customers' changing demands and heightened expectations (Matzner et al., 2018). Inevitably, however, technological advancements have fundamentally transformed value creation (Rust and Huang, 2014), which has come at the cost of increasing complexity for organizations since they are forced to turn into service system providers that holistically develop, implement, manage, and adapt service (eco-)systems that employ digital technology in uncertain and complex environments (Breidbach et al., 2014; Beverungen, Breidbach, et al., 2019; Beverungen, Müller, et al., 2019; Vargo et al., 2020).

It has been observed that the proliferation of digital technology boosts the two complementary megatrends of *digitalization* and *servitization*, given that "the service revolution and the information revolution are two sides of the same coin" (Rust, 2004, p. 24), and that digitalization is a key driver of servitization (Matzner et al., 2018; Böhmann et al., 2018). The fusion of these trends results in *digital servitization* (Sklyar et al., 2019), which is driven by technological change (Akaka and Vargo, 2014). Moreover, the fusion of both trends has led to an exponential increase in their global impact and, in academia, to the convergence of academic inquiry on related transformative digital phenomena and their managerial implications. Technological advancements fundamentally impact value co-creation processes (Bitner et al., 2010; Matzner et al., 2018; Breidbach et al., 2019) with technology becoming an operant resource in some of these processes—representing primary resources in value co-creation processes—that can act on other resources instead of solely representing an operand resource that is acted upon (Akaka and Vargo, 2014; Ardolino et al., 2018). What adds to the ever-increasing complexity arising from these trends is the unprecedented speed at which digital technology develops (Christensen, 2006) and its pervasiveness. Indeed, as technology is "becoming more powerful, and transforming organizations much faster than in the past" (Demirkan et al., 2016, p. 14), organizations are forced to adapt while having to undergo radical transformation (Yoo et al., 2012). The transformational impact of technology constitutes the second machine age (Brynjolfsson and McAfee, 2014). It facilitates comprehensive organizational transformation processes primarily aimed at increasing employees' productivity, reducing costs of front- and backstage processes, and enhancing value co-creation by providing additional touchpoints for internal and external actors, resulting in an improved value-in-use (Matzner et al., 2018).

2.2.3 Engineering Digitalized Service Systems

Service research in IS yields several approaches and methods for designing and digitally transforming service systems condensed in the research strand *Service Systems Engineering (SSE)*. SSE deals with the design of socio-technical service systems, adopting a system perspective (Böhmann et al., 2014; Böhmann et al., 2018). SSE was introduced in 2014 to "advance evidence-based design knowledge on service systems [to] enhance collaborative and contextualized value cre-

ation" (Böhmann et al., 2014, p. 74), comprising engineering of service architecture, engineering of service system interaction, and engineering resource mobilization (Böhmann et al., 2014). Any of the engineering dimensions implies the employment of (new) technology and thus implicitly refers to DSST. Hence, SSE is positioned at the intersection of digital innovation and service innovation, postulating the need not to overemphasize one over the other but to design service systems comprehensively, e.g., in ADR projects (Böhmann et al., 2014). Recently, SSE was reframed with a view to becoming more human-centered (Böhmann et al., 2018), i.e., increasingly requiring that the needs and priorities of both human and machine actors in service systems are taken into consideration and balanced. This necessity stems from rapid advancements in digital technology and the ever-accelerating speed of DSST.

Given the pervasiveness of digital technology that increasingly affects all service systems, in some way or other, and with a different kind of impact compared to that brought about by previous technological advancements, a holistic socio-technical transformation process is required (Ardolino et al., 2018; Lusch and Nambisan, 2015). Transforming service systems into digitalized service systems can be described as a tradeoff between the extent of digitization (EoD) and the range of digitization (RoD) that need to be taken into account for transforming a service system (Kathuria et al., 2014). EoD describes the share of digital services within a service system, while RoD describes the number of unique digital touchpoints that exist in a service system (Kathuria et al., 2014). However, DSST can result in different types of service systems, with different types of outcomes: *Digtial service systems* or *smart service systems* (see Table **??**). Importantly, both transformation paths are equally valuable to DSST and which path to follow depends on a service system's context.

In digital service systems, digital technology enables a service to become digitalized (Beverungen et al., 2017). Digital service represents a type of service in which technology enables digital interactions between a service provider and a service customer (Beverungen et al., 2017; Kathuria et al., 2014)—in most cases, via the internet. Retailers that establish e-commerce solutions by implementing online shops are one example of digital service systems. Such online shops allow service customers to digitally access a retailer's stock, e.g., checking product availability, price, and shipping conditions. Other cases in point are online booking platforms for hotels, car sharing services, and many more. All these digital service systems

have in common that they enable a service customer to autonomously access a service provider's resources (i.e., information) without direct interaction. Digital service systems can be built around digital platforms that provide a means to enter and share data (i.e., information) for asynchronous value co-creation processes. This type of service system enables service providers to target a broad spectrum of loosely coupled, heterogeneous customers in service ecosystems (Barrett et al., 2015) because access to a digital service is either not or only partially restricted. For example, one might have to sign up as a customer before using an online shop, while in principle everyone eligible to sign a contract can create a customer profile.

In smart service systems, digital technology is employed as a boundary object to enable a smart service (Leigh Star, 2010; Star and Griesemer, 1989). Boundary objects are smart products that act as an interface between a service provider and a service customer for their mutual benefit (Beverungen, Müller, et al., 2019; Medina-Borja, 2015). Smart products are digitalized physical products that are interconnected with other smart products and thereby enable the configuration of enhanced value propositions in service systems (Beverungen, Breidbach, et al., 2019). First and foremost, smart products are physical devices provided to and used by customers (e.g., smart washing machines, smartphones, manufacturing machines). The use of smart products enables customers to engage in various interaction opportunities in the value co-creation process. First, a smart product can use its properties (e.g., sensors, actuators, computational capacity) to analyze data and reconfigure itself to serve customer demands better (Medina-Borja, 2015; Beverungen, Müller, et al., 2019). A smart washing machine, for example, can regulate water and electricity consumption based on its analysis of usage data. Second, service providers can analyze data transmitted not only by one smart product but by all those installed in its entire customer base. The acquired data is analyzed back-stage, and used to improve existing, and offer new value propositions to the benefit of customers (Wünderlich et al., 2015; Beverungen, Müller, et al., 2019). In the example of a smart washing machine, a service provider can analyze all of its customers' washing behaviors, the reasons for machine breakdowns and, on the basis of this data, fine-tune a machine's set-up to avoid future breakdowns resulting from sub-optimized usage. Third, customers can benefit from accessing data reports on product use and performance through self-service (Frank et al., 2019; Beverungen, Müller, et al., 2019). For example, customers can plan

Concept	Definition
Digital Service	"A digital service is the application of digital "competencies through deeds, processes, and performances for the benefit of another entity or the entity itself" (see Vargo and Lusch 2007, p. 26). Digital competencies refer to digital assets and digital capabilities that one entity makes available to another entity through access or temporary possession. Also, digital service refers to making any asset or capability applicable to others using information technology, thereby enabling digital processes of value co-creation" (Beverungen et al., 2017, p. 784).
Digital Service System	"Service systems equipped with information technology [are] digital service systems" (Beverungen et al., 2017, p. 784).
Smart Service	"Smart service is the application of specialized competences, through deeds, processes, and performances that are enabled by smart products" (Beverungen, Müller, et al., 2019, p. 12).
Smart Product	"Smart products use sensors to obtain contextual data, exchange data with other actors, store and process data locally, make autonomous decisions, and act physically by means of actuators" (Beverungen, Müller, et al., 2019, p. 8).
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, Müller, et al., 2019, p. 12).

Table 2.3: Types of Digitalized Service Systems.

their washing processes, obtain current product status information, and remotely control the product. Hence, a smart service system that employs digital technology as a smart product becomes 'smarter' because it is "capable of learning, [of] dynamic adaptation, and decision making based upon data received, transmitted, and/or processed to improve its response to a future situation. The system does so through self-detection, self-diagnosing, self-correcting, self-monitoring, self-organizing, self-replicating, or self-controlled functions" (National Science Foundation, 2014, p. 5).

SSE has a strong presence in both scholarly publications (e.g., Böhmann et al., 2014; Böhmann et al., 2018; Patrício et al., 2011; Höckmayr and Roth, 2017; Grenha Teixeira et al., 2017; Beverungen et al., 2018), and management-driven initiatives (e.g., Deutsches Institut für Normung e.V., 2008; Deutsches Institut für Normung e.V., 2009; Deutsches Institut für Normung e.V., 2019), with the overall aim of guiding organizations in their efforts of engineering service system transformation. However, the segmentation of service science publications into separate research silos has meant that, despite having generated methods on how to de-

sign and implement different types of service systems, the crucial part of how an organization's organizing logic needs to be transformed to achieve service systems transformation, is missing. As any service system is, arguably, also a socio-technical system (Böhmann et al., 2018), and both digital and smart service systems impact the value networks of service ecosystems, organizations are required to adapt their operational processes and organizational structures to integrate customer processes via digital touchpoints (Coreynen et al., 2017). Hence, DSST goes beyond the mere engineering and implementation of isolated elements of service systems. It requires an accompanying transformation process that efficiently and effectively aligns an organization's internal and external processes.

2.3 Technology-Induced Organizational Change

2.3.1 Organizations as Socio-Technical Work Systems

A socio-technical lens assumes that any organization or organizational unit can be described as a socio-technical work system (Bostrom and Heinen, 1977a; Alter, 2014), in which humans and machines conduct processes to integrate and apply resources (e.g., technology and information) with the aim of creating value for a customer (Alter, 1999). The term Socio-Technical System (STS) originated in the 1950th and was introduced by Emery (1959). Others suggested earlier that all operative systems are STS (e.g., Nadel, 1951), since they consist of both a social and a technical system (see Figure 2.2). The social system is concerned with people—their capabilities, characteristics, skills, and relationships—reward systems, and authority structures, while the technical system refers to processes, tasks, and technology (Bostrom and Heinen, 1977a). The subsystems rely on joint interactions that transform inputs into desired outputs. Thus, the subsystems "can only be jointly optimized. Attempts to optimize for either the technical or social system alone will result in the suboptimization of the socio-technical whole" (Trist, 1981, p. 24).

In socio-technical systems, technology functions as a boundary object between the social system and other internal and external entities (Trist, 1981). Early work postulates that both the social and the technical system impose requirements that need to be aligned to a high fit (Emery et al., 1978), which implies "variety-increasing

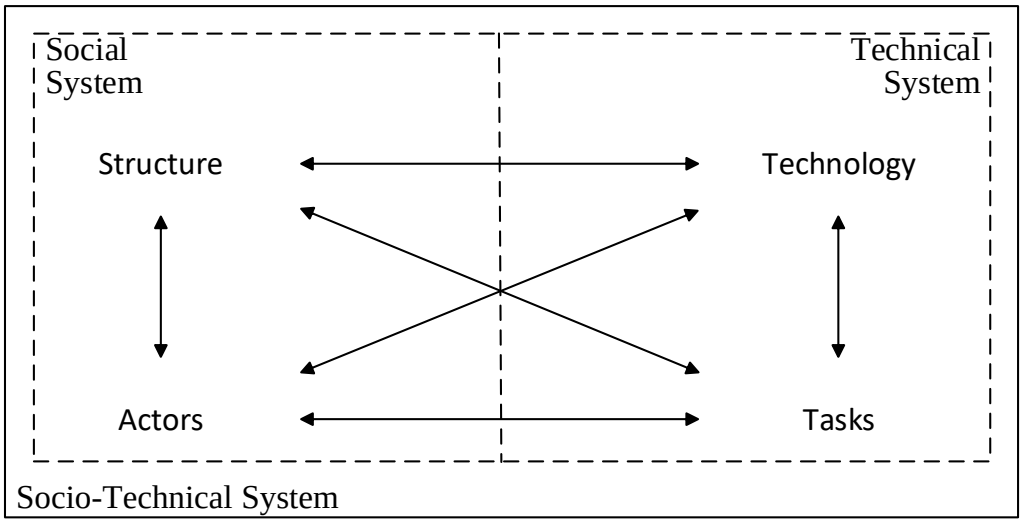

Figure 2.2: A Basic Socio-Technical System Model (Adapted From Bostrom and Heinen, 1977a; Bostrom and Heinen, 1977b).

for both the individual and the organization" (Trist, 1981, p. 9). Consequently, the conceptual framing of work systems evolved from a social system view to a socio-technical understanding of these systems (Trist, 1950). Since the output of any socio-technical system is jointly generated in iterative interaction between a social and a technical system, one crucial research task is to study the diffusion of socio-technical innovations as a joint optimization of the social and technical systems. The need for a holistic perspective is additionally emphasized by the observation that the evolution and implementation of technology have unanticipated consequences that may be either constructive or destructive (Trist, 1981). Hence, STS represent a conceptualization of work systems (Alter, 2002) that provides a "view of work as occurring through a purposeful system" (Alter, 2002, p. 91). A seminal definition of work systems has been provided by Alter (1999).

> "A work system is a system in which human participants and/or machines perform a business process using information, technology, and other resources to produce products and/or services for internal or external customers. Organizations typically contain multiple work systems and operate through them." (Alter, 1999, p. 8)

Early IS-related studies argued that many IS implementations failed because only the technical system was taken into consideration while neglecting a much-needed comprehensive socio-technical view (Lucas, 1975). Further efforts confirmed these insights, outlining that "technical system intervention can actually

facilitate social systems change" (Bostrom and Heinen, 1977a, p. 27) by causing an 'unfreezing force' on the social system that induces new behavioral patterns as people try to employ the new technologies (Bostrom and Heinen, 1977a). More recent studies further confirmed these findings, leading scholars to postulate that digitalized processes tend to drift more than their analog counterparts (Pentland et al., 2020). According to Trist, 1981, "this transformation is imperative for survival in a fast-changing environment. It involves nothing less than the working out of a new organizational philosophy" (Trist, 1981, p. 44). Moreover, the recent technological advancements that have led to "variety-increasing system directively correlated with the complexities and interdependencies of technology" (Trist, 1981, p. 36), require increased adaptive flexibility. Since humans have the capacity for self-regulation, they are the elements in socio-technical systems that meet the requirement for flexibility. Consequently, the adaptive behavior of humans (e.g., through alteration of routines) lies at the core of the transformation of socio-technical systems.

The IS knowledge base suggests that Adaptive Structuration Theory (AST) be used as a meta-theory for examining information systems within an organizational context (Bostrom et al., 2009). Existing studies focus on STS design as a comprehensive, problem-solving engineering process that requires interdisciplinary work (Mumford, 2000), and propose methods and frameworks for Socio-Technical System Engineering (STSE) (Baxter and Sommerville, 2011). Moreover, socio-technical models for organizational change, which consider all the elements of a socio-technical system: actors, processes, tasks, and technology, have been developed (Leavitt, 1964), applied (e.g., Lyytinen et al., 1998), and enhanced and refined (e.g., Lyytinen and Newman, 2008). One overarching design principle for STS is minimal critical specification (Cherns, 1976; Herbst, 1974). It states that only mandatory decisions are made a priori to allow the progressive evolution of STS. Given the fast-changing environment we live in today, and the characteristics of digital technology, this design principle for socio-technical structures seems to be more up-to-date than ever before concerning DSST. However, on the other hand, establishing mutable systems emphasizes the need to anticipate possible evolution paths of socio-technical structures to avoid these paths that will jeopardize the ambitions to develop trustworthy systems that contribute to shaping DSST for positive transformational impact.

2.3.2 Structural Organizational Change

Business Process Management (BPM) is a boundary-spanning subdiscipline of IS that deals with a wide range of aspects of business processes in an organizational context including their identification, discovery, analysis, (re-)design, implementation, and monitoring and control (Dumas et al., 2018). Business processes and the activities they organize are positioned at the heart of work systems (see Figure 2.3), integrating all its internal and external elements (Alter, 2013). In its history, the discipline's assumptions and how it is defined have evolved multiple times, changing the discipline's gestalt. Smith and Fingar (2003) summarized this evolution as having occurred in three consecutive waves. In the first wave, it was assumed that business processes are not designed but rather emerge from actors' behaviors. Hence, BPM was about analyzing the activities of actors (Smith and Fingar, 2003). In the second wave, the prevalent interpretation of BPM was that business process models could be designed in manual, one-time engineering activities. The resulting standardized process models were often codified in enterprise-wide information systems (e.g., Enterprise Resource Planning (ERP) systems) to ensure minimum deviation from standard processes through human actors (Smith and Fingar, 2003). In the third wave, however, this interpretation was withdrawn and replaced the earlier views, in recognition of the need for more flexible, integrative, and innovative ways of organizing business processes. In particular, the third wave of BPM emphasizes the need to establish process modeling from the top-down and bottom-up, to enable flexibility and scalability in organizations whilst considering all organizational elements as well as all elements in an organization's environment (Smith and Fingar, 2003).

Some 15 years later, however, in the BPM literature, the prevalent view has become that business processes, as IT artifacts, can be holistically designed (top-down or bottom-up) and thus guide employees' future behavior in a desired and predetermined way. Furthermore, it is assumed that business processes are best practices and hence represent the systematization of actions that suits best the execution of activities in organizational contexts (Alter, 2015). Indeed, ubiquitous information systems in organizations, like ERP systems, Manufacturing Execution System (MES) systems, or Customer Relationship Managemen (CRM) systems, strongly draw on this view, aiming to standardize all activities in organizations (Botta-Genoulaz et al., 2005). Moreover, process standardization is mandatory for imple-

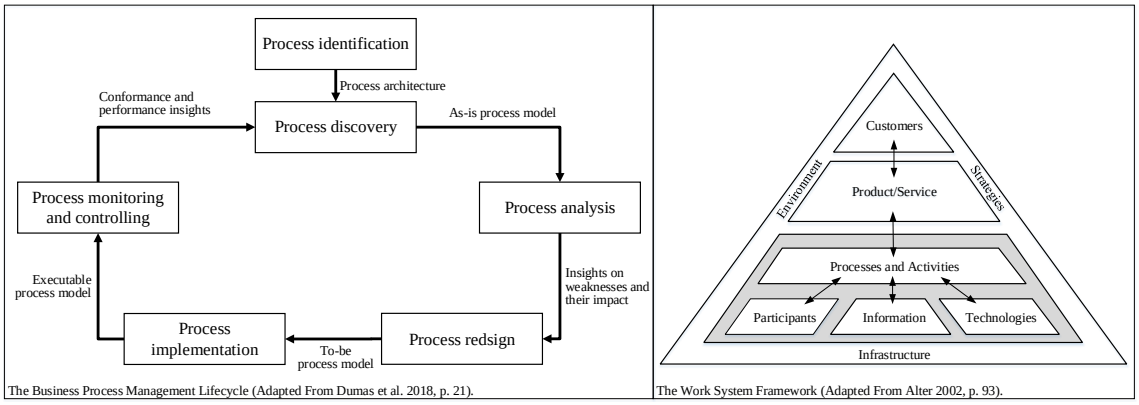

Figure 2.3: Business Process Management as a Means for Structural Organizational Change.

menting and streamlining cross-functional processes (Markus, 2004) that enable information systems to positively impact operations by achieving, e.g., greater efficiency and quality gains, whilst decreasing future maintenance costs (Romero et al., 2015). Standardization, in the BPM literature, includes the implementation of configurable business process models (La Rosa et al., 2011) that allow for process variations in different process instances to enable organizations to deal with different customer groups, environments, and cultures. Still, such variations are assumed to be predetermined by and codified in IT artifacts, for example, information systems and business process models (Frei et al., 1999). Hence, most change initiatives in organizations are realized through top-down management, including the design and implementation of aimed-for business processes that will guide future behavior.

However, from an organizational change perspective, one predominant engineering view on business processes in the BPM literature draws on the premise of a "rather strong form of technological determinism" (Pentland and Feldman, 2008, p. 234). As IT artifacts, business process models cannot be holistically designed because there are potentially an infinite number of requirements (Alexander, 1964) which underlie second-order design effects (Germonprez et al., 2011), as employees are sometimes forced to deviate from processes to conduct their daily work (Goh et al., 2011), or to improve effectiveness and efficiency (Alter, 2015). Thereby actors' deviation from standardized processes shapes new ways of conducting work that might be implemented in re-designed process models (Creswell et al., 2017). However, the predominant view in the BPM literature deems any deviation from standardized business processes to be undesirable, non-compliant

behavior (Hadasch et al., 2016), while simultaneously acknowledging that especially digitized business processes drift over time (Pentland et al., 2020) and thus are subject to non-designable second- and higher order-effects. Consequently, phenomena related to DSST provide evidence that the BPM discipline needs to evolve in such a way that IT artifacts (e.g., process models) do not only reflect current issues and requirements but also, by design, are adaptable to future demands (Mendling et al., 2020).

> "Because organisations now operate in an environment of constant change, the challenge is not how to design a response to a current issue, but how to design a means of continually responding, adapting and innovating." (Burns et al., 2006, p. 21)

2.3.3 Emergent Organizational Change

In socio-technical systems, second-order changes only occur in the long-term and have the power to change a system fundamentally, impacting its "metarules" (Levy, 1986). The IS literature suggests that technology-driven organizational change (*technochange*; Markus, 2004) can lead to desired outcomes for organizations if corresponding projects are carefully planned and conducted in complete interventions, comprising technology and organizational change.

Adaptive Structuration Theory (AST), as proposed by DeSanctis and Poole (1994), is based on Anthony Giddens (1984) structuration theory and enables to contrast, and understand, the duality of structure (Orlikowski, 1992) that is inherent in technology (i.e., designed IT artifacts) and emerges in any context where humans use technology. This view of structure postulates that technology does not determine but rather enables and constrains human behavior (DeSanctis and Poole, 1994). Hence, it is imperative for investigating the consequences and limitations of design for DSST to focus on the *social structure*, e.g., in organizations, that is iteratively shaped by the design of IT artifacts and 'in action', i.e., during the use of these IT artifacts (DeSanctis and Poole, 1994). AST suggests that two elements can be used to describe social structure: The *structural features* of an IT artifact (i.e., its form and function) and the *spirit of the feature set*, i.e., the use cases intended by the design (DeSanctis and Poole, 1994). Regarding the latter, neither a designer's

intention nor a user's interpretation can comprehensively describe an IT artifact's spirit (DeSanctis and Poole, 1994).

While both the designer and the user are reflected in the IT artifact, an IT artifact's spirit is rather a property of an IT artifact's implementation (DeSanctis and Poole, 1994). The appropriation of an implemented IT artifact in context is coined *structuration* (DeSanctis and Poole, 1994). DeSanctis and Poole (1994, p. 128) explain that "structuration is the process by which social structures (whatever their source) are produced and reproduced in social life. [...] Technology-triggered organizational change thus takes time to occur, as technology structures are produced and reproduced in interaction."

One theoretical lens that applies to the emergent nature of organizational change are organizational routines (Feldman and Pentland, 2003; Pentland and Feldman, 2005), described as "continuously emerging systems with [their own] internal structure and dynamic" (Pentland and Feldman, 2005, p. 794). The theoretical construct of organizational routines originated in the Organizational Science discipline and has since been adapted and introduced in IS as being related to the concept of IT artifacts (Beverungen, 2014). This import has enabled IS researchers to examine endogenous, technology-driven organizational change (Feldman and Pentland, 2003; Danner-Schröder and Geiger, 2016). Organizational routines provide a similar concept like business process, focusing on emergent change on an individual or on a collective level (Feldman, 2000; Becker et al., 2005). As these micro-level changes are generally not observable in business processes, their study is mostly neglected in the BPM literature. Hence, business processes are a subset of organizational routines (Becker, 2004) because routines also incorporate standard operating procedures for the effortful accomplishment (Pentland and Rueter, 1994) of such work practices in organizations that are not structured in business processes (March and Simon, 1958; Cohen, 1991; Egidi, 1996; Pentland et al., 2012).

Organizational routines consist of a mutually constitutive interplay comprising ostensive and performative aspects that enable researchers to investigate employees' work practices on a micro-level (Becker et al., 2005). The ostensive aspects prescribe an ideal abstract pattern as a sequence of activities, which have manifested in an individual's mind, representing a schema of how activities ought to be enacted to accomplish a specific task. The performative aspects of a routine capture the actual enactment of a specific task by a specific actor, under specific conditions,

and at a particular point in time, often resulting in deviations from the abstract ostensive aspects (Beverungen, 2014). Deviations in the actual enactment of routines, over time, lead to exogenous organizational change (Pentland et al., 2012; Howard-Grenville, 2005). In the context of organizational routines, IT artifacts represent distinct concepts that have a recursive relationship to the performative and ostensive aspects (see Figure 2.4) of organizational routines (Pentland and Feldman, 2005; Beverungen, 2014). Related to organizational routines, IT artifacts often occur in the form of business process models and information systems. Such IT artifacts are designed top-down on the organizational level and subsequently become prevalent by implementation in technology, constraining and enabling the performative and ostensive aspects of organizational routines that represent actors' behavior (Beverungen, 2014; D'Adderio, 2011).

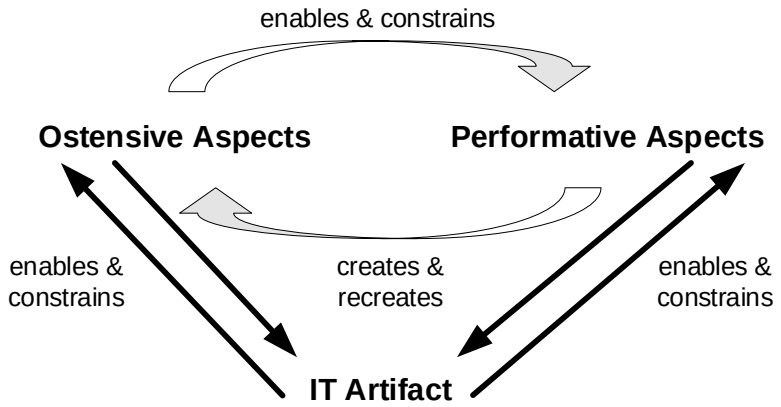

Figure 2.4: Organizational Routines Framework (Adapted From Pentland and Feldman, 2005; Beverungen, 2014).

In an organizational context, IT artifacts are often positioned at the center of routines (D'Adderio, 2011) and employees are often forced to use specific IT artifacts to accomplish a task (Bhattacherjee et al., 2018). Hence, designing IT artifacts is one means by which desired behavior is manifested and restricts employees' ability to deviate from predefined processes. However, due to human agency, employees can deviate from the prescribed pattern in the ostensive aspects of a routine in any instantiation, unleashing the potential to change IT artifacts, too (Leonardi, 2011). Hence, organizational routines provide a suitable theoretical lens with which to study the impact of the implementation of digital technology in socio-technical service systems, leading to insights on, and explaining the tech-

nology's impact on individuals and on the emergent and emerging behaviors that constitute organizational change.

3 Research Design

3.1 Research Paradigms in Information Systems

Information Systems research investigates phenomena related to the analysis, construction, implementation, use, evaluation, evolution, and the management of IT artifacts in organizations (Orlikowski and Barley, 2001; Hevner et al., 2004). IS researchers study phenomena at the intersection between people, organizations and technology (Davis and Olson, 1985; Lee, 1999). As an interdisciplinary research discipline that investigates socio-technical phenomena in a naturalistic context, it is "both reactive and proactive with respect to technology" (Hevner and March, 2003, p. 113). Thus, IS researchers offer generalized contributions to the theoretical knowledge base by deriving the requirements for and evaluating the truth and utility of IT artifacts, and related theories, from observations in their real-world environments (Hevner et al., 2004). Contributions are developed in infinite and iterative research cycles of develop/build and justify/evaluate (see Figure 3.1). These dual research cycles are guided by rigorously conducted and validated research methods, adding contributions with high practical relevance that build on and add theoretical knowledge to the IS literature (Hevner et al., 2004).

Drawing upon the dual structure of IS research cycles, the discipline is separated into two distinct but complementary research paradigms that approach IS phenomena from a social perspective—a behavioral paradigm that enables justify/evaluate cycles—and a technical perspective—Design Science Research (DSR) paradigm that enables develop/build cycles (Hevner et al., 2004; March and Smith, 1995). Studies following the behavioral research paradigm in IS investigate the human appropriation of information systems as IT artifacts in organizational contexts to justify and evaluate theories for explanation and prediction, ascertaining "what is true" (Hevner et al., 2004, p. 98). Behavioral studies are reactive, often

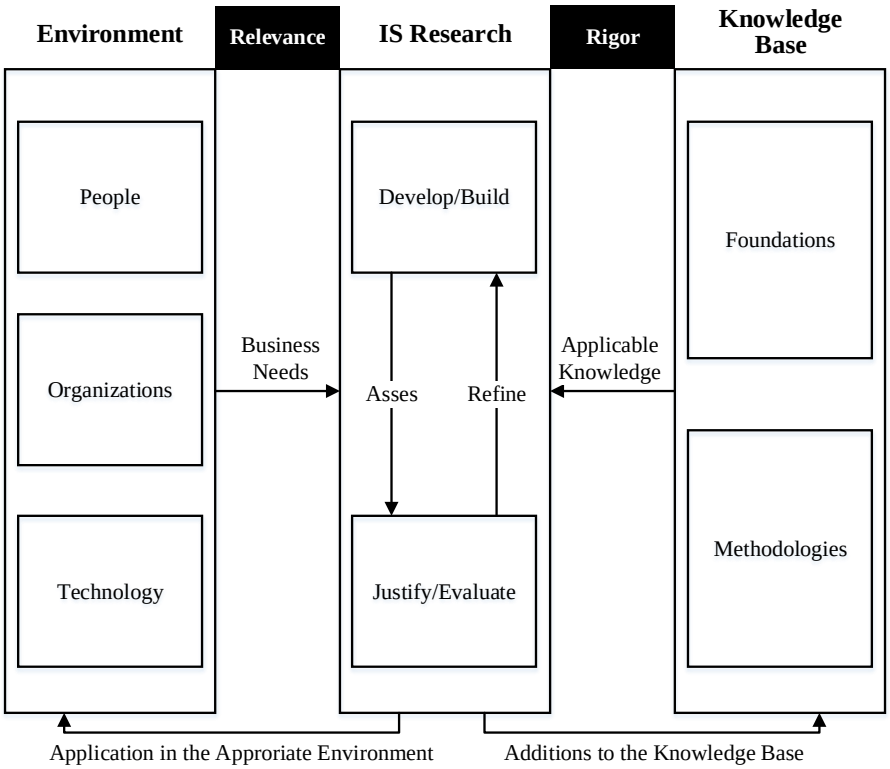

Figure 3.1: The Information Systems Research Cycle (Adapted From Hevner et al., 2004).

leading to overemphasizing the context while neglecting design decisions inherent to an IT artifact's form and function that impact the artifact's context. DSR studies aim to design innovative IT artifacts in iterative build and evaluation cycles that fit with a given context (i.e., environment) and solve an unsolved problem, ascertaining "what is effective" (Hevner et al., 2004, p. 98). This means that DSR studies are often proactive and tend to overemphasize particular features of technologies rather than consider their theoretical embedding, taking into account their specific context (Hevner et al., 2004). Hevner et al. (2004, p. 80) conclude that "the goal of behavioral science research is truth. The goal of design science research is utility. [...] Truth and utility are inseparable. Truth informs design and utility informs theory." Hence, the behavioral paradigm and the DSR paradigm are two sides of the same coin that constitutes the IS discipline.

Research paradigms are "set[s] of beliefs about the nature of social reality" (Shanks, 2002, p. 76). A research paradigm, representing a worldview, consists of three dimensions: ontology, epistemology, and methodology (Guba and Lincoln, 1994). Ontology refers to assumptions about the form and nature of

physical and social reality (Žukauskas et al., 2018; Guba and Lincoln, 1994). The perception of what exists refers to whether reality is objective and independent of humans or subjective and thus only a result of human actions (Orlikowski and Baroudi, 1991; Guba and Lincoln, 1994). Epistemology defines the general assumptions on how knowledge about reality can be generated and evaluated, and thus, declares what can be known (Žukauskas et al., 2018; Guba and Lincoln, 1994). Methodology concerns the question of how knowledge about a phenomenon of interest can be obtained (Guba and Lincoln, 1994), determining which research methods are valid for obtaining empirical evidence on reality (Orlikowski and Baroudi, 1991).

The DSR paradigm and the behavioral paradigm in IS refer to different research philosophies that imply different ontological, epistemological, and methodological assumptions that impact reasoning (Bunge, 1996). The DSR paradigm is based on a pragmatic philosophy (Hevner et al., 2004; March and Smith, 1995), considering "practical consequences or real effects to be vital components of both meaning and truth" (Hevner, 2007, p. 91). Behavioral research is based on different philosophies, including positivism, interpretivism (as a subset of constructivism), and critical realism. Hence, it is essential to delineate these positions and relate particular research paradigms in IS to their ontological, epistemological, and methodological embedding.

Pragmatism assumes that because "humans [are] acting in a world which is in a constant state of becoming" (Goldkuhl, 2012, p. 142), reality consists of actions and change (Goldkuhl, 2012). Actions provide meanings to structures and relations through change (Blumer, 1986). In a pragmatist view, actions are practical implementations of meanings enabled and constrained by purpose and knowledge. Consequently, actors implement knowledge through actions to trigger changes that result in desired outcomes (Goldkuhl, 2012). Thus, interpreting actions and changes enables researchers to understand reality because "the meaning of a specific concept [lies in] the different actions, which we conduct, based on the belief in this concept" (Goldkuhl, 2012, p. 142). In this regard, reality is ambiguous and practical implications are important because truth is what is (currently) efficient. This view enables actors to perform controlled change in a specific part of reality (Žukauskas et al., 2018). Hence, pragmatist researchers aim to generate knowledge on how to reach a desired state (Goldkuhl, 2012) while theoretical preconceptions are not presumed. Rather, methods are employed based on the

underlying problem and its context (Žukauskas et al., 2018). Goldkuhl (2012, p. 143) further explains that "pragmatism is concerned with an instrumental view on knowledge; that it is used in action for making a purposeful difference in practice." A second important factor in pragmatism is *appropriateness* against which any efficient solution is assessed (Rescher, 2000).

From a positivist standpoint, reality is objective and thus independent of the researcher who takes a passive and value-neutral role, enabling unbiased understanding of the world (Žukauskas et al., 2018; Orlikowski and Baroudi, 1991). In this regard, understanding is only a problem of measuring data that exists independently of the researcher and represents stable relations of a phenomenon of interest that can be examined from a value-neutral perspective. Consequently, theory can be tested empirically with valid and reliable instruments, enabling "deterministic explanations of phenomena" (Orlikowski and Baroudi, 1991, p. 13). While theory and empirical observations are distinct elements, theory is only valid if it is not falsified in multiple attempts. Positivists assume that conflicts in data and dysfunctional behavior in a given context are abnormal and can be eliminated (Orlikowski and Baroudi, 1991). Hence, truth about a phenomenon is unique, allowing researchers to make nomothetic statements about reality (Orlikowski and Baroudi, 1991). Arguably, the weaknesses of this philosophical standpoint are that it neglects the historical and contextual impact on the current status quo and that, therefore, non-deterministic-reciprocal relationships cannot be identified (Orlikowski and Baroudi, 1991).

Interpretivism argues that the world is neither a given nor objective and can only be understood by interpreting shared subjective meanings (given by humans) that already exist because reality is socially constructed (Weber, 1978). Interpretivism aims to "understand the actors' views of their social world and the role of it" (Orlikowski and Baroudi, 1991, p. 14) which are shaped, disseminated, and negotiated among actors, thus evolving over time (Orlikowski and Baroudi, 1991). From an interpretivism viewpoint, the researcher is not an uninvolved observer but has an active role in the reciprocal process of analyzing and understanding the socially constructed reality from the actor's perspective (Glaser and Strauss, 1967). Value-neutral examination of phenomena is impossible because the researcher affects theory development (Žukauskas et al., 2018; Orlikowski and Baroudi, 1991). Interpretivist researchers try to understand how and why actors' knowledge (including meanings, beliefs, and intentions) impacts their actions that

constitute their reality (Orlikowski and Baroudi, 1991; Goldkuhl, 2012). Hence, interpretivism draws on a constructivist ontology, postulating that reality is not objective but full of meanings and interpretations that are "produced and reinforced by humans through action and interaction" (Orlikowski and Baroudi, 1991, p. 14). A weak constructivist position assumes that the researcher cannot directly access reality and, thus, research can and should be complemented with positivist research. In this regard, interpretivisim research generates hypotheses that can be empirically tested in positivistic studies. However, a strong constructivist position denies that positivist research methods are a valid means of understanding reality and discovering truth (Orlikowski and Baroudi, 1991). Weaknesses of interpretivism refer to not examining the conditions under which reality is constructed, not explaining unintended consequences, neglecting inconsistencies between actions and meaning, and neglecting the historical evolution which constituted the current reality (Orlikowski and Baroudi, 1991).

Critical realism's explicit aim (Bhaskar, 1978; Bhaskar, 1979) is to overcome the shortcomings of both positivism and interpretivism (Cruickshank, 2002). It argues that phenomena (often called events) are solely observable in closed systems and thus only represent a small subset of all the events that (can) occur (Mingers, 2000). Drawing on a realist ontology, it assumes that reality is "intransitive" (Archer et al., 2013), implying that open systems have "emergent properties" (Archer et al., 2013) that are independent social structures which are neither constructed nor directly observable by humans (Bhaskar, 1978; Cruickshank, 2002; Mingers, 2000). It assumes the existence of enduring natural, social, and conceptual entities that have *powers* and *tendencies* which, regardless of whether or not they play out, constrain and enable specific events to occur (Mingers et al., 2013). What is important to note here is that these events also exist if they have not (yet) occurred, because reality is "stratisfied" (Archer et al., 2013) in the domains of *the real*, *the actual*, and *the empirical*. The real encompasses all enduring elements and mechanisms that can trigger events. The actual are all events that can potentially be triggered. The empirical is a small subset of the events that humans can observe and perceive (Archer et al., 2013). Mingers (2004, p. 380) explains that "for an empiricist only that which can be perceived can exist, whereas for a realist having a causal effect on the world implies existence, regardless of perceptibility." Consequently, the goal of research is to generate *transcendental* arguments about causal mechanisms, aimed at discovering "what the world must be like for this to occur" (Mingers

et al., 2013, p. 796), thereby favoring causality over perceptibility (Mingers et al., 2013).

Critical realism purports to overcome the epistemological bias inherent in different ontological perspectives by acknowledging that a realist ontology, and by implication, scientific knowledge, is not intransitive by virtue of being constructed by humans (Bhaskar, 1978). In this regard, a realist ontology assumes "epistemic relativity" (Mingers et al., 2013), i.e., the view that knowledge is always methodologically and conceptually mediated (Mingers et al., 2013). It acknowledges the existence of different types of knowledge—i.e., physical, social, and conceptual (Mingers et al., 2013; Cruickshank, 2002)—that can be generated by different methodologies (Mingers et al., 2013). A critical realist view thus allows researchers to abductively[5] design and conduct pluralist, multi-, and mixed-method research (Mingers, 2001; Mingers et al., 2013). From a critical realism standpoint, competing explanations for phenomena may exist and can only be judged if they are found to be self-consistent, i.e., they are true if not contradicting themselves (Mingers, 2001).

Depending on the underlying research paradigm and its fundamental philosophical assumptions, IS research can result in one of five distinct but interrelated types of theory that contribute to the theoretical knowledge base (Gregor, 2006). No single theory type can be assigned exclusively to any specific underlying paradigm but "specific paradigms favor some forms of theory more than others" (Gregor, 2006, p. 631). According to Gregor (2006), theory for analyzing and describing (type I) refers to descriptive theories that are especially valuable when little is known about a phenomenon. The goal of type one theory is to analyze the construct's relationships. This type of theory is not related to any specific paradigm or philosophy. Theory for explaining (type II) is foremost related to research that adopts an interpretivist view and investigates how, why, and when phenomena occur in a specific context to provide a better understanding of a known phenomenon. Positivist researchers often develop theory for predicting (type III), which makes probabilistic predictions on an outcome without explaining the relationships between the dependent and independent input variables. In most instances, theory for explanation and prediction (type IV), which is aimed at pre-

[5] The original term coined in critical realism by Bhaskar (1978) is *retroduction*. However, because abduction is generally used to contrast the logical reasoning approaches of induction and deduction (Frankfurt, 1958), the term abduction is used here.

dicting an outcome and understanding the relationships among the underlying constructs, is based on a positivist worldview, too. Theory for design and action (type V) is generated by DSR researchers pursuing a pragmatic philosophy and is aimed at explaining how to do something by designing and evaluating IT artifacts and prescribing their design in the form of generalized design theories or design principles. Thereby, DSR values the "importance of **both** the contributions made in the form of viable artifacts and the contributions at more abstract levels" (Gregor and Hevner, 2013, p. 341). However, Gregor (2006, p. 619) clarifies that the "decision to allocate a theory to one class might not be straightforward," but can be achieved by determining "what the primary goals of a theory are."

3.2 Research Methods

3.2.1 Design Science Research Methods

The IS discipline has long recognized the interrelatedness of technological change and organizational behavior. The adoption of DSR as one of the discipline's fundamental research paradigms reflects this recognition (Peffers et al., 2018). The raison d'être of DSR is the building and application of IT artifacts that can improve the efficiency and effectiveness in organizations (Hevner et al., 2004; Goldkuhl, 2012). In particular, DSR is appreciated for its ability to observe organizational change induced by design decisions or by specific technological interventions (Avison et al., 1999; Avison et al., 2001). Thus, DSR is on a dual mission (Sein et al., 2011). (1) It solves problems relevant to an application domain by designing IT artifacts that support practitioners, and (2) it develops generalized theoretical knowledge in the form of type five theory for design and action (Gregor and Hevner, 2013; Gregor, 2006), presenting, for example, design theories (Gregor and Jones, 2007) or design principles (Gregor et al., 2020).

Referring to the general IS research framework, Hevner (2007) elucidates that any DSR project consists of three interrelated and equally important research cycles: the design cycle, the relevance cycle, and the rigor cycle. The design cycle comprises the iterative process of building and evaluating the activities in which an IT artifact is developed. The design cycle is informed by equally important requirements that stem from the two other cycles. The relevance cycle ensures that DSR

projects relate to a specific context by converting its peculiarities into requirements for an IT artifact's form and function. Furthermore, the relevance cycle provides criteria for assessing an IT artifact's fit with the context, ensuring its usefulness in practice. The rigor cycle relates DSR projects to the current IS knowledge base, including kernel theories, engineering methods, and state-of-the-art knowledge on rival IT artifacts. The thorough grounding in existing theory ensures that contributions are developed that add new insights to the IS literature.

Gregor and Hevner (2013) postulate that DSR can result in three different contribution types—*situated implementations, nascent design theories,* and *well-developed design theories*—based on the maturity of the theoretical knowledge that is developed. Situated implementations represent concrete instantiations of IT artifacts, nascent design theories present knowledge in the form of operational principles and architectures, and well-developed design theories account for embedded phenomena. Moreover, by defining their problem and solution domain, DSR contributions can be framed as one of four knowledge contributions. *Routine designs* are the weakest contributions in that they do not add knowledge to the literature, instead providing known solutions to known problems (Gregor and Hevner, 2013). *Improvements* provide new solutions to known problems, *exaptations* extend known solutions to new problems. By offering new solutions to new problems *inventions* represent the most radical form of contributions (Gregor and Hevner, 2013). The prescriptive knowledge that is generated in iterative build and evaluation cycles (March and Smith, 1995; Hevner et al., 2004) can represent process theories (set of activities to design an IT artifact) or product theories (the IT artifact itself) which, being strongly interrelated, can only be improved jointly (Hevner et al., 2004).

In DSR, IT artifacts fall into four different types (March and Smith, 1995). (1) *Constructs* represent a kind of vocabulary and are conceptualized as logical structures to describe domain-specific problems and solutions. (2) *Models* depict the relationships between the constructs of a specific domain and describe how things are. (3) *Methods* describe a process consisting of consecutive steps that can be employed to perform an activity and are built upon underlying constructs and models. (4) *Instantiations* operationalize the constructs, models, and methods, implementing an IT artifact in its context. Due to the large scope of many DSR projects, more

often than not, more than one type of IT artifact is developed. However, research papers tend to present and theorize only the primary IT artifact[6].

Evaluating IT artifacts and corresponding design theories is a crucial task in DSR projects (Hevner et al., 2004; March and Smith, 1995). Hence, IS research has developed various evaluation strategies for DSR projects to ensure rigorous development of the contributions. While most papers refer to abstract criteria that need to be met (e.g., utility, quality, and efficacy; Hevner et al., 2004), much knowledge on IT artifact evaluation has been developed, including the presentation of evaluation criteria (e.g., Delone and McLean, 2004), evaluation principles and activities (e.g., Sonnenberg and vom Brocke, 2012), and evaluation strategies (e.g., Pries-Heje et al., 2008). Prat et al. (2014) conducted a literature analysis identifying all papers that provide IT artifact evaluation strategies. The proposed framework organizes the evaluation criteria along five system dimensions—goal, environment, structure, activity, and evolution—that can be instantiated in a generic evaluation method to align with the requirements of a specific DSR project. Venable et al. (2016) conceptualized the Framework for Evaluation in Design Science (FEDS) that comprises evaluation strategies for the formative and summative evaluation of IT artifacts and design theories. Depending on the context of the DSR project and the type and properties of an IT artifact, an evaluation is planned by organizing four consecutive steps: defining the goals of the evaluation, declaring the evaluation strategies, choosing the properties to evaluate, and developing individual evaluation activities and processes (Venable et al., 2016). According to FEDS, four different evaluation strategies can be employed: a purely technical evaluation, an evaluation of technical risk and efficacy, a quick and simple evaluation, or an evaluation for human-risk and effectiveness (Venable et al., 2016).

Moreover, balancing the importance of IT artifacts and design theories in DSR projects is extremely important because elaborating both in-depth is often impeded by DSR project's large scope. Baskerville et al. (2018) suggest that the embedding in the current literature is a mandatory preconception for any DSR

[6] Some argue, that, in the IS discipline, the concept *IT artifact* has been "so variedly defined, that it has lost much of its usefulness" (Chatterjee et al., 2017, p. 5717)—cf. March and Smith (1995), Orlikowski and Barley (2001), Benbasat and Zmud (2003), Agarwal and Lucas Jr (2005), Österle et al. (2011), and Iivari (2017). The ambiguity of the concept's meaning has led some researchers to criticize the dogmatic but sometimes meaningless use of this term in DSR studies (see Alter, 2015; Alter, 2017). In this dissertation, however, the term IT artifact explicitly refers to a construct, model, method, or instantiation as defined by March and Smith (1995).

project, while the result must at least be theorized to some degree to contribute to the knowledge base. However, DSR contributions "do not need to have a close deductive relationship with existing scientific knowledge" (Baskerville et al., 2018, p. 367). Consequently, since DSR projects are longitudinal and IT artifacts and design theories continually evolve, early-stage contributions are "*sufficient* contribution[s] when the newness and usefulness of an artifact can be demonstrated" (Baskerville et al., 2018, p. 368). In this view, an IT artifact must not necessarily be based on kernel theories. Hence, theorizing IT artifacts in abstracted design theories is a desirable but not mandatory goal of DSR studies in the short-term but enables continuous improvement of the IT artifact in the long-term (Baskerville et al., 2018).

While DSR researchers agree upon fundamental guidelines outlined by Hevner et al., 2004 (see Table **??**), some argue that the heterogeneity of DSR researchers leads to DSR projects pursuing distinct goals that inevitably result in different types of contributions (Peffers et al., 2018). Hence, deviating from the singular conceptualization of DSR contributions with varying theoretical maturity, Peffers

Guideline	Description
1. Design as an Artifact	Design science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
2. Problem Relevance	The objective of design science research is to develop technology-based solutions to important and relevant business problems.
3. Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.
4. Research Contributions	Effective design science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
5. Research Rigor	Design science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
6. Design as a Search Process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
7. Communication of Research	Design science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

Table 3.1: Fundamental Design Science Research Guidelines (Adapted From Hevner et al., 2004).

et al. (2018) identify different *genres* of DSR contributions. As Peffers et al. (2018) identified, DSR researchers interpret the paradigm differently, although all studies conduct *design processes* that result in a *knowledge contribution* (Peffers et al., 2018). However, opinions diverge upon the focus of DSR projects, the process that should be conducted to develop a contribution, the role of theory, and which evaluation strategies are eligible (Peffers et al., 2018). For conducting DSR studies, this inherent diversity can be both advantageous, such as by allowing different research foci and balancing of rigor and relevance, and disadvantageous, e.g., lack of comparability and different expectations being imposed on knowledge contributions. As a consequence, serious problems in developing, justifying, and assessing type five theory for design and action have hampered the IS discipline since the assessment of the rigor of DSR studies has became more subjective than objective (Peffers et al., 2018). Consistent with this observation, Peffers et al. (2018) suggest five heterogeneous genres for DSR contributions, to enable a like-for-like comparison.

An *Information Systems Design Theory (ISDT)* represents the main contribution in DSR and is comparable to behavioral theories in so far as its contribution is independent of the context in which it was applied (Peffers et al., 2018). Such theory is mostly developed deductively as it is based on and enhances underlying kernel theories. In particular, adjustments made to the kernel theories point out the primary theoretical contribution made by an ISDT. Gregor and Jones (2007) outline eight components of an ISDT: (1) purpose and scope, (2) constructs, (3) principles of form and function, (4) artifact mutability, (5) testable propositions, (6) justificatory knowledge, (7) principles of implementation, and (8) expository instantiation. From an ISDT perspective, the development and demonstration of a corresponding IT artifact are not mandatory but beneficial for outlining a theory's fundamental design principles and its usefulness (Gregor and Jones, 2007). In contrast, deduced testable propositions are mandatory since they are employed to test the theory in subsequent (often empirical) research.

An *Explanatory Design Theory (EDT)* is similar to theory in behavioral science (Baskerville and Pries-Heje, 2010; Niehaves and Ortbach, 2016). It enables the systematic development, manipulation, and evaluation of specific features of an IT artifact to investigate its impact on the environment and develop a corresponding design theory. Thereby, only the explanatory components that are taken into consideration—general requirements, general components, and their

circular relationships—can form the essence of a design theory (Baskerville and Pries-Heje, 2010). Hence, and EDT draws on kernel theories to deduce hypotheses, but views them as endogenous input. The IT artifact then becomes rather a vehicle for theory development because it is needed for testing (design) variables, and is, thus, not at the center of interest. From an EDT perspective, the description of how to design an IT artifact is outsourced to a *design practice theory* that is, according to Baskerville and Pries-Heje (2010), the second component of a design theory. Both complementary components—an EDT and a design practice theory—constitute a design theory (Baskerville and Pries-Heje, 2010).

Design-Oriented Information Systems Research (DOIS), also referred to as "gestaltungsorientierte Wirtschaftsinformatik" (Winter, 2008; Österle et al., 2011), aims to develop information systems and guiding their implementation and operation in practice. This particular genre of DSR is specifically conducted in the German-speaking IS community, in which IS's sister discipline *Wirtschaftsinformatik* originates from engineering disciplines, while IS itself is Anglo-American influenced, emanating from the Social Sciences. From an engineering-centered perspective, the process of developing DOIS consists of four stages—analysis, design and development, evaluation, and diffusion—and draws on the assumption that different types of IT artifacts are not stand-alone concepts but interdependent systems (see Figure 3.2; Winter, 2008).

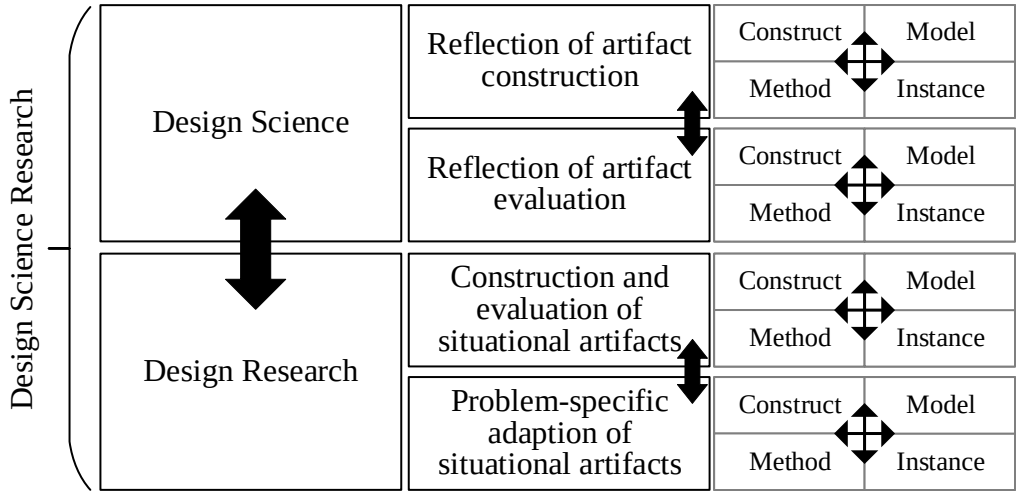

Figure 3.2: Design-Oriented Information Systems Research (Adapted From Winter, 2008).

DOIS studies apply context-dependent evaluation strategies that encompass laboratory experiments, pilot applications, simulation procedures, expert reviews,

and field experiments (Österle et al., 2011; Winter, 2008). Moreover, within the DOIS genre, design research and design science represent the two constituents of DSR[7].

The *Design Science Research Methodology (DSRM)* takes an IT artifact-centered perspective that focuses on technical aspects and primarily refers to the development of IT artifacts that are useful in various practical application contexts (Peffers et al., 2007). The method draws on the three cycle view of DSR, as proposed by Hevner et al. (2004), in the sense that the requirements guiding an IT artifact's development process stem from both the context and the (domain-specific) theoretical knowledge base. The development of an IT artifact is achieved by conducting an iterative process (see Figure 3.3) that comprises five stages (Peffers et al., 2007): problem identification and motivation, definition of the objectives of a solution, design and development, demonstration, evaluation, and communication. The first four stages are all eligible for initiating a DSR project, depending on whether the approach is problem-centered, objective-centered, design and development-centered, or client/context-centered.

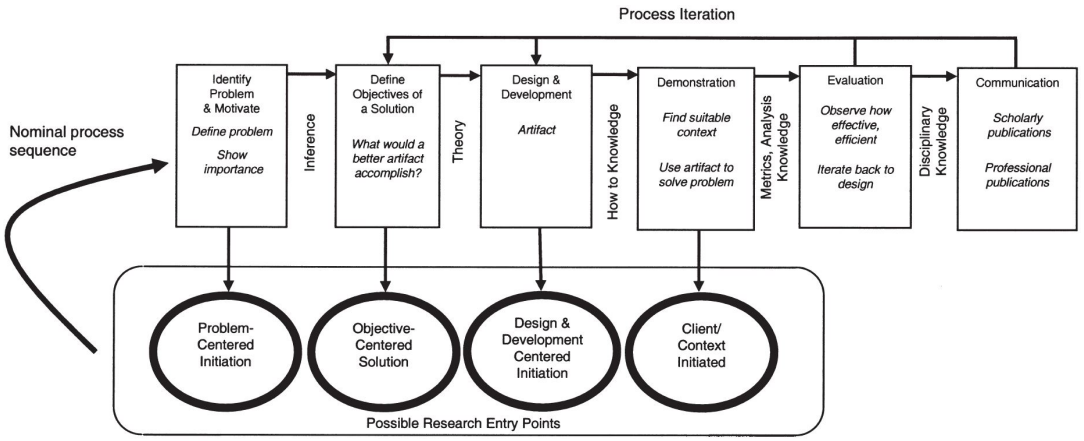

Figure 3.3: Design Science Research Methodology Process Model (Adapted From Peffers et al., 2007).

[7] *Design Science Research, Design Science*, and *Design Research* are often used as synonyms in the IS knowledge base or without specifically declaring their meaning. Österle et al. (2011) and Winter (2008) postulate that the term Design Research is used when referring to the development and application of design knowledge that applies to a class of relevant real-world problems (i.e., developing and evaluating IT artifacts) while the term Design Science is used when reflecting on the philosophy of science and on developing standardized design processes. The term DSR, in contrast, describes the overarching research paradigm that implicates both contribution types, namely, Design Research and Design Science (Hevner et al., 2004). However, the IS knowledge base does not provide an agreed upon distinction of the terms.

Action Design Research (ADR) draws upon interventions in real-world contexts to design practice-inspired IT artifacts (Sein et al., 2011). Hence, ADR is employed for "generating prescriptive design knowledge through building and evaluating ensemble IT artifacts in an organisational setting" (Sein et al., 2011, p. 40). The research process (see Figure 3.4) comprises four stages and seven principles—beginning with a problem formulation stage that incorporates theoretical knowledge and stakeholder demands to enable the design of "theory-ingrained artifact[s]" in "practice-inspired research [projects]" (Sein et al., 2011, both p. 40). The IT artifact is then reciprocally developed in several cycles of the build, intervention, and evaluation stage at the center of the ADR process. The first and second stages are in a mutual relationship with stage three for reflection and learning. The third stage is aimed at relating the knowledge gained from specific real-world interventions, in which a concrete IT artifact is applied to solve a particular problem, to a corresponding class of problems. In the final stage—formalization of learning—the outcomes of the first three stages are abstracted, theorized, and disseminated.

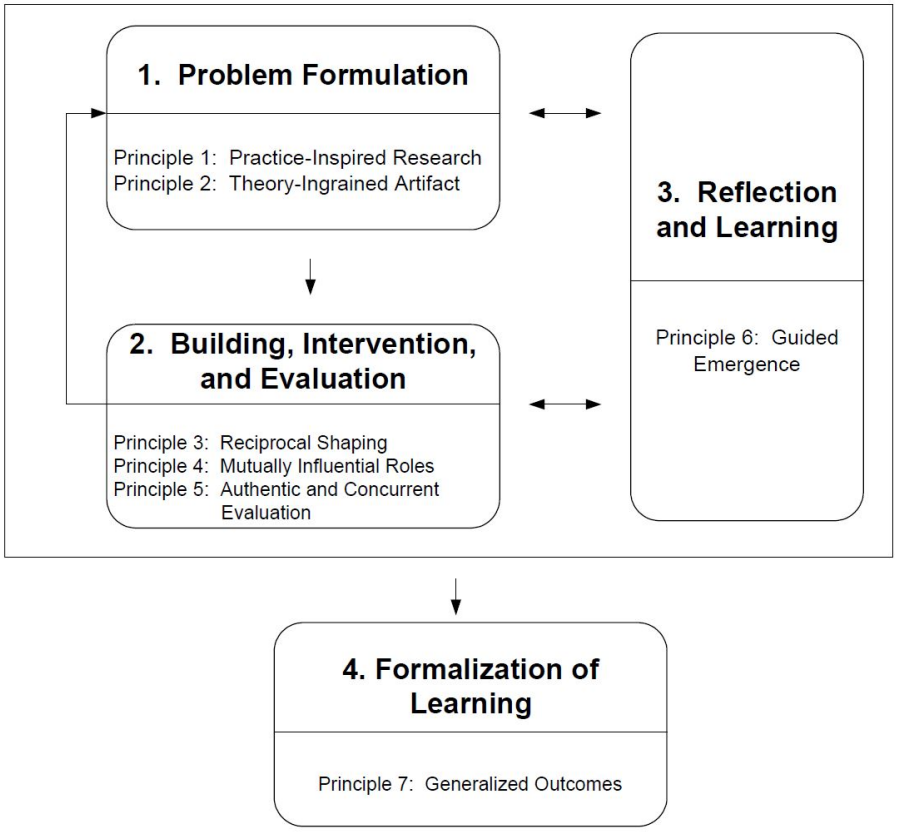

Figure 3.4: Action Design Research Method (Adapted From Sein et al., 2011).

3.2.2 Behavioral Research Methods

Behavioral research in the IS discipline harnesses qualitative research methodologies developed in the social sciences, as well as on quantitative research methodologies that originate in the natural sciences and that are based on either a positivist, an interpretivist, or a critical realism view. Behavioral research in IS is foremost descriptive and reactive in nature, and is aimed at generating theoretical knowledge gained from theory development (inductive reasoning) and theory testing (deductive reasoning) based on observations in the real-world (Bariff and Ginzberg, 1982). To study the behavioral aspects of information systems design and implementation on the individual, group, organizational, and societal level, behavioral researchers in the IS discipline draw on qualitative and quantitative research methods borrowed from various disciplines—e.g. anthropology, organizational behavior, political science, psychology, and sociology (Bariff and Ginzberg, 1982). Research methods include, amongst others, case studies, ethnographies, action research, survey research (e.g., interviews, questionnaires, document analysis), field experiments, laboratory experiments, observations, protocol analysis, self-report instruments, correlational research, and causal modeling (Bariff and Ginzberg, 1982).

Qualitative research can be conducted by drawing upon either positivist, interpretivist, or critical ontological assumptions (Myers and Young, 1997). Applying qualitative research methods enables researchers referring to different underlying philosophical paradigms to generate findings that are not derived from statistical procedures or other means of quantification (Myers and Young, 1997). Qualitative researchers conduct, e.g., case study research, ethnography, action research, or grounded theory, to discover relationships in a real-world context through the (inductive) interpretation of field data, often with the goal of developing theory (Gioia et al., 2013). Qualitative research strategies are a valid methodology for gathering data on a rather isolated real-world phenomenon, enabling access to and understanding the phenomenon's underlying cultural and social context (Kaplan and Maxwell, 1994).

Quantitative research, in contrast, often draws upon a positivist philosophical paradigm. Its quality is highly dependent on the validity and realiabilty of the research instruments (Kimberlin and Winterstein, 2008) employed to analyze big data sets that often represent whole populations related to a phenomenon (Cooper

et al., 2003). Its aim is to develop theory with general validity (Cooper et al., 2003). Quantitative researchers conduct deductive studies, e.g., different types of experiments, surveys, and correlational analysis, to test theory through the verification or falsification of hypotheses.

Field experiments and laboratory experiments are distinct subtypes of experiments that are foremost associated with quantitative research methods in the behavioral sciences, and hence are based upon a positivist epistemology (Harrison and List, 2004). Both types of experiments are employed to test hypotheses that are sketched on an observed phenomenon. Through the controlled manipulation of independent variables, experiments allow to study cause-effect relationships between dependent and independent variables (Harrison and List, 2004). For such research designs, participants are randomly assigned[8] to treatment and control groups. Independent variables are then manipulated in a treatment group. The occurring effects are compared to those effects in the control group(s) in which no variables were manipulated (Bhattacherjee, 2012). Different techniques are available to ensure that the observed effects are neither biased nor caused by other factors, thus enabling their objective investigation. With such elimination techniques, researchers in an experimental setting aim to ensure that no variables other than the independent variables impact the dependent variable. Using the inclusion technique, the effects of extraneous variables are included a priori in the experimental design (Bhattacherjee, 2012), e.g., by measuring participants' beliefs and attitudes before and after the manipulation. Statistical control techniques quantify extraneous variables and include them as covariates in statistical testing processes (Bhattacherjee, 2012). While both laboratory and field experiments enable researchers to manipulate and measure variables, field experiments are carried out in a natural setting (Benbasat et al., 1987), implying that not all variables can be controlled by the researchers (Harrison and List, 2004). While field experiments can provide high internal and external validity of the results by reflecting on the real-world (Rubin, 2005), they are also complex endeavors, due to the real-world embedding, which need to be carefully conducted if one is to achieve high validity (Bhattacherjee, 2012).

Case study research can be employed to investigate contemporary phenomena in their real-world contexts and answer *how* and *why* questions (Yin, 2017). It is a particularly useful method if little is known about a phenomenon, or if it is rather

[8] If participants are not randomly assigned, it is a *quasi-experiment* (Meyer, 1995).

complex, requires a holistic investigation, or if it can only be studied in situ (Benbasat et al., 1987; Yin, 2017). There are four basic types of case study design: holistic single-case design, holistic multiple-case design, embedded single case design, and embedded multiple case-design (Yin, 2017). Holistic case studies are conducted if the unit of analysis is at the aggregated level, while embedded case studies enable in-depth investigation of a subset/subunit of a case. Researchers that apply single case designs aim to study critical, unusual, common, revelatory, and longitudinal cases (Yin, 2017). The rationale for conducting multiple-case studies is based on replication logic to increase robustness. To prevent results from being caused by case-specific idiosyncrasies, findings from one case are confirmed in one or multiple other cases to claim general validity (Cavaye, 1996). A *literal replication* logic assumes that the cases provide similar results, while a *theoretical replication* logic assumes that the cases are expected to provide different results (Yin, 2017).

Regardless of the case study type, one essential strength of case study research is that it enables researchers to study contemporary phenomena situated in their context (Yin, 2017). Case study researchers acquire multiple sources of evidence when collecting data, including documentation, archival records, interviews, direct observations, participant-observations, physical artifacts, and e-mails (Miles and Huberman, 1994). Data collection is conducted until 'theoretical saturation' (Glaser and Strauss, 1967) is reached, i.e., when more data no longer yields any new information on a concept, construct, or relationship. In most studies, interviews and direct observations are treated as primary sources of evidence, while other data sources are often conceived as secondary. In the research process, data from multiple sources is triangulated, which enhances the robustness of the study's results (Yin, 2017). In a multiple case study, data is first analyzed and interpreted within each case before it is compared in cross-case triangulation. Depending on the underlying philosophical assumptions, case study research is conducted in either a deductive (positivist) or an inductive (interpretivist) research endeavor (Paré, 2004).

Positivist case studies are generally deductive (Yin, 2017; Eisenhardt, 1989; Shanks, 2002). They are used to logically deduce hypotheses (empirically testable statements) from the theoretical knowledge base that are then empirically tested—often by employing large-scale data sets (Cooper et al., 2003) collected in a case study to be verified or falsified (Shanks, 2002; Orlikowski and Baroudi, 1991). Both

qualitative and quantitative studies are generally structured into six stages comprising problem description, hypotheses development, research design, data gathering and analysis, and interpretation of the results to test the hypotheses (Nunamaker et al., 1990; Bailey, 2008). However, especially in single case studies, the generalization of results must be undertaken with great caution—if ever possible at all (Shanks, 2002). In positivist case studies rigor can be achieved by following four methodological guidelines (Lee, 1989; Yin, 2017). *Construct validity* shows if the measures used to study the concepts are correct and is improved by drawing on multiple data sources that should result in the same outcome. *Internal validity* is concerned with the data, and the information abstracted from it, referring to the same phenomenon and theoretical element. *Reliability* ensures consistency and repeatability within the case over time. *External validity* enables generalizability in a specific domain and is facilitated by carefully selecting one or multiple cases (Yin, 2017).

Interpretive case studies are generally inductive—"using theory more as a 'sensitizing device' to view the world in a certain way" (Klein and Myers, 1999, p. 75)—and focus on the interpretation of small subsets of data on observed phenomena (Walsham, 1995b; Walsham, 1995a). Inductive reasoning in case study research is often inspired by *grounded theory* (Glaser and Strauss, 1967; Locke, 1996), where theory is directly obtained from data gathered in the real-world. Researchers take the role of an outside observer or an involved researcher (Walsham, 1995a). In both cases, they aim to assess others' interpretations of the world, hence, directly impacting theory development through their own biased interpretations (Walsham, 1995a). Thus, it is essential to ensure the rigorous conduct of theory development in interpretive studies. Gioia et al. (2013) suggest that structuring the gathered data is important for developing theory, and provide a framework for organizing first-order concepts (raw data), second-order themes, and aggregate dimensions, thus supporting researchers to make sense of data (Gioia et al., 2013). Qualitative Content Analysis (QCA) provides a similar strategy for subjectively interpreting data to generate theory by condensing, coding, categorizing, and theming data (Mayring, 2004). Both methods should be conducted in multiple iterations and by multiple researchers to avoid biased interpretations (Gioia et al., 2013; Mayring, 2004). Interpretive studies can generalize their results in four ways: the generalization of concepts, relating multiple concepts in a framework or theory, presenting specific implications in particu-

lar contexts, and providing "rich insights" with broad implications (Walsham, 1995a).

Another increasingly popular inductive research strategy in IS and related disciplines involves Big Data Analytics (BDA) techniques which concern data-driven research based on analyzing vast amounts of unstructured data (Müller, Junglas, vom Brocke, et al., 2016). Researchers can conduct explanatory or predictive studies (Müller, Junglas, vom Brocke, et al., 2016) to, e.g., conduct topic modeling (e.g., Antons and Breidbach, 2018; Amado et al., 2018; Debortoli et al., 2016), and content analysis (e.g., Lee et al., 2020; Amado et al., 2018) to develop theory (Berente et al., 2019), or to explicitly generate business value (Müller, Junglas, Debortoli, et al., 2016). Both types of inquiry are based on a new generation of BDA tools that enable the data-driven, inductive, real-time analysis of a phenomenon of interest and generate probabilistic results (Müller, Junglas, Debortoli, et al., 2016), which have to be triangulated with other data, however, as part of the data interpretation (Müller, Junglas, vom Brocke, et al., 2016). While it can also be applied to test theory, BDA provides an interesting means for interpretive researchers to develop "computationally intensive theory" (Berente et al., 2019, p. 51). Indeed, BDA enables researchers to analyze large amounts of data that cannot be manually coded, while still adhering to general rules for automated data coding (Müller, Junglas, vom Brocke, et al., 2016; Berente et al., 2019). Assuming that naturally occurring, unbiased data (i.e., data that was not generated to be used for theory development) is available, data-driven studies can also be conducted (Müller, Junglas, vom Brocke, et al., 2016), enabling researchers to "generate richer and more accurate understandings of social life (Berente et al., 2019, p. 50). Müller, Junglas, vom Brocke, et al. (2016) outline a research process and guidelines for utilizing BDA in IS with four iterative phases. In the initial phase, a research question is developed that aligns with the study's intention (exploratory vs. predictive). In the data collection phase, valid and reliable data are acquired, and the research process is justified and documented. Data preprocessing steps are performed and documented in the data analysis phase before data are analyzed with a valid algorithm. In the last phase, the results are interpreted by triangulation with other sources of evidence and discussed against the backdrop of the current theoretical knowledge base. If applicable, the results are additionally replicated via other means and then compared (Müller, Junglas, vom Brocke, et al., 2016).

Conceptual research[9] is a non-empirical research method (Yadav, 2010; Gilson and Goldberg, 2015) which, depending on the intention and purpose of a study, can be conducted with positivism, interpretivism, or critical realism as underlying ontological assumption (Mora et al., 2008). Conceptual research aims to develop an agreed-upon meaning (van der Waldt, 2020) that reflects social reality as it is constructed by humans (Mora et al., 2008). Inherently, any conceptual research process integrates current theory and checks its representational power concerning a real-world phenomenon (Meredith, 1993). It reflects on and enhances existing theoretical knowledge to understand—or improve the understanding of (Mora et al., 2008)—a concept, construct, or theory by the integration of new relationships through logical argumentation (Gilson and Goldberg, 2015). Thus, conceptual research provides a fundamental method for theory building (Jaakkola, 2020), which is often rather broad in scope and bridges currently unconnected research streams within or across domains and disciplines (Mora et al., 2008; Gilson and Goldberg, 2015). Data are only involved a priori to empirically develop and test theories and concepts that a conceptual paper draws upon (Jaakkola, 2020) and, a posteriori, to empirically verify or falsify testable propositions that can result from conceptual papers (Gilson and Goldberg, 2015). Hence, conceptual papers need to thoroughly argue how and why a particular theory or concept is integrated (Jaakkola, 2020).

According to the general academic knowledge inquiry process, theory is generated in a less-well demarcated and iterative process of knowledge discovery, i.e., theory development, and knowledge justification, i.e., theory testing (Yadav, 2010). A common weakness of conceptual research refers to the oversimplification and reductionism of complex phenomena that lead to its misrepresentation by conceptual means (van der Waldt, 2020). Hence, to make a valid contribution, any conceptual research process should be carefully planned and conducted in four abstracted steps proposed by Mora et al. (2008), involving the identification of the knowledge gap, the selection of the research method, the definition of the study's purpose, the identification and collection of data (i.e., relevant theories, concepts, constructs, and their relationships), and its analysis and synthesis (Mora et al., 2008). Its contribution is aimed at complementing or supplementing existing theory (Jaakkola, 2020). Thus, conceptual research methods can produce four different types of outcomes: conceptual models, conceptual frameworks, concep-

[9] In this dissertation, conceptual research is understood as what Mora et al. (2008) refer to as *conceptual behavioral research* while *conceptual design research* (Mora et al., 2008) is interpreted as a constituent part of DSR.

tual systems, or theory—of increasing explanatory power in this order (Meredith, 1993).

3.3 Research Approach

The research approach is informed, first and foremost, by Hevner et al.'s (2004) IS research framework, which conceptualizes theory development in IS as iterative cycles of design science and behavioral science research, and by their stipulation that the holistic study of IS phenomena should be conducted with research methods drawn from different research paradigms. In this regard, the view that "methodological monism" (Jones, 2019) might not suffice for the investigation of complex phenomena in their real-world context has spread in the IS community in the last two decades.

DSST is described as a complex evolutionary process of the digital transformation of socio-technical service systems. Thus, a holistic perspective is needed to comprehensively study the prospects, limitations, and consequences of design in DSST, and to account for the real-world complexity when investigating DSST in specific contexts. Given the aim to constitute a comprehensive investigation to gain complementary knowledge on DSST, a pluralistic view is taken, combining a diverse range of paradigms and methodologies (Bhaskar, 1978; Bhaskar, 1979; Archer et al., 2013). While different views on pluralism can be identified among IS researchers, this dissertation is in line with the view of those who "strive to be trans-paradigmatic, routinely combining philosophically distinct research methods" (Mingers, 2004, p. 295).

In line with a pluralist view, the behavioral and the DSR paradigms are combined to enable the abductive investigation of DSST. Applying DSR methods enables develop/build cycles with which to design innovative IT artifacts for the DSST in high street retail, and digitally transform high streets into socio-technical service ecosystems. Moreover, it enables the observation of the direct consequences of design in high street ecosystems and to relate these consequences to design decisions, making desired outcomes more likely to occur than undesired ones. However, based on a pragmatist epistemology, DSR research can solely design IT artifacts that are currently efficient, but cannot be used to reflect on the long-term consequences of the design decision. Hence, behavioral research is needed to

complement the results of DSR studies in the justify/evaluate cycle, by investigating how IT artifacts in DSST are appropriated in organizational contexts, and to examine their long-term consequences. Besides analyzing isolated phenomena in positivist research, interpretivism is of particular importance because many phenomena related to DSST are relatively new. Hence, interpretivist research methods can be employed to help explain these new phenomena to be observed in the real-world before they are inductively explained in the context of the current knowledge base. In this regard, interpretivism allows to observe emergent behavior in DSST over the long-term, to analyze how and why actors behave in a particular way, and how and why the behavior is reproduced in organizational contexts.

Consequently, critical realism is applied as a meta-theoretical standpoint and, hence, a realist ontology because critical realism "acknowledges the conjoint existence of the objective and subjective dimensions" (Mingers and Brocklesby, 1997, p. 497). Critical realism allows researchers to design multi-paradigm and multi-method research strategies (Mingers and Brocklesby, 1997). Mingers and Brocklesby (1997) explain why researchers can benefit from such an approach and underline that the holistic understanding of a phenomenon requires the application of diverse research methods from different paradigms[10]. Content-wise, a realist ontology allows to anticipate emergent change in response to the implementation of digital technology in service systems because it can take into account events that have not yet occurred but might do so in the future. Thus it enables the description of causal mechanisms of design and emergent change in DSST that would otherwise remain undiscovered.

> "Adopting a particular paradigm is like viewing the world through a particular instrument [...]. Thus, in adopting only one paradigm one is inevitably gaining only a limited view of the problem situation [...]. This argument is a strong one in support of multimethodology, suggesting that it is *always* wise to utilize a variety of paradigms." (Mingers and Brocklesby, 1997, p. 492–493)

Accordingly, to examine both structure and agency (Giddens, 1984) in the DSST, the research design in this dissertation is informed by a pluralist, a multi-paradigm, and a multi-method approach (Mingers, 2001; Mingers et al., 2013;

[10] Beyond a content-wise argument, Myers (2011) argues that socialization in and the application of plurality of research methods is a desirable goal for any Ph.D. student.

Venkatesh et al., 2013). Based on the assumption that the complex nature of DSST is best understood by triangulating multiple and diverse paradigms and methods rooted in, respectively, a pragmatic, a positivist, and an interpretivist epistemology, a combination of research methods is applied (Lee, 1989; Mingers and Brocklesby, 1997). Thereby, the advantages of pragmatism, on the one hand, and interpretivism and positivism, on the other, are combined. A pragmatic study allows to investigate how the implementation of efficient technology can trigger change, while interpretivism and positivism help to generate understanding of structural and emergent change in service systems (Goldkuhl, 2012).

The research design of a study represents its logic and reflects on the researcher's decisions about how a particular research goal can be achieved via combining appropriate theories, research methods, and research questions (Flick, 2018). Methodologies from different paradigms tend to support specific situations more than others (Mingers and Brocklesby, 1997), such that particular research methods need to be chosen with high caution. By embracing a critical realist ontology, the papers in Part B draw on a variety of research methods from various paradigms. Furthermore, the two-fold research design follows *the fundamental principle of the hermeneutic circle* (Klein and Myers, 1999), which "suggests that we come to understand a complex whole from preconceptions about the meanings of its parts and their interrelation" (Klein and Myers, 1999, p. 71).

In pursue of RO1, publication P1 is based on an interpretivist epistemology and applies a data-driven method for theory development (Müller, Junglas, vom Brocke, et al., 2016; Berente et al., 2019), while publications P2–P6 are based on a pragmatic epistemology and methodology and apply DSR methods. P2, and P3 apply the DSRM (Peffers et al., 2007) to design and evaluate digital platforms as IT artifacts. P4 employs a conceptual modeling method to develop a domain-specific modeling language (DSML) (Frank, 2013) and P5 performs selected phases of the BPM lifecycle (Dumas et al., 2018) to design process models for governance processes. The ADR method (Sein et al., 2011) guides the design and evaluation of a digital actor engagement platform in P6.

To examine RO2, P7, P8, and P11 draw upon an interpretivist epistemology and methodology while P9 and P10 are based on a positivist epistemology. In P7, a qualitative empirical research design is performed inductively, inspired by grounded theory (Glaser and Strauss, 1967). An interpretive, multiple case study (Walsham, 1995a) that is based on a literal replication logic is conducted in

P8. Publication P9 is based on a deductive qualitative study in which hypotheses are derived from the theoretical knowledge base (Kaplan and Maxwell, 1994). In P10 a randomized field experiment is conducted (Harrison and List, 2004) to test hypotheses derived from the literature. In publication P11, a conceptual behavioral research method (Mora et al., 2008) is applied to bridge disintegrated research streams in service research.

Approaching RO3, publications P12 and P13 both draw on an interpretivist epistemology and methodology. In publication P12, a single revelatory case study is performed inductively to enable in-depth exploration of a contemporary phenomenon (Walsham, 1995a), while in publication P13 conceptual behavioral research is conducted to discuss future research perspectives for the BPM discipline.

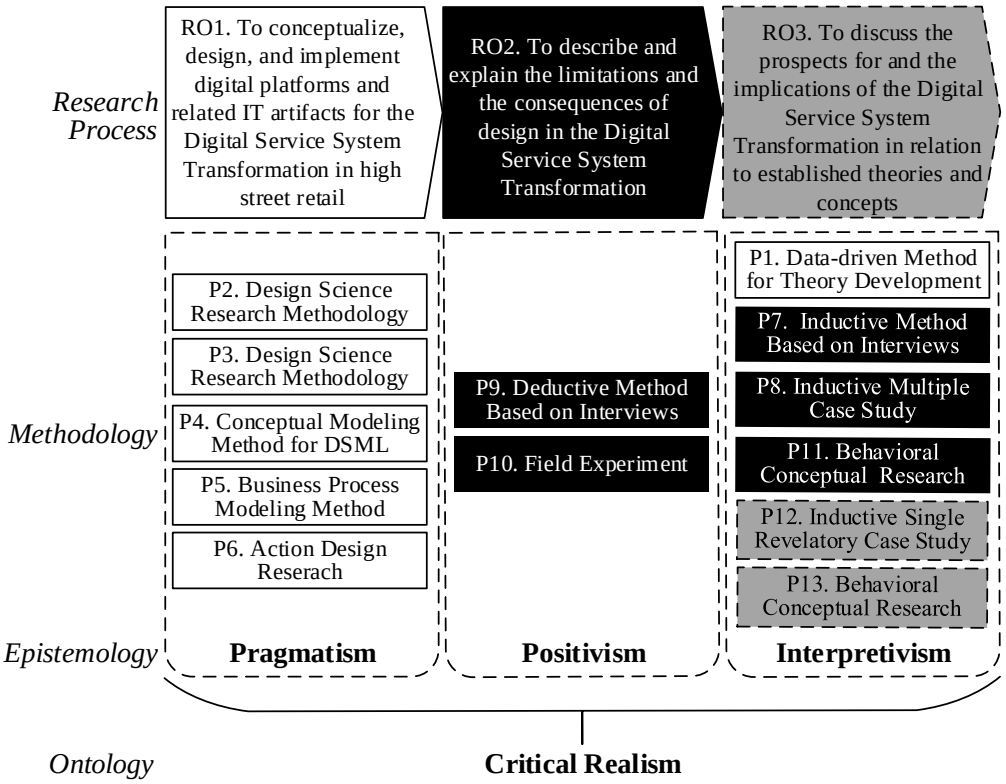

Figure 3.5: Philosophical Assumptions and Research Design.

The research design framework (see Figure 3.5) depicts the research process. Furthermore, it outlines the ontological, epistemological, and methodological positioning of the parts (epistemology; methodology) and as a whole (ontology). In this regard, the contributions made on the conceptual, descriptive, and prescrip-

tive level (Iivari, 1983) mutually constitute (i.e., refine) each other and need to be considered equally as valuable and self-contained contributions and overall composition.

The multi-paradigm and multi-method research design is aimed at providing a comprehensive study of DSST. The research process allows to develop type one theory for analysis, type two theory for explaining, and type five theory for design and action (Gregor, 2006). Because we cannot predict the unpredictable (i.e., emerging technological innovation and actors' behaviors in socio-technical service systems), these theory types seem particularly appropriate to provide relevant insights and shape the DSST from an IS perspective. However, the development of type three theory for predicting and type four theory for explaining and predicting are explicitly excluded. Type five theory for design and action provides theoretical contributions that enable IS researchers to gain insights on how IT artifacts for the DSST in high street retail ought to be designed. The development of type one theory for analyzing and type two theory for explaining is aimed at providing an in-depth investigation of the limitations and consequences of design, based on understanding structural and emergent change in socio-technical service systems.

4 Results and Contribution

4.1 Synopsis and Discussion of Findings

The most effective way to narrow down complex (design) problems is their *decomposition* (Alexander, 1964; Simon, 1996). *Near decomposition* describes how a given hierarchical structure can be sliced into functional parts by separating the underlying structures[11] (Simon, 1996). The resulting subsets are deemed to have both maximum inner meaningfulness and minimum interdependency because "the fewer links there are between the major subsets of the decomposition, the better" (Alexander, 1964, p. 124). While there is no one correct solution to the decomposition of functional components, because suitable solutions can be arrived at via various alternative routes (Simon, 1996), it has been argued, however that "for every problem, there is one decomposition which is especially proper to it" (Alexander, 1964, p. 83). Consequently, designing solutions for the subsets of a problem (i.e., subsystems) only helps if the subsets are carefully chosen in light of the underlying goals. Even though a system can be carefully decomposed, neglecting or underemphasizing the relationships between the decomposed parts (i.e., subsystems) can prove to be problematic. Nevertheless, decomposition is still the best approach to finding solutions to complex (design) problems.

Socio-Technical Theory (STT) (on its introduction in IS see Bostrom and Heinen, 1977a; Bostrom and Heinen, 1977b) provides the theoretical foundations that enable scholars to investigate the interactions between social and technical systems in organizations (Bostrom et al., 2009). These subsystems constitute organizations as socio-technical systems (Emery, 1959). However, only joint interactions between the subsystems allow socio-technical systems to transform inputs into desired outputs and, thereby, create value (Bostrom and Heinen, 1977a). Hence, "any

[11] According to Simon (1996), hierarchical structures will always outperform non-hierarchical structures in the long-term due to their superior speed of evolution. Hence, it is assumed that any complex system has a hierarchical structure.

design or redesign of a work system must deal with both systems in an integrated form" (Bostrom and Heinen, 1977a, p. 17–18).

Decomposing organizations as STS, comprising a technical and a social subsystem, provides a suitable functional decomposition of organizations to study the DSST[12]. In this regard, the adaptation of an IT artifact's form and function can be described as the technical subsystem's adaptation, and the changes in actors' behaviors as the social subsystem's adaptation. While decomposing organizations into STS has the advantage of enabling each subsystem's semi-independent adaptation, it can lead to one subsystem being overemphasized over another, which negatively impacts the system's overall performance. However, applying STS as a theoretical framework to the study of DSST seems appropriate and "offer[s] a potential solution for the need in IS for more integrated theories" (Bostrom and Heinen, 1977a, p. 18).

As DSST is concerned with socio-technical system change that is subject to contingency (Luhmann, 1995), changes "can only—if ever—be understood afterward and not in advance" (Fischer and Herrmann, 2011, p. 2). Consequently, the degree to which DSR initiatives can anticipate changes and develop IT artifacts that support organizations transforming into digital service system providers in specific contexts is naturally constrained to the degree to which the design of any STS is limited. However, it also becomes apparent that, although the DSST cannot be designed holistically in a planned manner in any specific context, understanding emergent behavior can reduce uncertainty and mitigate against undesired outcomes in the short- and the long-term. This is highly relevant because most of a design problem's complexity stems from high uncertainty of the problem space and the multiplicity of possible solution paths (Simon, 1996).

All the papers depicted in Figure 4.1 were published in a peer-reviewed IS outlet, and have therefore been assessed as making a valid contribution to the IS knowledge base[13]. Hence, the contributions of each paper in Part B are subsequently outlined and their positioning in the STS model (Figure 4.1) is justified—organized

[12] Indeed, organizational structure can be decomposed differently (e.g., by functional areas, departments, business processes). However, none of these possible decompositions seem to provide better subsets to the study of Digital Service System Transformation.

[13] While most of the papers are uniquely positioned in the model due to representational aspects, P6 and P8 deviate from this conception because of their holistic perspective on digitally transforming service systems. However, many of the papers address more than one of the relationships and elements within socio-technical systems.

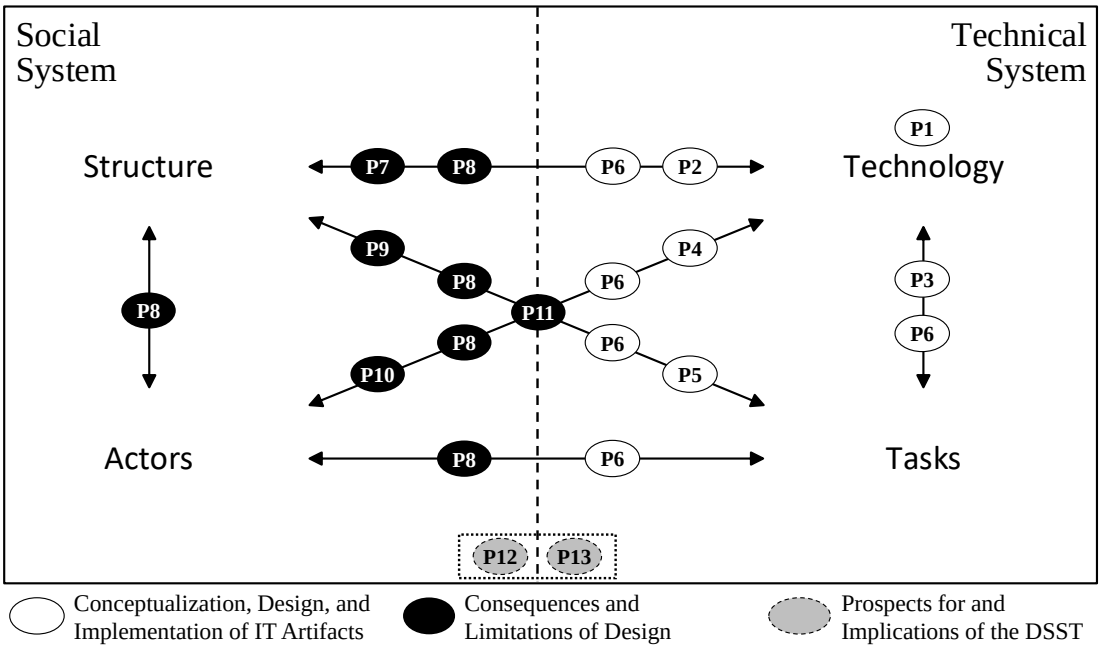

Figure 4.1: Synopsis of Findings in a Decomposed Socio-Technical System Model.

by the dissertation's three interrelated research objectives. Furthermore, selected aspects concerning the prospects, consequences, and limitations of design in DSST are discussed in the backdrop to the seminal work on design by (Alexander, 1964) and Simon (1996).

> ***Research Objective 1.*** *To conceptualize, design, and implement digital platforms and related IT artifacts for the Digital Service System Transformation in high street retail.*

In IS research, the investigation of (digital) platforms is undertaken from two major perspectives: an economic/social perspective and an engineering/technical perspective. These inherently opposing perspectives cause an ambiguous use of the term *platform* that calls for its conceptual clarification. Publication *P1. Systematizing the Lexicon of Platforms in Information Systems: A Data-Driven Study*, addresses this issue and provides much-needed conceptual clarification of the term *platform* in the IS literature. Employing an inductive, data-driven research approach (Müller, Junglas, vom Brocke, et al., 2016) enabled the identification and analysis of 95 % of all papers (11,049 in total) ever published in the IS discipline concerning platforms. This inclusiveness afforded unique insights that systematize the current knowledge base on platforms. The four unique data-driven

insights derived from the comprehensive analysis provided the basis for the development of a conceptual framework that offers an empirical grounding for past and future research in IS concerning platforms. First, in the IS literature, platform economics and online communities are currently separate research strands. Second, the *service* concept can be used to bridge this conceptual gap. Third, in the technical realm of platform research, digital platforms as IT artifacts feature a modular technology stack, which the IS literature has subdivided into three layers: technological infrastructure, programming and execution environment, and software and application system architectures. Fourth, the technical research strands in IS are disconnected from the economic research strands, which inhibits the ability to relate design decisions to the observed consequences of applying platforms in context, and, vice versa, and conceals new demands that the continually changing context places on platforms as IT artifacts. Finally, DSR is identified as a research paradigm that embraces the needed duality between IT artifacts and context, at the same time as providing adequate methods with which to enhance our knowledge on the relationships and the mechanism that underpin DSST.

P1 unveils that design-oriented research provides a substantially needed perspective in the IS discipline. The main argument is that our discipline deals with the design of artificial objects situated in an organizational context (i.e., IT artifacts) and related phenomena. Because artificial artifacts cannot be found in the natural world, the research paradigms employed in natural or social sciences are only partially suited for their investigation (Simon, 1996; Alexander, 1964). As Simon (1996, p. 114) has argued, "the natural sciences are concerned with how things are. [...] Design, on the other hand, is concerned with how things ought to be, with devising artifacts to attain goals." Both world-views are two sides of the same coin since they enable academia—and, in particular, IS researchers—to obtain descriptive and prescriptive/normative knowledge that provides valuable insights that enhance our understanding of the world. However, the research methods used in IS to investigate social phenomena, and which generate descriptive knowledge, can also investigate the consequences of using technology as an IT artifact. Nevertheless, they cannot relate these consequences to design decisions made earlier due to the perception of IT artifacts as "given," which leads to black-boxing its peculiarities in IS studies (Majchrzak et al., 2016). Thus, while purely descriptive knowledge enables scholars to describe and explain particular phenomena it does not help them decide which relations between form and context to choose

if confronted with a design problem with multiple options (Alexander, 1964). In contrast, IT artifacts resulting from DSR studies can subsequently be accessed and studied by behavioral research. Vice versa, DSR is postulated to build upon descriptive knowledge for the design of IT artifacts (March and Smith, 1995). Moreover, DSR develops IT artifacts that pursue artificial (human-constructed) goals that change over time, the resulting IT artifacts are short-lived and need to be theorized and justified by abstracting and continuously reassessing the abstracted design knowledge added to the literature.

Publications *P2. Designing Multi-sided Community Platforms for Local High Street Retail* and *P3. Designing Digital Community Service Platforms for Crowd-Based Services in Urban Areas* both pursue the dual mission of DSR (Sein et al., 2011) and describe the development and evaluation of digital platforms as IT artifacts (March and Smith, 1995) in the context of high street ecosystems. The design knowledge derived from these papers is subsequently abstracted and theorized by postulating eight components of a nascent IS design theory (Gregor and Jones, 2007). P2 outlines an IS design theory for multi-sided community platforms for local high street retail as a new class of IT artifacts to facilitate the co-creation of online-offline customer experience in high streets by enabling digital interactions to take place between groups of retailers, on the one hand, and groups of customers, on the other. The results show that multi-sided digital community platforms are able to support high street retail by helping them build a virtual community on an ecosystem level that complements the physical ecosystem. In this regard, digital platforms allow high street ecosystems to develop into hybrid online-offline communities to better meet current customer demands. Because the IT artifact alters the structure of the socio-technical system by adding digital touchpoints to the servicescape, the paper is positioned at the technology-structure relation in the technical subsystem. P3 sketches a design theory for digital community service platforms as a new class of IT artifacts that is aimed at strengthening the sense of (digital) community in high street ecosystems among all stakeholders by connecting sourcers and workers that are voluntarily fulfilling micro tasks for each other. Hence, this paper refers to the interrelation between technology and tasks in the technical subsystem. The results indicate that digital platforms can be harnessed by high street ecosystems to facilitate both virtual and physical interactions among different groups of actors. The greater the extent and the quality of

interactions, the higher the participation among actors, which in turn improves the quality of life and relationships in urban neighborhoods.

Publications *P4. Data-driven Customer Journey Mapping in Local High Streets: A Domain-Specific Modeling Language* and *P.5 Governance of Platform Ecosystems—Designing Understandable Processes for Digital High Street Retail* are both concerned with designing IT artifacts related to digital platforms in the context of high street ecosystems. In P4, a High Street Journey Modeling Language (HSJML) was developed to depict online-offline customer journeys in high streets to understand customer behavior better, capitalizing on the massive amount of data generated by employing digital platforms in high streets. The resulting customer journey models visualize information about high street journeys and can be mapped, analyzed, and prescribed to facilitate resource integration activities among customers and retailers to co-create a better customer experience. Hence, this publication is positioned at the intersection between technology in the technical subsystem and actors in the social subsystem. The IT artifacts developed in P5 aim to decrease the inherent complexity of digitalized high street ecosystems for its actors, and at the same time, they represent understandable governance processes that support actors in pursuing DSST in high street retail. The process models focus on understandability because high street ecosystem actors are generally not supportive of BPM. The results underline the importance of BPM for governing hybrid digital and physical ecosystems and, at the same time, explain how BPM can be employed for this purpose. Publication P5 structures the relationship between tasks in a technical subsystem and the structure of a social subsystem.

The ever-increasing complexity of design problems in DSST impedes the ability to comprehensively describe the problem space for IT artifact development. The only viable way to gain design knowledge is to consider a limited set of requirements to prevent the most critical outcomes (Alexander, 1964). Hence any design process is an abstracted substitute for trial and error in the real-world because the latter is too expensive and too slow (Alexander, 1964). To solve complex design problems, DSR research methods are intended to support scholars in defining requirements and building associations to narrow down complex problems, to describe a desired future state, and subsequently prescribe particular action paths resulting in this desired state (Simon, 1996). As P2 and P3 show, abstracting design problems enables IS researchers to develop digital platforms as IT artifacts that constitute a significant piece in the jigsaw of the DSST in high street retail. In response to

the increasing complexity of online-offline ecosystems, consisting of networks of socio-technical service systems, IS research can counteract this development by designing and implementing related IT artifacts (e.g., P4, P5) which constrain and enable actors' behavior in DSST in a desired way.

In publication *P6. Designing Digital Actor Engagement Platforms for Local High Streets: An Action Design Research Study*, an ADR study is conducted in which a digital platform for high street ecosystems is developed to facilitate actor engagement through iterative interventions in the real-world context. Thus, this publication refers to all relations within a technical subsystem of a socio-technical system. In this paper, the designed IT artifact is iteratively evaluated for a good fit with its context and subsequently theorized to add prescriptive design knowledge to the IS literature. It became apparent that digital actor engagement platforms that provide LBA via Bluetooth Low Energy (BLE) beacons can foster actor engagement in high street ecosystems. Simultaneously, privacy concerns seem to have a strong impact on actors' willingness to integrate resources via digital platforms that provide LBA. Thus, the paper's results reveal that a good fit with requirements that were determined a priori from an IT artifact's context and the scientific literature, and its actual fit once implemented in context, are two distinct issues, which require separate solutions. On the one hand, we were able to design an IT artifact's form and function that fits well with the imposed requirements obtained from its context and proved its usefulness in the first two iterations of the ADR cycles when applied to almost real-world contexts (Venable et al., 2016). On the other hand, once employed in its natural context, the IT artifact only partially fulfilled the ultimate goal of fostering actor engagement due to demands inherent to the context which, from a designer's perspective, were unknowable beforehand.

Indeed, IS researchers can only ever directly impact an IT artifact's form and function, not its context, which is "that part of the world which puts demands on this form [and function]; anything in the world that makes demands of the form [and function] is context" (Alexander, 1964, p. 19). Abstracting design problems from real-world complexity comes at the cost of pitfalls that might impede its real-world fit. The biggest concern is that an IT artifact's context can never be holistically converted into problem formulation or requirements, and thus, the actual status-quo of the context and especially its evolution is always uncertain to a designer (Alexander, 1964). Hence, even when a designed IT artifact meets

the design brief and solves the design problem in the short-term, the intervention in its real-world context may have unpredictable consequences (Simon, 1996). "Under these circumstances one can never be certain that a partial sequence of actions that accomplishes certain goals can be augmented to provide a solution that satisfies all the conditions and attains all the goals (even though they be satisficing[14] goals) of the problem" (Simon, 1996, p. 124). However, even though this nexus is well-known by DSR researchers, some misfits that occur between an IT artifact's form and function and its context do not provide ad-hoc feedback to a designer and can only be observed in the long-term (Simon, 1996). Being aware of this fact reveals that the fit between an IT artifact and its context in DSST cannot be evaluated holistically and ad-hoc, but needs to include feedback from the social subsystem and the overall socio-technical system. Hence, DSST can only be achieved when investigated in longitudinal projects and corresponding studies that incorporate iterative phases of design, intervention, and feedback. Accordingly, interdisciplinary and intradisciplinary studies and, in particular, ADR seem to provide the most suitable research approaches in IS that account for the nature of DSST. However, publications P1–P6 revealed the existence of design constraints inherent in DSST which, when left ignored, can result in unintended and undesired consequences. Hence, it is necessary to investigate the limitations and consequences of design in DSST.

> ***Research Objective 2.*** *To describe and explain the limitations and the consequences of design in the Digital Service System Transformation.*

The DSST can be described as the digitalization of socio-technical work systems (Alter, 2002). In publication *P7. Digitalization of Work Systems—An Organizational Routines' Perspective*, a qualitative study is conducted that investigates how digital technology holistically transforms organizations as socio-technical work systems. Organizational routines are taken as a theoretical micro-level lens to study the dynamics of endogenous change in employees' daily work practices. Four reoccurring patterns were identified that illustrate how the interplay between the ostensive and performative aspects of organizational routines and IT artifacts constitute the digitalization of work systems: *dissemination and technology push, dissemination and demand pull, diffusion and technology push, diffusion*

[14] The term *satisficing* was introduced by Simon (1956) for decision situations in which a system is confronted with multiple goals but cannot determine an *optimal* path and thus employs "a choice mechanism that will lead it to pursue, a "satisficing" path, a path that will permit satisfaction at some specified level of all of its needs"(Simon, 1956, p. 136).

and demand pull. The patterns reveal a mutually constitutive relationship between IT artifacts that are disseminated in organizational routines (ostensive aspects) or diffused in organizational routines (performative aspects), thus transforming work systems triggered by either a technology-push or a demand-pull. Referring to the paper's results, DSST can be triggered either by the implementation of IT artifacts, or by the emerging use of digital technology by actors, which induces the digitalization of a work system. This publication is thus positioned at the intersection between the structural element in the social subsystem, represented in this paper by organizational routines, and technology in the technical subsystem.

P7 explains that DSST is not only triggered by the design and implementation of IT artifacts that aim to enable and constrain actors' routines. Rather, with the proliferating and ubiquitous use of digital technology, which profoundly transforms actors' lives both at work and in the private sphere, employees often demand to use digital technology at work, too. Consequently, employees will use digital technology in specific instances of their daily work (e.g., smartphones, cloud services), even if their organization does not provide it. Hence, the difficulty arises that if ICT design projects are initiated and realized, their development would often be undertaken without awareness of the organizational routines that have emerged from employees' actual work practices. Moreover, actors' behavior in a social subsystem can also impose new demands on IT artifacts in the technical subsystem over time. The observed behavior of actors often deviates from expected behavior. Consequently, DSR studies can only strive to design mutable IT artifacts (Gregor and Jones, 2007) that can both enable and constrain actors' routines (Beverungen, 2014). These artifacts should then be redesigned in flexible and agile processes to adapt to actors' emerging behavior.

Publication *P8. Workarounds as Generative Mechanisms for Restructuring and Redesigning Organizations—Insights from a Multiple Case Study*, enlarges the analysis of the consequences and the limitations of design in DSST. In particular, this study focuses on how human agency—which inherently enables humans to "do otherwise" (Giddens, 1984)—leads employees to implement workarounds as a response to perceived misfits in a socio-technical system. In this paper, a multiple case study is performed that obtains three different types of misfits—technological, strategic, and organizational—that cause the implementation of workarounds by individual actors, altering their organizational routines to overcome obstacles to accomplish their daily work. These workarounds diffuse in a

socio-technical system through communication and observation. A conceptual framework depicting the *Gordian Knot* of workaround diffusion in organizations describes how workarounds restructure and redesign organizations. If a misfit occurs, workarounds can re-balance organizational routines and IT artifacts, and either provide a temporary fix or are turned into official work practices. Moreover, if accumulated, they can trigger the innovation of processes and IT artifacts to solve the underlying misfits. Hence, workarounds caused by severe misfits have the potential of not only causing changes to be made to an IT artifact's form and function (or even to its entire redesign), but also to reorganize the organizational structure, both of which constituting the technical subsystem. Because of its holistic view on emergent change in social-technical systems, this publication is positioned at all relations within the social subsystem of a socio-technical system.

IT artifacts (March and Smith, 1995) are employed in an organizational context, amongst others, in light of goals and cultural aspects that are, by definition, artificial. We can observe that the technical subsystem's adaption through the (re-)design of IT artifacts causes first-order effects (ad-hoc observable in the technical subsystem) and second- and higher-order effects (long-term effects observable as an additive change in the social subsystem; Mulder, 2013; Simon, 1996). In organizations, long-term additive change "only becomes significant at that moment when a failure or misfit reaches critical importance — at that moment when it is recognized, and people feel the form [of an IT artifact] has something wrong with it" (Alexander, 1964, p. 44). In response, actors implement workarounds that alter their routines to cope with the misfits. Subsequently, actors' changing behavior alters an IT artifact's context and puts new demands on its form and function (Leonardi, 2011). While these indirect effects are hard to predict, they might have serious consequences (Mulder, 2013) because "there seems to be a freedom provided by the new technology to seek new ways of behaving. This new freedom may make a planned social system change possible" (Bostrom and Heinen, 1977a, p. 27). While it is impossible to predict all the potential misfits in a DSR project, major misfits on the overall system's level, however, will always lead to change, while a good fit between an IT artifact's form and function and its context will not (Alexander, 1964). Consequently, to reach a sustainable equilibrium between IT artifact and context for a good fit, an IT artifact's form and function must be adapted faster than its context is able to change (Simon, 1996).

Publications *P9. The Impact of Process Automation on Manufacturers' Long-Term Knowledge* and *P10. Quantifying the Impact of Geo-Spatial Recommendations: A Field Experiment in High Street Retail* both investigate the consequences of the DSST. Publication P9 describes a qualitative study which was performed to analyze the effects of automation in manufacturing enabled by digitalization. The analysis reveals that the (partial) automation of a manufacturing service system (especially where tasks or whole processes are outsourced) requires new structures in the social subsystem to be implemented in order to update the knowledge base needed for future service innovation. In publication P10, a field experiment is conducted in order to quantify the impact of geo-spatial recommendations on actors' behavior in high street ecosystems. The results show that data-driven value propositions enabled by digital technology can positively impact the actors' perceived value-in-use of integrating resources (e.g., integrating location data to enable location-based services) in value co-creation processes in high street ecosystems. However, the results further suggest that there are design limitations because it is not possible to anticipate actors' behaviors in response to digital technology, which means that the success of the latter is highly contingent on context.

Organizations have to continuously adapt to their environment, whether it is changing markets or customer needs. In this effort, they need to measure the fit (in terms of impact) of their IT artifacts with their inner and outer environment (Simon, 1996). IT artifacts can be designed to act as an interface between different system components (inner environment) or to act as an interface to external entities (outer environment). In most cases, the IT artifact's form and function will directly impact human behavior, and thus human behavior itself is aligning with the complexity of a given IT artifact in the long-term (Simon, 1996). Hence, employing IT artifacts that lower complexity for humans (P9) might impede the ability of humans to cope with future complexity and, vice versa, to employ IT artifacts that increase complexity for humans (P10) might cause complex behavior that induces new (design) problems. Simon (1996, p. 53) explains that "human beings, viewed as behaving systems, are quite simple. The apparent complexity of our behavior over time is largely a reflection of the complexity of the environment in which we find ourselves."

Publication *P11. Conceptualizing Task-Technology Fit for Technology-Pervaded Value Co-Creation* was inspired by calls in IS and service research for deconstructing the relationship between technology and value co-creation processes (Ostrom

et al., 2015; Barrett et al., 2015; Böhmann et al., 2014) and conceptualizes value co-creation processes in the DSST, considering and combining all elements of a socio-technical system. The paper approaches this goal by designing a conceptual task-technology fit model that holistically depicts technology-pervaded value co-creation processes in service systems. The model suggests that such processes involve actors performing single tasks of technology-pervaded resource integration activities while being impacted by a service system's structure. In this regard, P11 is positioned at the heart of the socio-technical service system, involving all of its elements in a conceptual model. The model can be instantiated in any context to depict a specific DSST project and to understand the nature of resource integration processes in a particular service system.

Publication P11 unveils that DSST can be framed as a complex (design) problem that first needs to be fully understood before a solution can be found. Following (Simon, 1996, p. 132), "solving a problem simply means representing it so as to make the solution transparent." Finding suitable representations for a problem is one of the most critical steps to solve this problem subsequently. The question of whether or not the representation is initially both complete and correct is not of crucial importance because "even though our classification is incomplete, we are beginning to build a theory of the properties of these representations" (Simon, 1996, p. 134). Moreover, a first conceptual representation of a problem and/or of its solution provides a basis for empirical investigation and for the further refinement and redesign of the single components in a semi-independent way (Simon, 1996). Hence, in order to grasp the full complexity of DSST—and avoid any issues arising from failing to do so—it is imperative to find representations that can capture DSST holistically. In this regard, the question arises if all of the existing theories and concepts in the IS knowledge base are still appropriate to represent and examine transformative digital phenomena observed in the DSST or if they need to be revisited and updated.

> ***Research Objective 3.*** *To discuss the prospects for and the implications of the Digital Service System Transformation in relation to established theories and concepts.*

The DSST is currently ongoing and will, over time, transform organizations both comprehensively and sustainably. This entails opportunities and challenges for both management and research. In publication *P12. Establishing Smart Service Sys-*

tems is a Challenge: A Case Study on Pitfalls and Implications, a single case study is conducted which reveals that practitioners still struggle to develop and manage digital service systems due to several pitfalls that hamper a fully successful DSST. P12 suggest that, on the one hand, established structures, and deeply rooted product-centered thinking and acting lead to organizations not holistically transforming a socio-technical system but often solely transforming the technical subsystem. On the other hand, weak methodological support from academia and limited awareness and relevance of existing methods inhibit the successful accomplishment of DSST in practice.

Regarding design problems in an organizational context, designers are faced with the particular pitfall that any design problem reflects, or responds to real-world complexity and, thus, a potentially infinite set of requirements (Alexander, 1964). Hence, not all of a problem's context can be holistically understood and targeted in the design process. This issue is faced by the problem abstraction that "turn[s] to procedures that find good enough answers to questions whose best answers are unknowable" (Simon, 1996, p. 28). Moreover, applying design projects to a real-world context comes with an inherent bias, comprising two facets. First, a designer's limited ability to describe and understand the interplay between IT artifacts in the technical subsystem and the evolving structures in the social subsystem will result in formulating an unbalanced problem description (Alexander, 1964). This inability will automatically lead to overemphasizing those facets of the design problem that can best be described compared to those that are harder to describe adequately. Consequently, an IT artifact's form and function might less reflect the more critical misfits (i.e., requirements) than any minor misfits, because of the difficulty for the designer to balance a problem description decisively (Alexander, 1964). Indeed, a designer who sets out to design an IT artifact in the technical subsystem, for example, will naturally be better at describing the technical requirements of that technical subsystem than compared to those arising from the social subsystems (Alexander, 1964), including its structures and the consequences of actors' emergent behaviors. Second, the conceptualization of problems is self-perpetuating (Alexander, 1964). Thus, a transformation project that is aimed at developing an IT artifact to be implemented in the technical subsystem will unintentionally overemphasize this subsystem's requirements over those of the social subsystem, as well as over the relational requirements occurring at the intersection of these two subsystems. Both factors impede the ability to

achieve a good fit between an IT artifact's form and function and its context and thus they need to be considered jointly to accomplish DSST.

Finally, publication *P13. Seven Paradoxes of Business Process Management in a Hyper-Connected World* reflects on the implications of the DSST on BPM as a fundamental subdiscipline of IS. BPM deals with processes that align technology with operational capabilities and thus lies at the heart of DSST research. Consequently, the convergence of servitization and digitalization has a considerable impact on the concepts, theories, and artifacts in the BPM discipline. The hyper-connected world, which DSST brings about, as actors and technology interact via multiple channels, means both greater opportunities as well as increasing complexity for the BPM discipline. Publication P13 considers how four technological enablers—social computing, smart devices, big data analytics, and real-time computing—leave their mark on the discipline's potential evolutionary paths in the four dimensions of analysis, implementation, modeling, and strategy. Eleven challenges are identified and contrasted in seven paradoxes that the BPM discipline needs to resolve in future research concerning the closer integration of the strategy, modeling, implementation, and analysis of business processes. Strategic challenges refer to the increasing speed of technological advancements, managing and integrating multiple channels, considering the physical consequences of process execution and the unintended consequences that might occur due to increasing process complexity. Modeling challenges deal with advancing constructs to depict new types of artifacts and process instances and a tighter integration of processes. Implementation challenges point out the need to simplify the implementation of features in distributed systems, while preserving process variability that accounts for an increasing and a diverse number of process participants. Challenges that refer to analysis activities include employing BDA techniques to analyze data from multiple sources, interpreting the results of the analysis, and guarantee fairness, accuracy, confidentiality, and transparency of data usage. Addressing these challenges can help researchers advance the discipline's knowledge base and, at the same time, support organizations in accomplishing the DSST in specific transformation projects.

Regarding the design of artifacts, seven paradoxes that stem from the eleven challenges need to be resolved for further developing the BPM discipline. (1) Adapting the elements of social systems, in particular (2) to cope with the speed of innovativeness in technology evolution; (3) the increasing complexity of de-

sign problems (e.g., scattered and heterogeneous data); (4) the growing severity of the threat represented by currently neglected misfits; (5) increasing resource consumption due to the constant need to adapt artifacts; (6) aligning the standardization and individualization of processes by developing new IT artifacts; and (7) acknowledging the importance of relating design to its consequences, with the latter being one of the fundamental claims of this thesis.

4.2 Contribution to Research and Management

This dissertation contributes to both research and management not only with its parts but also as a whole. As a whole, it contributes to the IS literature by providing new comprehensive knowledge about how to shape the DSST with a view to it achieving positive transformational impact. Three types of theory are added: type one theory for analyzing, type two theory for explaining, and type five theory for design and action (Gregor, 2006). Figure 4.2 depicts the primary contribution to the IS knowledge base made by each of the papers—systematized by contribution types.

First, conceptual knowledge in the form of type one theory for analyzing is added to the IS knowledge base (Gregor, 2006). In particular, P1, P11, and P13 examine phenomena that are fundamental to DSST. These papers bring together currently disconnected IS research strands which impede the discipline's ability to establish consistent knowledge with which to clearly describe digital platforms, technology-pervaded value co-creation processes, and implications of DSST for BPM. P1 presents a conceptual framework that enhances the IS knowledge base on the inner structures of platform-related research in IS, "providing clear delineation of the uniformities of classes" (Gregor, 2006, p. 623). P11 conceptualizes a task-technology fit model that describes and explains technology-pervaded value co-creation processes, providing a means to comprehensively describing, prescribing, and analyzing these processes in future research in service-related IS studies. P13 analyzes the implications of transformative digital phenomena occurring in the BPM discipline as one of the key disciplines involved in the study of phenomena related to DSST, reflecting on observations made on transformative digital phenomena that emphasize the need for updating the BPM discipline's knowledge base. The results suggest that many taken-for-granted theories, constructs,

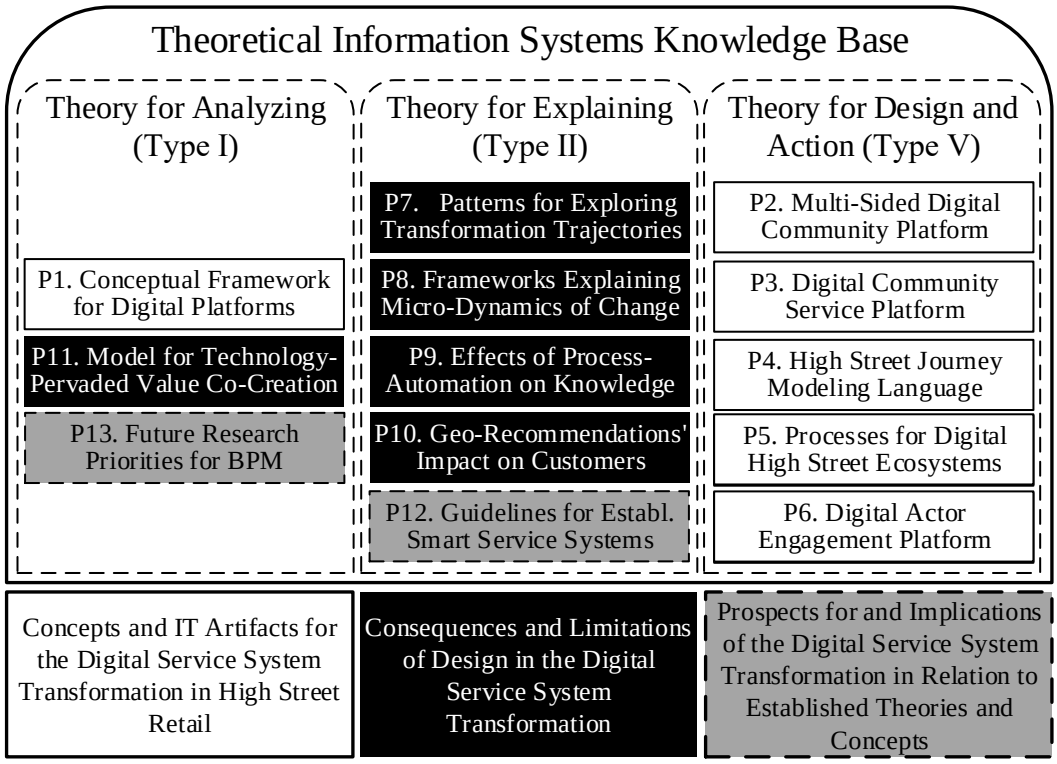

Figure 4.2: Knowledge Contribution to the Information Systems Discipline.

and concepts need to be revisited or revised, enhanced, or even withdrawn in future research. For example, the assumption that only humans can act on machines, but machines cannot act on humans is overturned by the fact that digital technology can act autonomously and is thus able to participate in value creation without human interference (cf. Demetis and Lee, 2018).

Second, as regards type two theory for explaining (Gregor, 2006), papers P7 to P10, as well as P12, develop theoretical knowledge for explaining the consequences and the limitations of design in DSST. P7 and P8 examine the micro-dynamics of technology-induced organizational change with organizational routines as a theoretical lens—emphasizing workarounds as generative mechanisms for redesigning and restructuring organizations. P9 and P10 examine the impact and consequences of digitalizing service systems on customer behavior and the organizational long-term knowledge base. P12 discusses the implications for and the consequences of DSST for research and management by postulating guidelines that reflect the pitfalls of service transformation projects that organizations currently experience. Many of the identified issues stem from shortcomings in the theoretical knowledge base, where some of the theories, methods, and constructs

lack relevance and feasibility in practice. In turn, the current shortcomings impact the future development of academic disciplines like BPM. All of the contributions mentioned above represent the second subtype of type two theory, explaining "how and why things happened in some particular real-world situation"(Gregor, 2006, p. 624).

Third, type five theory for design and action is added to the IS knowledge base (Gregor, 2006). The contributions comprise concrete instantiations of IT artifacts for the DSST in the context of high street ecosystems that were abstracted and theorized in corresponding design theories. P2, P3, and P6 all design and theorize on the phenomenon of digital platforms, particularly multi-sided digital community platforms (P2), digital community service platforms for crowd-based services (P3), and digital actor engagement platforms (P6). The latter was conducted in a prolonged ADR study. Thus, this publication does not solely present design knowledge but also contributes to the IS literature by discussing and explaining the nexus of actor engagement and digital platforms in high street ecosystems. Moreover, P4 and P5 develop type five theory for design and action concerning related IT artifacts: a modeling language for hybrid online-offline customer journeys in high streets (P4) and governance processes for digitalized high street ecosystems (P5). All the contributions in this category were peer-reviewed and hence fulfilled the criteria for type five contributions in IS, comprising "utility to a community of users, the novelty of the artifact, and the persuasiveness of claims that [the artifact] is effective" (Gregor, 2006, p. 629).

Alongside the theoretical contributions, manifold contributions providing strongly needed insights on managerial aspects of the DSST are added to the knowledge base. The design, development, evaluation, and instantiation of IT artifacts for high street retail provide different high street ecosystem stakeholders with knowledge and concrete IT artifacts to digitalize their businesses, or entire high street ecosystems. All IT artifacts presented were developed in iterative cycles of design and evaluation, continuously involving various stakeholders, as suggested by the DSR paradigm (Hevner, 2007). The principles of implementation included in the corresponding design theories (P2, P3, and P6) further enhance the contributions' managerial relevance by giving detailed advice on how to instantiate the IT artifacts in particular contexts. The high street journey modeling language (P4) and the governance processes (P5) complement the conglomerate of IT artifacts that allow practitioners to embark on and accomplish the DSST in high

street retail, engaging customers and stakeholders who deal with overarching topics (e.g., city managers).

Moreover, the insights obtained and discussed concerning the limitations and consequences of design provide further indications on how to understand and enable the organizational change that is needed when digitally transforming service systems. One of the crucial findings for managers is that the digital transformation of service systems is primarily a design problem requiring organizational change, and only secondarily requiring the development and implementation of IT artifacts. The results emphasize that it is essential to implement IT artifacts that fit with current requirements and anticipate future demands resulting from actors' behavioral changes. P7 and P8 highlight that employees represent a critical source of innovation and continuous improvement in organizations, enabling ambidextrous organizational transformation through design *and* emergence that allow organizations to adapt to changes induced by rapid technological developments continuously. To achieve such a continuous transformation, organizations must introduce management processes that empower employees to simultaneously enable radical innovation and incremental improvement. Furthermore, the contributions point out that organizations have to continuously assess and readjust their transformation paths to achieve the overall goal of digitally transforming a service system. P9 and P10 explain that the complexity of technology affects human behavior. Thus, service system transformation through digital technology is not necessarily the best course of action in any situation, because in the long-run the use of the technology might impact behavior and knowledge in undesired and irreversible ways. Additionally, P12 explicitly reflects upon current managerial requirements by outlining the pitfalls of service transformation projects and presenting guidelines that aim to support management to accomplish DSST in future endeavors. Also, this paper concludes that service transformation should not always be conducted due to uncertainty over its long-term consequences.

Conceptual knowledge can inform management on important aspects underlying transformation projects. P1 outlines the interrelated conceptual layers of platforms, relating technological characteristics to community aspects and economic effects. Thus, it supports management in developing strategies on how to establish platform-related business models successfully by relating design aspects to consequences concerning economic effects. P11 provides management with insights on how to design value creation processes that align technology with hu-

man resource integration activities. Hence, it enables practitioners to incorporate the premises of value co-creation as demands that inform the design of IT artifacts that can support these processes more effectively. Finally, enhancing our theoretical knowledge in the BPM discipline (P13) will ultimately equip management with theories, methods, models, and tools that better fit with their real-world demands and thus support them in accomplishing DSST because "to understand change, we need to understand process, and vice versa" (Mendling et al., 2020, p. 209).

4.3 Conclusion and Outlook

This dissertation follows calls in IS for comprehensive research to be undertaken on the transformative phenomena related to DSST. By applying fresh theoretical lenses to the study of DSST, it yields new perspectives (Rai, 2016) and contributes substantive insights on the prospects, limitations, and consequences of design in the DSST. The fact that design is, fundamentally, a search process (Simon, 1996; Hevner et al., 2004) accounts for, and emphasizes the view that DSST should be viewed as a movement along a continuum (Ardolino et al., 2018; Oliva and Kallenberg, 2003), with an uncertain outcome. Conceiving of DSST as an ongoing process, therefore, implies that its design can never be fully comprehensive, nor deemed entirely completed at any point in time, subject as it is to constant revision and adaptation. Instead, design in DSST is primarily concerned with preventing critical misfits that lead to undesired outcomes in the short- and long-term, thereby increasing the likelihood of achieving desirable outcomes and positive transformational impact.

In service systems, the most serious misfits appear in the interdependence between the social and technical subsystems, and thus, at an abstract level that is not fully comprehensible from a designer's perspective. In this view, the misfits—emerging from second- and higher-order changes—are not directly accessible. Additionally, any system's real-world context will always impose a potentially infinite set of requirements (Alexander, 1964), only some of which can be addressed at any point in time. Both issues imply that a balanced problem description is pertinent to the design of DSST. Hence, in order to avoid undesired outcomes, it is crucial to identify and address the most critical potential misfits from a holistic

system perspective because their number will always be limited and thus they can be summarized in a finite list of manageable requirements (Simon, 1996). In this regard, finding solutions to design problems in DSST can be understood as involving the elimination of misfits (Alexander, 1964), to enable the designer to identify these misfits and anticipate actors' potential responses to them. However, the design process itself remains a complex and almost unsolvable problem, which is subject to continuous adaption and improvement, because "we are searching for some kind of harmony between two intangibles: a form which we have not yet designed, and a context which we cannot properly describe" (Alexander, 1964, p. 26).

Researchers can draw on these results to further investigate the emergent consequences of design in DSST. Behavioral researchers, for example, could investigate second- and higher-order changes in service systems that are induced by technology. Organizational routines and workarounds provide suitable theoretical lenses with which to investigate emergent change in an organizational setting. In this regard, future research can build on the four patterns that describe endogenous change in the digital transformation of socio-technical work systems. Concatenating the patterns to describe transformation trajectories in in-depth longitudinal studies can yield new insights into the micro-dynamics of DSST. Moreover, researchers can further examine the critical role of workarounds as a source of innovation for the redesign and restructuring of organizations and, therefore, as a trigger for fundamental transformation processes. Thus, a better understanding of emergent change in DSST can be achieved.

Additionally, researchers can build on the conceptual framework for digital platforms as a basis for further empirical investigations of digital platforms in the IS discipline. DSR researchers could use it to develop IT artifacts (especially digital platforms) and enhance design knowledge that informs and supports DSST so that it can achieve a positive transformational impact, on an individual, organizational, and societal level. For example, future research could design and evaluate specific digital and smart services, and examine their impact on service ecosystems in specific contexts. Analyzing how digital platforms ought to be designed would help to build virtual and physical communities in service ecosystems.

Service researchers in the IS discipline could explore how far the service concept can bridge the currently somewhat separate research streams about

economics/community aspects and technical/engineering aspects of digital platforms. Moreover, they can build on the results to further disentangle the relationship between digital technology and service to better understand the specific properties and mechanisms of DSST. Ultimately, researchers can reflect on the need to update existing concepts, constructs, and theories in the IS literature by developing new and enhancing existing service engineering and BPM methods as well as other artifacts that account for the challenges implicit in DSST.

As both the DSR paradigm and the behavioral research paradigm constitute the IS discipline, critical realism provides researchers with an ontological perspective that allows to integrate design decisions and their consequences in a context in future research endeavors. Investigating the mutually constitutive relationship between design and emergent change is critically important for future research because the results of this dissertation emphasize that the two are inextricably linked and, together, constitute reality.

From a managerial perspective, one critical remark is highly pertinent when seen in the context of recent developments in the German retail industry, which decided to build a strategic alliance with Google to facilitate the digitalization of (high street) retail (HDE, 2020b). Applying the results of this dissertation to this context raises the question of whether it is wise for high street retailers to voluntarily transfer consumer data to one of the very hub firms that contribute to the demise of high street retail. Even though Google is not a retail company, providing them with this data could lead to a high-dependency future relationship, which is probably irreversible.

However, we can learn from history that the societal climate for innovating socio-technical systems can be either positive or negative at any given moment in time (Walton, 1979). Current discussions on the trustworthiness of socio-technical systems that employ digital technology emphasize the decisive role played by academia to generate and communicate insights on DSST that can lead to a positive societal assessment and improve DSST's social consequences. This perception can be achieved by enabling the digital transformation of service systems while avoiding undesired consequences.

The results provide an in-depth understanding of DSST and emphasize that, despite its inherent limitations, the contributions offered to the IS knowledge base can bring us one step closer to understanding the prospects and constraints of

design in the DSST. In this regard, IS research has a pivotal role to play by contributing crucial knowledge on how to shape our future in desired ways, because "although the future is not predictable in any detail, it is manageable as an aggregate phenomenon'' (Simon, 1996, p. 179).

Part B
Included Publications

1 Concepts and IT Artifacts for the Digital Service System Transformation in High Street Retail

1.1 Systematizing the Lexicon of Platforms in Information Systems: A Data-Driven Study

Title	**Systematizing the Lexicon of Platforms in Information Systems: A Data-Driven Study**	
Publication Type	Working Paper	
Publication Outlet	Paderborn University, Faculty of Business Administration and Economics	
VHB-JOURQUAL3	N/A	
Status	Published	
	Name	**Contribution**
Authors	Christian Bartelheimer Philipp zur Heiden Hedda Lüttenberg Daniel Beverungen	30% 30% 30% 10%
Full Citation	C. Bartelheimer, P. zur Heiden, H. Lüttenberg, and D. Beverungen 2021. "Systematizing the Lexicon of Platforms in Information Systems: A Data-Driven Study," *Working Paper Series, Paderborn University, Faculty of Business Administration and Economics* (No. 79)	

Table 1.1: Fact Sheet of Publication P1.

1.2 Designing Multi-Sided Community Platforms for Local High Street Retail

Title	**Designing Multi-Sided Community Platforms for Local High Street Retail**	
Publication Type	Conference Proceedings	
Publication Outlet	European Conference on Information Systems (ECIS)	
VHB-JOURQUAL3	B	
Status	Published	
	Name	**Contribution**
Authors	Christian Bartelheimer Jan H. Betzing C. Ingo Berendes Daniel Beverungen	40% 30% 20% 10%
Presentation	Christian Bartelheimer, Jan H. Betzing, C. Ingo Berendes	
Full Citation	C. Bartelheimer, J. H. Betzing, I. Berendes, and D. Beverungen 2018. "Designing Multi-sided Community Platforms for Local High Street Retail," in *Proceedings of the European Conference on Information Systems,* Paper 140	

Table 1.2: Fact Sheet of Publication P2.

1.3 Designing Digital Community Service Platforms for Crowd-Based Services in Urban Areas

Title	**Designing Digital Community Service Platforms for Crowd-Based Services in Urban Areas**	
Publication Type	Conference Proceedings	
Publication Outlet	International Conference on Design Science Research in Information Systems and Technology (DESRIST)	
VHB-JOURQUAL3	C	
Status	Published	
	Name	**Contribution**
Authors	Christian Bartelheimer Verena Wolf Nico Langhorst Florian Seegers	70% 10% 10% 10%
Presentation	Christian Bartelheimer	
Full Citation	C. Bartelheimer, V. Wolf, N. Langhorst, and F. Seegers 2020. "Designing Digital Community Service Platforms for Crowd-Based Services in Urban Areas," in *Proccedings of the 15th International Conference on Design Science Research in Information Systems and Technology*, vol. 12388, pp. 35–41. (doi: 10.1007/978-3-030-64823-7_4)	

Table 1.3: Fact Sheet of Publication P3.

1.4 Data-Driven Customer Journey Mapping in Local High Streets: A Domain-Specific Modeling Language

Title	**Data-Driven Customer Journey Mapping in Local High Streets: A Domain-Specific Modeling Language**	
Publication Type	Conference Proceedings	
Publication Outlet	International Conference on Information Systems (ICIS)	
VHB-JOURQUAL3	A	
Status	Published	
	Name	**Contribution**
Authors	C. Ingo Berendes Christian Bartelheimer Jan H. Betzing Daniel Beverungen	45% 35% 10% 10%
Presentation	Christian Bartelheimer, C. Ingo Berendes, Jan H. Betzing	
Full Citation	C. I. Berendes, C. Bartelheimer, J. H. Betzing, and D. Beverungen 2018. "Data-Driven Customer Journey Mapping in Local High Streets: A Domain-Specific Modeling Language," in *Proceedings of the 39th International Conference on Information Systems*, San Francisco, California, USA	

Table 1.4: Fact Sheet of Publication P4.

1.5 Governance of Platform Ecosystems—Designing Understandable Processes for Digital High Street Retail

Title	**Governance of Platform Ecosystems—Designing Understandable Processes for Digital High Street Retail**	
Publication Type	Conference Proceedings	
Publication Outlet	International Conference on Wirtschaftsinformatik (WI)	
VHB-JOURQUAL3	C	
Status	Published	
	Name	**Contribution**
Authors	Christian Bartelheimer Claudia Cappelli Kate Revoredo Flávia M. Santoro	70% 10% 10% 10%
Presentation	Christian Bartelheimer	
Full Citation	C. Bartelheimer, C. Cappelli, K. Revoredo, and F. M. Santoro 2020. "Governance of Platform Ecosystems—Designing Understandable Processes for Digital High Street Retail," in *Proceedings of the 15th International Conference on Wirtschaftsinformatik*, Potsdam, Germany	

Table 1.5: Fact Sheet of Publication P5.

1.6 Designing Digital Actor Engagement Platforms for Local High Streets: An Action Design Research Study

Title	**Designing Digital Actor Engagement Platforms for Local High Streets: An Action Design Research Study**	
Publication Type	Working Paper	
Publication Outlet	Paderborn University, Faculty of Business Administration and Economics	
VHB-JOURQUAL3	N/A	
Status	Published	
	Name	**Contribution**
Authors	Christian Bartelheimer	30%
	C. Ingo Berendes	30%
	Philipp zur Heiden	30%
	Daniel Beverungen	10%
Full Citation	C. Bartelheimer, C. I. Berendes, P. zur Heiden, and D. Beverungen 2021. "Designing Digital Actor Engagement Platforms for Local High Streets: An Action Design Research Study," *Working Paper Series, Paderborn University, Faculty of Business Administration and Economics* (No. 80)	

Table 1.6: Fact Sheet of Publication P6.

2 Limitations and Consequences of Design in the Digital Service System Transformation

2.1 Digitalization of Work Systems—An Organizational Routines' Perspective

Title	**Digitalization of Work Systems—An Organizational Routines' Perspective**	
Publication Type	Conference Proceedings	
Publication Outlet	Hawaii International Conference on System Sciences (HICSS)	
VHB-JOURQUAL3	C	
Status	Published	
	Name	**Contribution**
Authors	Verena Wolf Christian Bartelheimer Daniel Beverungen	45% 35% 20%
Presentation	Verena Wolf	
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*, Maui, Hawaii	

Table 2.1: Fact sheet of Publication P7.

2.2 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	N/A	
Status	Published	
	Name	**Contribution**
Authors	Verena Wolf Christian Bartelheimer Daniel Beverungen	45% 35% 20%
Full Citation	V. Wolf, C. Bartelheimer, and D. Beverungen 2020. "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 2.2: Fact Sheet of Publication P8.

2.3 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	International Conference on Information Systems (ICIS)	
VHB-JOURQUAL3	A	
Status	Published	
	Name	**Contribution**
Authors	Chris Gernreich Christian Bartelheimer Verena Wolf Christopher Prinz	30% 30% 30% 10%
Presentation	Jan H. Betzing, Christian Bartelheimer, C. Ingo Berendes	
Full Citation	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*, San Francisco, California, USA	

Table 2.3: Fact Sheet of Publication P9.

2.4 Quantifying the Impact of Geospatial Recommendations: A Field Experiment in High Street Retail

Title	**Quantifying the Impact of Geospatial Recommendations: A Field Experiment in High Street Retail**	
Publication Type	Conference Proceedings	
Publication Outlet	European Conference on Information Systems (ECIS)	
VHB-JOURQUAL3	B	
Status	Published	
	Name	**Contribution**
Authors	Jan H. Betzing Christian Bartelheimer Marco Niemann Ingo C. Berendes Daniel Beverungen	25% 25% 20% 20% 10%
Presentation	Jan H. Betzing, Christian Bartelheimer	N/A
Full Citation	J. H. Betzing, C. Bartelheimer, M. Niemann, C. I. Berendes, and D. Beverungen 2019. "Quantifying the Impact of Geospatial Recommendations: A Field Experiment in High Street Retail," in *Proceedings of the 27th European Conference on Information Systems*, Stockholm & Uppsala, Sweden	

Table 2.4: Fact Sheet of Publication P10.

2.5 Conceptualizing Task-Technology Fit for Technology-Pervaded Value Co-Creation

Title	**Conceptualizing Task-Technology Fit for Technology-Pervaded Value Co-Creation**	
Publication Type	Conference Proceedings	
Publication Outlet	European Conference on Information Systems (ECIS)	
VHB-JOURQUAL3	B	
Status	Published	
	Name	**Contribution**
Authors	Christian Bartelheimer	100%
Presentation	Christian Bartelheimer	100%
Full Citation	C. Bartelheimer 2020. "Conceptualizing Task-Technology Fit for Technology-Pervaded Value Co-Creation," in *Proceedings of the 28th European Conference on Information Systems*, Paper 49	

Table 2.5: Fact Sheet of Publication P11.

3 Prospects for and Implications of the Digital Service System Transformation

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	International Conference on Wirtschaftsinformatik (WI)	
VHB-JOURQUAL3	C	
Status	Published	
	Name	**Contribution**
Authors	Verena Wolf Alena Franke Christian Bartelheimer Daniel Beverungen	40% 30% 20% 10%
Presentation	Verena Wolf, Alena Franke	
Full Citation	V. Wolf, A. Franke, C. Bartelheimer, and D. Beverungen 2020. "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 P12.

3.2 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 Paper	
Publication Outlet	Business & Information Systems Engineering (BISE)	
VHB-JOURQUAL3	B	
Status	Published	
	Name	**Contribution**
Authors	Daniel Beverungen et al. Christian Bartelheimer	8% 4% 4%
Full Citation	D. Beverungen, J. C. A. M. 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-Río-Ortega, M. La Rosa, F. M. Santoro, A. Solti, M. Song, A. Stein, M. Stierle, and V. Wolf 2021. "Seven Paradoxes of Business Process Management in a Hyper-Connected World," *Business & Information Systems Engineering* (63), pp. 145–156. (doi: 10.1007/s12599-020-00646-z)	

Table 3.2: Fact Sheet of Publication P13.

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