Navigating the Digital Innovation Landscape:
Novel Perspectives on Digital Innovation Processes and Outcomes

Dissertation
zur Erlangung des Grades einer Doktorin der Wirtschaftswissenschaft
der Rechts- und Wirtschaftswissenschaftlichen Fakultät
der Universität Bayreuth

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Tag der mündlichen Prüfung:	*09.04.2025*

“Everything great that ever happened in this world happened first in somebody’s imagination.”
(Astrid Lindgren, 1958, from the speech held at the reception of the H C Andersen Award)

Mit dieser Dissertation blicke ich auf ein einzigartiges, bereicherndes und unvergessliches akademisches Abenteuer zurück. Mein Weg wurde durch ein dynamisches Umfeld geprägt, das viele Möglichkeiten und Glücksmomente geboten hat. Daher möchte ich die Gelegenheit nutzen Danke zu sagen:

Mein besonderer herzlicher Dank gilt meiner Doktormutter Anna Maria Oberländer sowie Maximilian Röglinger als akademischer "Co-Parent" und Björn Häckel als Wegbegleiter dieser Promotion. Liebe Anna, deine wissenschaftliche Führung, deine konstruktive Kritik, Inspiration und dein Engagement haben diese Arbeit und meine akademische Entwicklung maßgeblich geprägt. Darüber hinaus haben Max und du seit 2019 mit der Betreuung meiner Masterarbeit den Grundstein für diesen Weg gelegt. Euch beiden danke ich für euer Vertrauen und eure Unterstützung bei diesem Abenteuer. Ebenso möchte ich Euch dreien für die Ratschläge und Euer stets offenes Ohr danken.

An meine Freund:innen, Ko-Autor:innen und Kolleg:innen: Herzlichen Dank für die Freundschaften welche weit über die Promotion hinausreichen sowie für die vertrauensvolle Zusammenarbeit. Mit Euch habe ich gemeinsam Erfolge gefeiert und Pläne zur Lösung von Herausforderungen geschmiedet. Die Zusammenarbeit mit Euch hat diese Zeit so einzigartig und besonders gemacht.

An meine Familie, besonders an meine Eltern: Herzlichen Dank Euch! Wie Astrid Lindgrens Bücher, die ihr mir als Kind vorgelesen habt, meine Fantasie beflügelt haben, habt ihr meine Kreativität und Begeisterungsfähigkeit für Digitale Technologie und Innovation stets gefördert. Wie Lindgren sagte: "Alles Große, das in der Welt vollbracht wurde, spielte sich zuerst in der Fantasie eines Menschen ab" - Ihr habt mich gelehrt zu träumen und diese Träume mit Entschlossenheit zu verfolgen. Ihr habt meinen Wertekompass geprägt und mir das Fundament für dieses Abenteuer gegeben. Ihr gebt mir Rückhalt, und zeigt mir neue Perspektiven. Diese Arbeit, die meine Faszination für digitale Innovation ausdrückt, widme ich Euch, denn ihr habt diesen Weg möglich gemacht, mich unterstützt und stets begleitet.

Danke für die Vorbilder, die Ihr mir alle immer wart und seid sowie für alles, was ich von Euch lernen durfte. Herzlichen Dank!

Copyright Statement

The following sections are partly comprised of content from the research papers included in this dissertation. To improve the readability of the text, I omit the standard labeling of these citations.

Abstract

Digital technologies are transforming the innovation landscape, fostering the emergence of novel opportunities that enable organizations to address the challenges of digital transformation. Despite the transformative potential of digital innovation, organizations face significant challenges in leveraging digital technologies to generate and deliver value. The increasing complexity of digital ecosystems, characterized by heterogeneous actors, rapid technological advancements, and ever-evolving consumer expectations, poses fundamental questions about how organizations can systematically navigate digital innovation processes and outcomes. Moreover, while data-driven innovations, smart service innovations, and digital social innovations offer new avenues for value creation, the mechanisms through which these innovations can be effectively harnessed remain insufficiently understood.

This dissertation explores how organizations can harness digital innovations to create value and sustain competitiveness in rapidly evolving markets. The research adopts a dual focus, examining the processes underlying digital innovations and the outcomes generated through the processes, with particular emphasis on data-driven innovations, smart service innovations, and digital social innovations. The dissertation is organized around two primary objectives: *understanding digital innovation processes across various digital innovation types* and *examining digital innovation outcomes and value delivery*. The findings are presented in five research articles, each contributing to the overarching theme of navigating digital innovation.

The first objective, understanding digital innovation processes, investigates how organizations systematically identify opportunities and generate innovative ideas. It underscores the critical role of the initiation phase in digital innovation process, highlighting how digital technologies reshape traditional approaches to opportunity recognition. Research Articles #1 to #3 contribute to this objective by exploring different facets of digital innovation processes. Research Article #1 examines the effects of digital technologies on opportunity recognition, shedding light on how digital technology influences entrepreneurial processes. Research Article #2 extends this perspective by proposing a multidimensional digital social innovation framework, emphasizing the interaction between digital and social innovation dynamics. Research Article #3 introduces the smart service innovation compass, a method designed to support the generation of smart service innovation ideas. The second objective focuses on improving digital innovations through data-driven outcomes and value delivery. It examines how organizations can maximize the potential of data-driven innovations and smart service innovations. Research Articles #4

and #5 directly contribute to this goal. Thereby, Research Article #4 delves into the archetypes of data-driven innovations, offering a structured approach to understanding different forms of data-driven innovation. Research Article #5 presents the ENVELOPE framework, a practical guide for navigating smart service value delivery in real-world contexts, highlighting strategies to enhance value creation through digital technologies.

In conclusion, the dissertation offers a novel perspective on digital innovation, analyzing digital innovation processes and their outcomes. It delivers valuable insights for both academic scholars and industry practitioners, emphasizing the importance of interdisciplinary approaches in navigating digital innovation. The research concludes with actionable recommendations for future research, underscoring the importance of digital innovation.

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Acronyms

AI	Artificial Intelligence
BMPPS	Business Model Product Process Services
DDI	Data-Driven Innovation
DDS	Data-Driven Service
DI	Digital Innovation
DSI	Digital Social Innovation
DSR	Design Science Research
DT	Digital Technology
ENVELOPE	Engage, Notice, Visualize, Enhance, Leverage, Orchestrate, Partner, Evolve
IoT	Internet of Things
IS	Information Systems
SmartSI	Smart Service Innovation
SDGs	Sustainable Development Goals

I Introduction

I.1 Motivation

Ada Lovelace, often regarded as the world's first computer programmer, developed a pioneering algorithm in the mid-19th century (Toole 1998). Her visionary work introduced the concept of programming as a means to instruct machines, laying the foundation for modern computing and digital technologies (DTs). Today, her ideas echo in digital innovations (DIs) such as smart services, where algorithms generate data-driven personalized services, autonomous systems, and intelligent decision-making (Beverungen et al. 2019b; Porter et al. 2014; Yoo et al. 2010). For example, Bosch's IoT-enabled smart home solutions automate heating, lighting, and security systems through a digital platform, enhancing convenience and energy efficiency (Sterk et al. 2022).

The blistering pace of DI presents an existential challenge to established organizations, as highlighted by Clayton Christensen's theory of disruptive innovation, which describes how new technologies and business models can fundamentally reshape industries and markets (Christensen et al. 2015). The decline in organizational longevity—from 33 years in 1965 to under 20 years today on the Standard & Poor's 500 —serves as a warning: adapt quickly or risk obsolescence (Anthony et al. 2018; Anthony et al. 2016). This unprecedented acceleration of digital technological change leaves no room for complacency, as DTs enable competitors to introduce disruptive business models rapidly. While DI creates opportunities for intrapreneurs to drive innovation from within, it also demands decisive action from established organizations to maintain their competitive position. DIs are fundamentally reshaping the business landscape through novel products, processes, services, and business models that leverage the (re)combination of DTs (Nambisan et al. 2017; Yoo et al. 2010), forcing incumbents to transform at a pace that would have been unimaginable in previous decades especially due to new DTs (i.e., Generative Artificial Intelligence) (Benbya et al. 2024).

DTs alter how organizations initiate, develop, and implement innovations (Kohli and Melville 2019). Prominent examples such as cloud computing, the Internet of Things (IoT), and artificial intelligence (AI) open avenues for new product and service development, enabling established organizations to create advanced applications. DTs serve both as a means of achieving innovation and as an outcome of the DI processes (Ciriello et al. 2018). Yoo et al. (2010) introduced DI ‘‘as the carrying out of new combinations of digital and physical components to produce novel products’’ (p. 725). DIs are vital for organizational success in rapidly changing markets. By harnessing algorithms and data, organizations can adapt to evolving customer

needs and transform interactions with customers and connected products (Lokuge et al. 2019; Oberländer et al. 2018). This transformation generates unprecedented business opportunities (Ciriello et al. 2018; Fichman et al. 2014; Henfridsson et al. 2018) while also presenting challenges for organizations, particularly as customer expectations continue to rise (Kreuzer et al. 2022).

To systematically understand these opportunities and challenges of DI, researchers have developed theoretical frameworks that guide organizations through the innovation process. For instance, Kohli and Melville (2019) present a framework for DI, as depicted in Figure 1, outlining four key actions: initiation, development, implementation, and exploitation. These actions are influenced by both the internal organizational environment and the external competitive landscape. The framework emphasizes that achieving DI outcomes requires structured process actions and alignment with organizational goals and market needs, underscoring the dual focus on process (i.e., DI actions) and outcome.

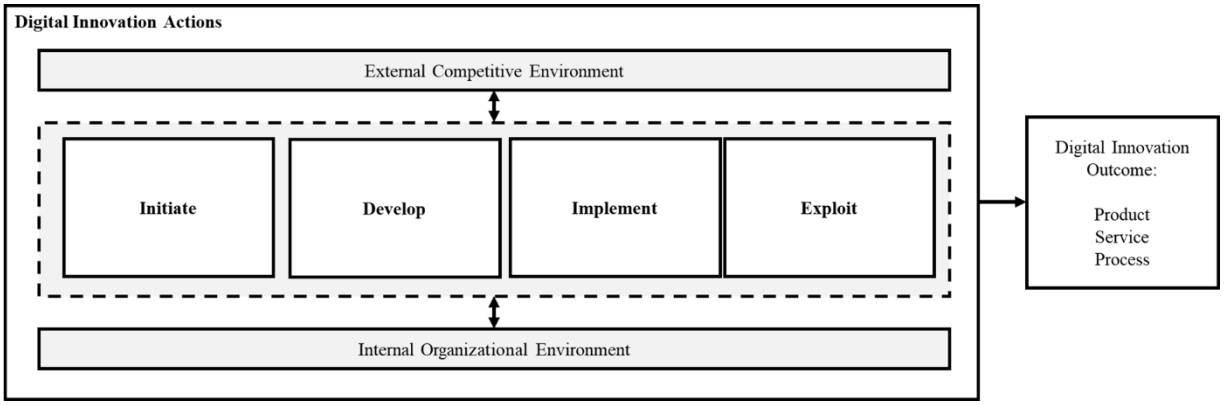


Figure 1 Digital Innovation Framework (Kohli and Melville 2018)

While this framework (depicted in Figure 1) provides a structured approach to DI, its practical application must account for the fundamental difference between DI and traditional innovation processes and outcomes. As emphasized by Ciriello et al. (2018), "*DI rarely follows traditional logics of governance and coordination, but rather emerges from the opportunities available in a digital ecosystem*" (p. 565). This shift is largely driven by DTs' distinctive characteristics, including reprogrammability, data homogenization, and its self-referential nature (Benbya et al. 2020; Yoo et al. 2010). Additionally, the generativity and convergence of DI outcomes expand the product and industry boundaries (Ciriello et al. 2018; Yoo et al. 2012). Furthermore, by examining how DTs blur boundaries between actors (e.g., multilateral relations), organizations can adapt their strategies to remain relevant in a rapidly evolving environment (Kreuzer et al. 2022). The results of DIs are economic disruptions, new global competition, and evolving customer demands to which organizations must adapt to maintain competitive advantage

(Barrett et al. 2015; Bharadwaj et al. 2013; Nambisan et al. 2019; Yoo et al. 2010). To achieve this adaption, organizations must continuously rethink their current offerings in light of DI (Nylén and Holmström 2015). This shift is particularly critical as DI increasingly demands new approaches tailored to its unique characteristics (Nambisan et al. 2017; Yoo et al. 2010). DI processes are exploratory, dynamic, and iterative, requiring methods that address their unique complexities (Kohli and Melville 2019; Svahn et al. 2017). A key challenge lies in the early stages of innovation, where organizations must identify and evaluate opportunities before clear ideas can exist, a phase known as the fuzzy front end (Eling and Herstatt 2017; Kohli and Melville 2019).

Equally, the outcomes of these DI types diverge significantly from traditional products and services. DI types refer to distinct innovation outcomes driven by DTs, shaping processes. Key types include Data-driven innovations (DDIs), which leverage data analytics and AI (Engelbrecht et al. 2016; Hunke et al. 2022); smart service innovations (SmartSIs), enhancing services through IoT and automation (Beverungen et al. 2019b; Kuch et al. 2024); and digital social innovations (DSIs), using digital solutions for social and environmental impact (Bonina et al. 2021; Buck et al. 2023b). DDI, DSI, and SmartSI often require ongoing adaptation, integration, and actor interaction to deliver value effectively. While all DI types share a reliance on DTs, their focus can be distinguished:

DDI leverages advanced analytics and AI to transform organizational capabilities. Through the integration of DTs into products, services, and business models, DDI enables organizations to extract actionable insights from vast data repositories (Engelbrecht et al. 2016; Hunke et al. 2022). The digital servitization of manufacturing exemplifies this transformation (Forkmann et al. 2017; Paschou et al. 2020; Ulaga and Reinartz 2011), as illustrated by Kaeser's evolution from selling air compressors to providing compressed air as a service. Through remote monitoring solutions, Kaeser optimizes maintenance and parts replacement (Bock et al. 2019; Breidbach and Maglio 2015), demonstrating how DDI can both refine existing services and generate novel offerings that address evolving customer demands (Fichman et al. 2014; Nylén and Holmström 2015).

SmartSI advances beyond data utilization by integrating connected physical products to enhance service-based value propositions. Operating within smart service systems—configurations of people, technologies, and resources—SmartSI leverages IoT, AI, and real-time data analytics to enable unprecedented value co-creation (Beverungen et al. 2019b; Nambisan et al. 2017; Yoo et al. 2010). Rolls-Royce's "Power-by-the-Hour" model exemplifies

this approach, transforming jet engine sales into a performance-based service. Through IoT sensors and predictive analytics, this system optimizes engine maintenance and fuel efficiency, demonstrating SmartSI's capacity to create digital services in addition to existing physical products (Ng et al. 2012).

DSI harnesses DTs to address societal challenges while maintaining economic viability (Bonina et al. 2021). By combining DI with social value creation, DSI utilizes digital platforms, open data, and AI-driven solutions to generate new opportunities (Buck et al. 2023a; Qureshi et al. 2021). The Ushahidi platform illustrates this potential, evolving from its initial application in monitoring election violence in Kenya to a global tool for disaster response and human rights advocacy (Mäkinen and Wangu Kuira 2008). While DSI shows considerable promise, its research landscape remains fragmented, necessitating more integrated approaches to understand its processes, outcomes, and sustainability impacts (Bonina et al. 2021; Buck et al. 2023b).

Implementing these diverse DI types introduces significant challenges in value creation and delivery, particularly as organizations transition from traditional product-centric approaches to more complex, service-oriented models. Especially, value creation and delivery in the DI context present unique challenges due to the complex interactions among various actors and technological components (Adler et al. 2024; Beverungen et al. 2019b). Seamless and efficient value delivery is essential to meet the demands of tech-savvy stakeholders (Teece 2010). This involves orchestrating structures, actors, resources, and processes to generate DI while managing costs (Kohtamäki et al. 2019). The challenges intensify when considering the distinct DI types (e.g., DSI, DDI, and SmartSI). For example, the fuzzy front end of DI presents significant obstacles, as organizations must identify opportunities amid uncertainty and ambiguity (Kreuzer et al. 2022). This stage often lacks structured methods, resulting in missed opportunities or inefficient resource allocation (Chesbrough 2010; Kohtamäki et al. 2019). Systematic processes are essential for understanding and integrating DTs into opportunity recognition and early innovation stages, leading to DI outcomes to address these gaps and enabling organizations to remain competitive (Beverungen et al. 2019b). Traditional innovation frameworks frequently fall short in addressing the complexities of digital transformation, creating a disconnect between existing processes and the needs of DI (Sjödin et al. 2020). Organizations must adopt new methods incorporating data-driven insights and DT capabilities, complementing and enhancing traditional frameworks (Vial 2019). Without new methods, organizations risk failing to fully leverage DTs, leading to suboptimal DI outcomes (Nambisan et al. 2017; Yoo et al. 2010).

Despite the challenges organizations face with DI (i.e., process and outcome), the existing literature lacks guidance on how to address these issues, especially in understanding how organizations can effectively manage DI processes and outcomes. This dissertation addresses three fundamental research gaps that impact organizational success in the digital era. First, while opportunity recognition serves as a cornerstone of DI success, existing research lacks systematic frameworks for identifying and evaluating digital opportunities (Nambisan et al. 2017). This gap becomes particularly critical as traditional opportunity recognition approaches prove insufficient for DTs' dynamic and complex nature (Briel et al. 2021; Shepherd et al. 2019). Organizations require new methods that can account for the rapid evolution of DTs and their transformative potential across different industries (Kuch et al. 2024). Second, a considerable gap exists in understanding value delivery mechanisms within the DI context (Beverungen et al. 2019b). Despite extensive research on traditional value creation and delivery, current frameworks fail to address the unique challenges posed by DI, particularly in managing complex stakeholder networks and technological interdependencies (Hund et al. 2021; Kohtamäki et al. 2019). This gap severely impacts organizations' ability to translate innovative digital solutions into sustainable value propositions, potentially leading to failed digital transformation initiatives and wasted resources (Svahn et al. 2017; Teece 2010; Vial 2019). Third, the relationship between DI processes and outcomes remains insufficiently explored (Nambisan et al. 2017; Sjödin et al. 2020). While research acknowledges the importance of both aspects, there is limited understanding of how different process approaches influence innovation success across various DI types. This knowledge gap particularly affects organizations' ability to develop effective DSIs (Bonina et al. 2021; Yoo et al. 2010).

Addressing these research gaps is crucial for several reasons: (1) organizations increasingly depend on effective DI processes (e.g., opportunity recognition) for competitive advantage, (2) failed DI outcomes (e.g., value delivery) lead to significant resource waste and missed opportunities, underscoring theoretical gaps in current understandings of value creation mechanisms, and (3) the acceleration of digital transformation across industries demands more robust frameworks for managing DI processes and outcomes, necessitating advancement in theoretical knowledge to bridge the gap between traditional innovation theories and digital contexts (Hund et al. 2021; Kohli and Melville 2019). This dissertation, therefore, focuses on two key objectives: "*understanding DI processes across various DI types*" and "*examining DI outcomes and value delivery*." These objectives directly address the identified research gaps while providing actionable insights for organizations navigating DI.

I.2 Research Objectives

This cumulative dissertation comprises five research articles that collectively explore the question of *how organizations effectively leverage DI?* by applying different qualitative methods, conceptual lenses, and varying levels of granularity. The dissertation is structured around two key objectives: "*understanding DI processes across various DI types*" and "*examining digital innovation outcomes and value delivery*" depicted in Figure 2. Together, these objectives offer a comprehensive perspective on DI within established organizations. To explore this question and according to its two objectives, the dissertation draws from the DI framework by Kohli and Melville (2019). The framework is structured along two key dimensions that enable a systematic categorization of the five research articles. The first dimension, DI focus (i.e., x-axes), distinguishes between DI process and outcome. The second dimension, DI type (i.e., y-axes), classifies the specific types of DI (i.e., DDI, DSI, and SmartSI). Together, these dimensions create a comprehensive framework that allows for a detailed analysis of how different innovation approaches intersect with various innovation types across the research articles.

First, the DI focus dimension reflects the dual nature of DI by distinguishing between process and outcome. On the process side, organizations must manage various DI stages, including initiation, development, implementation, and exploitation (Kohli and Melville 2019). The outcome side encompasses the tangible outcomes of these processes, which can manifest as new or enhanced digital products, services, processes, or business models (Ciriello et al. 2018; Fichman et al. 2014). This distinction is crucial as organizations need to excel in both aspects.

Second, the DI type categorizes the nature of innovation into DSI, DDI, or SmartSI. These categories were selected to represent distinct yet interrelated DI through which organizations utilize DTs but are not mutually exhaustive or exclusive. First, DSI emphasizes the creation of social value using DTs, often in a financially sustainable manner (Bonina et al. 2021). Second, DDI leverages data to generate actionable insights and drive value creation (Henfridsson et al. 2018). Third, SmartSI represents innovations enabled by smart, connected products, integrating advanced digital capabilities such as IoT, data analytics, and automation (Kohtamäki et al. 2019). This dissertation is relevant to researchers and practitioners because it covers theoretical and practical perspectives on DI.

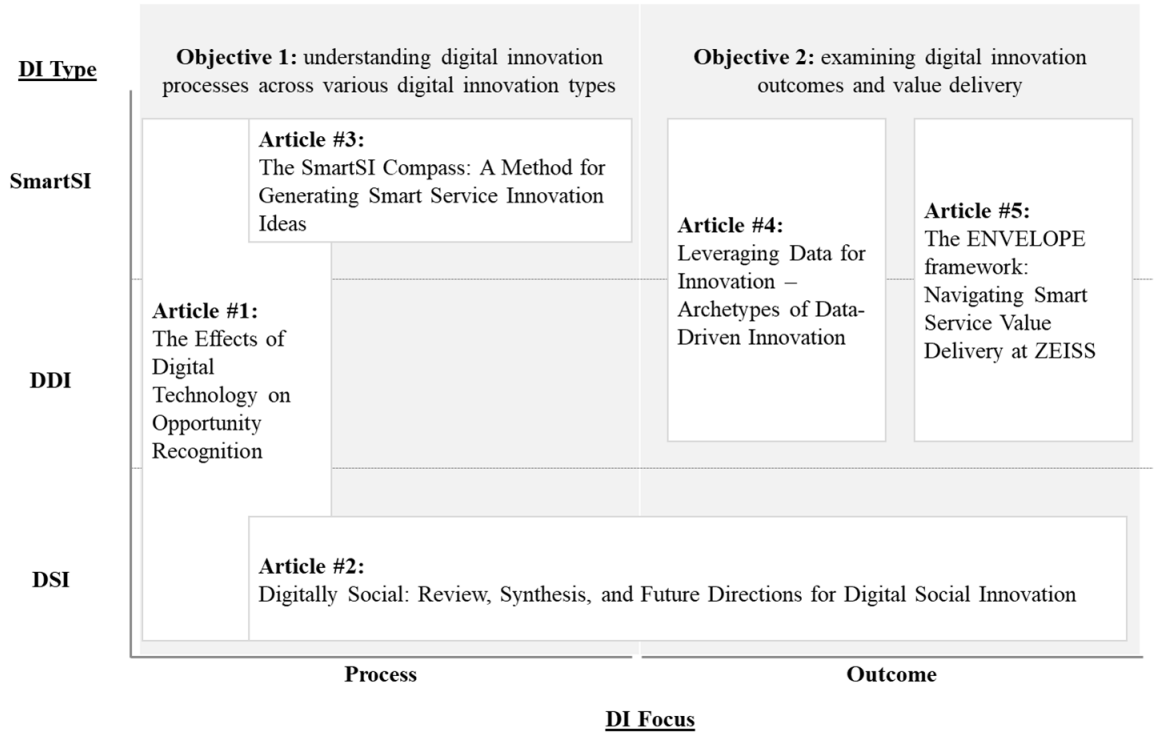


Figure 2 Assignment of the Research Articles

Objective 1: Understanding digital innovation processes across various digital innovation types

This objective focuses on the processes underlying DI, addressing how organizations can systematically initiate DI across different DI types from within the organization. **Research Article #1** (All DI types, Process) examines the effects of DTs on opportunity recognition. It highlights how DT changes traditional approaches and provides a new perspective on opportunity recognition, contributing foundational insights to DI processes. **Research Article #2** (DSI, Process & Outcome) examines the process of integrating DSI by identifying research gaps at the DI and social innovation interface. The article outlines how DT can systematically enable societal problem-solving, emphasizing the dual focus on process and outcome in DSI initiatives. This process orientation is particularly evident in how the agenda outlines research pathways for understanding DSI. While the article also addresses outcome-related aspects, its primary contribution is creating a systematic framework for investigating how organizations can effectively implement DTs to address societal challenges. **Research Article #3** (SmartSI, Process) proposes the SmartSI Compass to structure the process of generating ideas for SmartSI. Offering a practical method advances the understanding of how organizations can overcome challenges in initiating SmartSI.

In summary, the first objective aligns with the process perspective assigned to the DI focus axis,

encompassing all three DI types (i.e., DSI, DDI, and SmartSI). It emphasizes creating actionable frameworks and methods for initiating and advancing DI processes in diverse organizational contexts. Beyond providing practical frameworks and methods for initiating DI processes, these articles make theoretical contributions by advancing the understanding of how DTs transforms DI processes. The research articles establish new theoretical foundations for understanding DI processes across different contexts, particularly highlighting the unique dynamics and mechanisms that emerge when traditional innovation processes intersect with DTs. This theoretical advancement is crucial for both academic discourse and practical application in an increasingly digitalized innovation landscape.

Objective 2: Examining Digital Innovation Outcomes and Value Delivery

Research objective 2 emphasizes the outcomes of DI, exploring how organizations can optimize value delivery and achieve impact through specific innovation types such as DDI and SmartSI. Therefore, **Research Article #4** (DDI, Outcome) develops a taxonomy of DDI archetypes, enabling organizations to understand DDI outcomes. The taxonomy provides a foundation for categorizing and leveraging DDI to achieve competitive advantage. **Research Article #5** (SmartSI & DDI, Outcome) focuses on how organizations can enhance value delivery for SmartSI and DDI. The article provides actionable insights by analyzing the factors influencing value delivery outcomes, particularly in high-impact industries such as healthcare.

Thus, the second objective aligns with the outcome of the DI focus axis, concentrating on the outcomes of the DI process and their contribution to organizational success. It highlights the practical implications of achieving impactful outcomes through DDI and SmartSI.

Together, the two objectives emphasize the essential role of DTs in driving both the innovation processes (objective 1) and the outcomes (objective 2).

I.3 Structure of the Dissertation and Embedding of the Research Papers

This dissertation encompasses five research articles addressing and contributing to the above research objectives. Table 1 provides an overview of this dissertation's structure and how the research articles' are embedded.

I	**Introduction**
II.1	**DI Processes across various DI types**
	Research Article #1 Kreuzer, T., Lindenthal, A. K., Oberländer, A. M., & Röglinger, M. (2022). The effects of digital technology on opportunity recognition. Business & Information Systems Engineering, 64(1).
	Research Article #2 Krombacher, A.; Lindenthal, A.K.; Oberländer, A.M.; Schäfer, R. (2024). Digitally Social: Review, Synthesis, and Future Directions for Digital Social Innovation. 1st round of revisions: Outlet hidden due to double-blind review process.
	Research Article #3 Kuch, F., Lindenthal, A. K., Oberländer, A. M., Cortenraad-Wenninger, A., & Buck, C. (2024). The SmartSI Compass: A method for generating smart service innovation ideas. Information & Management, 61(5).
II.2	**Examining digital innovation outcomes and value delivery**
	Research Article #4 Dilger, P.; Lindenthal, A. K.; Meyer-Hollatz, T.; Oberländer, A.M.; Bitzer, M. (2025). Leveraging Data for Innovation – Archetypes of Data-Driven Innovation. Submitted to: Outlet hidden due to double-blind review process.
	Research Article #5 Lindenthal, A.K.; Adler, L.M.; Kuch, F.; Lindenthal, A.K.; Gebauer, H., and Oberländer, A.M. (2024). The ENVELOPE framework: Navigating Smart Service Value Delivery at ZEISS. Submitted to: Outlet hidden due to double-blind review process.
III	**Conclusion**
IV	**References**
V	**Appendix**

Table 1 Structure of this dissertation and embedding of the research papers

Section II is organized according to the two research objectives of the dissertation. The five research articles are systematically categorized within this structure, allowing for a focused examination of how organizations can leverage DI. Following Section II, Section III provides a conclusion that summarizes the dissertation's key findings, addresses the limitations, and outlines potential avenues for future research. Finally, Section V includes a detailed index of the research articles, clarifies the author's individual contributions, and presents the full versions of the research papers.

II Overview and Context of the Research Articles[1]

II.1 Understanding Digital Innovation Processes across various Digital Innovation Types

"The metaphor I often use—it's not the perfect one—is being a gardener. I want to make sure that the irrigation and fences are working, that the compost is alive, and that the plants are in roughly the right place, but I don't tell the plants how to grow. I watch how the garden's evolving. I may move things around, and I may prune here and there. But it's not under my control." **Joi Ito (MIT Media Lab's Joi Ito on Digital Innovation and Disruption 2016)**

Just as gardeners must understand and nurture various plants while adapting to changing environmental conditions, organizations must develop systematic approaches to manage different types of DI within their evolving technological landscape. The first objective - *understanding DI processes across various DI types* - examines how organizations can effectively cultivate DI processes while acknowledging their inherent complexity. Central to this cultivation of DI processes are the organizational actors who, similar to skilled gardeners, must carefully tend to nurture new ideas.

In established organizations, intrapreneurs serve as key actors driving the DI process. They harness their entrepreneurial mindset to identify opportunities and generate innovative ideas (Desouza 2011; Rigtering et al. 2019). The initiation stage of DI is critical, as it involves recognizing evolving DTs, competitive threats, and shifting customer needs, which all contribute to the development of new value propositions (Teece 2007; Vega and Chiasson 2019). The initiation stage, often seen as the front end of innovation, requires organizations to transform identified opportunities into actionable ideas (Kreuzer et al. 2022). This phase influences subsequent stages of the DI process, making opportunity recognition essential for DI success (Eling and Herstatt 2017). The complexities involved in generating SmartSIs, DDIs, and DSIs highlight the need for an understanding of the effects of DTs on the DI process and systematic methods to guide organizations through this process (Kohli and Melville 2019; Nylén and Holmström 2015).

Research has shown that organizations often struggle with idea generation during the initiation phase, emphasizing the necessity for structured guidance (Eling and Herstatt 2017; Kuch et al. 2024). Despite its importance, this stage remains poorly understood, with limited guidance on how established organizations can identify opportunities in the context of DI (Kreuzer et al. 2022). This challenge becomes more complex when considering specific types of DI. For DSI

[1] This section uses some content from the research articles in this dissertation. I have left out the usual citation labels to make the text easier to read.

initiatives, organizations face the distinct challenge of identifying opportunities that create both social and economic value. The current literature lacks comprehensive frameworks to guide organizations through this dual-objective process of aligning DI with social value creation. Beyond DSI, the emergence of SmartSI introduces another layer of complexity to the DI process, as organizations must specifically develop methods to leverage the different DI types. This requires unique ideation and opportunity recognition methods. To address this gap, Section II.1 of the dissertation focuses on the DI process and presents research articles that offer initial steps toward a deeper understanding.

Research Article #1: The Effects of Digital Technology on Opportunity Recognition.

In today's business landscape, DT serves as a catalyst for DI by enhancing hybrid products and services with digital functionalities (Piccoli et al. 2022; Yoo et al. 2010), becoming fundamentally embedded in our daily lives (Baskerville et al. 2020; Lokuge et al. 2019). The dual characteristics of convergence and generativity inherent in DTs facilitate the emergence of novel opportunity spaces, which are fundamental to entrepreneurial activities (Oberländer et al. 2021). Within entrepreneurship literature, opportunity recognition represents a cornerstone concept that has been examined through two primary lenses: a process-oriented perspective analyzing activities, inputs, and outcomes, as exemplified by Ardichvili et al. (2003), and a behavioral approach investigating individual conduct during opportunity recognition, as demonstrated by Baron (2007).

While entrepreneurship research has established robust frameworks for opportunity recognition in traditional contexts, the digital age introduces novel complexities that challenge these conventional approaches. A primary factor is the diminishing relevance of traditional opportunity recognition knowledge, developed in an era of less technological pervasiveness (Nambisan et al. 2017; Steininger 2019). In response, digital entrepreneurship has emerged as a distinct research domain that challenges conventional entrepreneurial paradigms and examines opportunity recognition in a digital context (Recker and Briel 2019). This field has redirected scholarly attention toward understanding opportunities enabled and shaped by DTs (e.g., Oberländer et al. (2021), Briel et al. (2021), or Nambisan et al. (2017)). However, a comprehensive understanding of DTs' effects on opportunity recognition remains elusive (Shepherd et al. 2019; Briel et al. 2021), both in terms of core theoretical constructs and specific aspects of the process and behavioral perspectives (Recker & von Briel, 2019; Steininger, 2019). This knowledge gap holds particular significance not only for digital entrepreneurship but also for adjacent fields. Notably, DI recognizes opportunity recognition as a crucial yet understudied initial phase of the innovation process (Abrell et al. 2016; Ciriello et al. 2018;

Holmström 2018). The current theoretical limitations impede both academic advancement and practitioners' ability to effectively identify opportunities in a digital landscape (Shen et al. 2018; Svahn et al. 2017). Addressing this research gap, Research Article #1 investigates ‘what are the effects of DTs on opportunity recognition?’.' The study employs opportunity recognition theory to analyze DTs' effects on opportunity recognition and explain the evolution from traditional to digital entrepreneurship.

Drawing from traditional entrepreneurship theory, this research conceptualizes opportunity recognition through four key constructs: actor, resource, market, and opportunity-idea. These foundational elements comprise an actor (organization or individual) (Davidsson 2015), an opportunity-idea as a possibility for action (Shen et al., 2018), market influences on the actor based on the market-based view (Brem and Voigt 2009; Zhou et al. 2005), and resources (e.g., assets and capabilities) based on the resource-based view (Ardichvili et al. 2003; Barney 1991). Through a systematic literature review (vom Brocke et al. 2015) and coding (Wolfswinkel et al., 2013), the study identifies three critical digital phenomena affecting opportunity recognition: digital invasiveness, enabled by layered modular architecture; dissolving company and customer boundaries, facilitated through digital platforms; and dissolving product and industry boundaries, driven by digital ecosystems. Digital invasiveness reflects DT's integration into both entrepreneurial ventures and daily life (Baskerville et al., 2020; von Briel et al., 2021), while digital platforms enable resource integration across organizational boundaries (Oberländer et al., 2021), and digital ecosystems foster interconnected entrepreneurial endeavors (Sahut et al. 2021). These developments collectively shape opportunity recognition (depicted in Figure 3) through three direct and three transitive effects, with DT serving as the crucial enabler for both resource- and market-related opportunity recognition in digital contexts (Kohli & Melville, 2019).

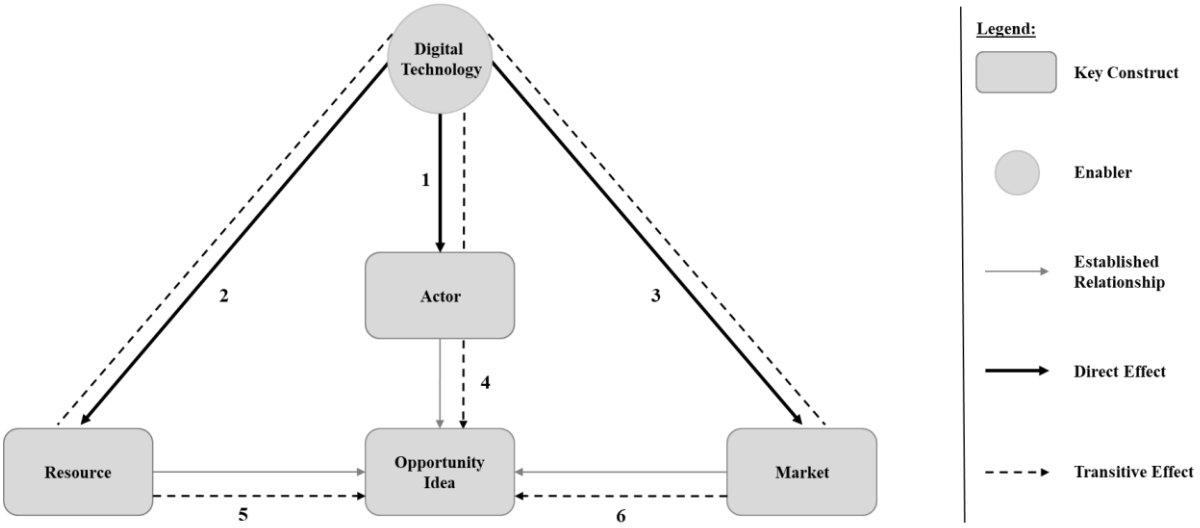


Figure 3 The Effects of Digital Technology on Opportunity Recognition

According to Research Article 1, DT has no direct impact on the opportunity-idea. As the primary construct of opportunity recognition, the opportunity-idea is transitively impacted by DT through every other construct, with the actor moderating. In accordance with Gregor's (2006) concept of causal explanations, Table 2 lists the direct and transitive effects of DT according to five components: First, DT (From) is not used to characterize the construct or established relationship. Second, DT's impact on the construct is described (To). Third, the digital phenomenon that is found to drive the effect (Driven by) is shown in Table 2, and fourth, Table 2 depicts the DT outcomes that led to the majority of the digital phenomena emerging (Through). Fifth, it enumerates explanations that shed light on how the effects are caused by digital phenomena.

	#	From	To	Driven by	Through	Rationales	References
Direct Effects	**1**	Homogenous entrepreneurs	Growing number and variety of actors (everyone)	Increasing digital invasiveness	Layered modular architecture	1.1 Due to the layered architecture of DT individuals and organizations are constantly working with and surrounded by DT driving digital invasiveness and fostering digital opportunities.	(Ciriello et al. 2017; Iivari et al. 2016)
						1.2 Increasing digital invasiveness fosters the ability of organizations and individuals to participate in opportunity recognition.	(Nambisan et al. 2017; Yoo et al. 2012)
						1.3 DT can take a supporting or leading role as an actor contributing to opportunity recognition.	(Barrett et al. 2015; Henfridsson et al. 2018)
	2	Exclusively internal access only	Externally shared access	Dissolving company and customer boundaries	Digital platforms	2.1 Digital platforms enable shared access to an enlarged resource base – beyond company-owned resources – dissolving company and customer boundaries and leading to digital opportunities.	(Lokuge et al. 2019; Saldanha et al. 2017)
						2.2 Digital platforms provide new digital capabilities, which digitally enhance existing products and can be shared between companies and customers for opportunity recognition.	(Gustavsson and Ljungberg 2018; Yoo et al. 2012)
						2.3 Digital platforms provide new digital assets such as digital infrastructure, digital applications, and data assets, which serve as foundation for opportunity recognition.	(Fichman et al. 2014; Henfridsson et al. 2018)
	3	Hierarchical relationships	Multi-lateral value networks	Dissolving product and industry boundaries	Digital ecosystems	3.1 Digital ecosystems transform competitors in hierarchy-based value systems into partners for opportunity recognition by dissolving product and industry boundaries.	(Ciriello et al. 2018; Oppong-Tawiah and Bassellier 2017)
						3.2 Digital ecosystems enable suppliers to contribute valuable knowledge to opportunity recognition and change existing supplier relationships.	(Lee and Berente 2012; Oborn et al. 2019)
						3.3 Within digital ecosystems, regulators facilitate opportunity recognition across industries by changing legislation that explicitly targets DT.	(Hinings et al. 2018; Suseno et al. 2018)
Transitive Effects	**4**	Context-dependent restrictions	Multitude of (re-) combination possibilities	Increasing digital invasiveness	Layered modular architecture	4.1 The layered architecture of DT shared by actors who are constantly surrounded by DT creates a variety of different compatible resources for opportunity recognition due to protocols and standards.	(Barrett et al. 2015; Lusch and Nambisan 2015)
						4.2 The layered architecture of DT allows actors new ways of recombination for opportunity recognition through loose coupling via standardized interfaces.	(Henfridsson et al. 2018; Yoo et al. 2010)
	5	Deterministic and final deployment	Continuous iterative development	Dissolving company and customer boundaries	Digital platforms	5.1 By dissolving company and customer boundaries between actors, digital platforms foster the continuous adaptation and iterative refinement of ever-evolving digital artifacts.	(Ciriello and Richter 2015; Gustavsson and Ljungberg 2018)
						5.2 Digital platforms enable actors to build on their own or other company's digital artifacts as a starting point for opportunity recognition.	(Oborn et al. 2019; Zapadka 2020)
	6	Few occasion-related interactions	Continuous integration	Dissolving product and industry boundaries	Digital ecosystems	6.1 By dissolving product and industry boundaries, digital ecosystems enable the continuous exchange of information and sharing of knowledge between actors.	(Lusch and Nambisan 2015; Suseno et al. 2018)
						6.2 Within digital ecosystems actors can communicate their needs more quickly through short product cycles, which leads to continuous opportunity recognition.	(Abrell et al. 2016; Dery et al. 2017)

Table 2 Direct and transitive effects of digital technology on opportunity recognition

The theoretical contributions of this research extend beyond digital entrepreneurship, establishing a comprehensive framework for understanding opportunity recognition in the digital context (Leidner 2018; Seidel and Watson 2020). The research presents a type II theory according to Gregor's (2006) classification, offering explanatory insights into the mechanisms by which digital transformation shapes opportunity recognition (Leidner 2018). This theoretical advancement illuminates the evolution from traditional to digital entrepreneurship through systematic analysis of opportunity recognition constructs. The study's implications are threefold: First, it provides a foundation for theory development and validation regarding opportunity recognition in the digital context, e.g., toward theories for predicting (i.e., Types III – IV) as well as design and action (i.e., Type V) (Gregor 2006). Second, it enables a detailed examination of the process and behavioral perspectives in opportunity recognition. Third, it addresses Berger et al. (2021) inquiry into DT's role in creating "opportunity spaces for entrepreneurial action" (p.7) by elucidating market and resource dynamics (Barney, 1991).

The identified effects reveal insights for DI processes in three key areas. First, organizations must navigate a higher complexity in DI processes, particularly in the early stages, necessitating an understanding of recombination possibilities within extended resource bases and multi-lateral value networks. This demands mature process knowledge to design robust DI processes. Second, organizations require enhanced operational flexibility to capitalize on opportunities, including collaboration with diverse actors (effect #1), utilization of shared resources (effect #2), and development of new relationships (effect #3), supported by DI capabilities (Buck et al. 2021). Third, the effects demonstrate a distinctly outward-facing orientation, particularly in effects #1, #5, and #6, emphasizing customer engagement as a critical source for opportunity-ideas and innovation

Research Article #2: Digitally Social: Review, Synthesis, and Future Directions for Digital Social Innovation.

Research Article #2 contributes to the understanding of DSI by synthesizing existing research and identifying future research pathways in a research agenda. The intersection of sustainability and DI represents a rich but fragmented body of literature characterized by diverse terminology (depicted in Table 3) and dispersed insights across multiple domains. This complexity is further amplified by the interplay between economic, social, and ecological aspects that form the three pillars of sustainability (Elkington and Rowlands 1999; Wiedmann et al. 2009). These pillars are often operationalized through the 17 Sustainable Development Goals (SDGs) set by the United Nations in 2015, calling for global action to achieve sustainable development (United NAtions 2025; Wu et al. 2018). The multifaceted nature of sustainability is a focal point across

various academic disciplines (Elliot 2011; Gholami et al. 2016). Particularly, Information Systems (IS) research holds significant potential to drive sustainable development due to its interdisciplinary nature and methodological diversity (Ketter et al. 2016; Thomas et al. 2020). Therefore, the IS discipline plays a crucial role in addressing societal challenges (Melville 2010; Venkatesh et al. 2019; Watson et al. 2010).

Research Article #2 addresses the challenge of understanding and synthesizing the vast but fragmented body of knowledge in the IS domain. The diverse terminology across sustainability and DI creates significant barriers to recognizing the full scope of existing research. Understanding these interconnections as meaningful solutions for societal challenges can only emerge from integrating insights. It highlights the potential of combining DI and social innovation to create what is termed DSI. This synthesis aims to leverage the capabilities of DT to generate social value and accelerate sustainable development, as outlined by Bria et al. (2015) and Qureshi et al. (2021).

DSI is defined as the use of DT to address societal challenges, drawing from both DI and social innovation. The paper reviews various definitions of DSI, such as those by Bonina et al. (2021) and Qureshi et al. (2021), noting the varied interpretations across the IS domain depicted in Table 3. To structure existing DSI research, the authors developed a multidimensional framework depicted in Figure 4 consisting of three dimensions: digital innovation, digital technology, and social innovation. This framework serves as the theoretical foundation of the study, allowing for a comprehensive analysis of DSI literature.

Source	Definition
Qureshi et al. (2021, p. 647)	"Digital social innovation (DSI) involves the **use of digital technologies** in the development and implementation of innovative products, services, processes, and business models that seek to improve the well-being and agency of socially disadvantaged groups or **address social problems** related to marginality, inequality, and social exclusion."
(Tim et al. 2021, p. 324)	"Digital social innovation (DSI)—the **novel use of digital technology to addrress major societal challenges**—has been the bedrock of sustainable development and has therefore garnered increasing attention amongst researchers and practitioners particularly in recent years."
Bonina et al. (2021, p. 698)	"[…] we define DSI broadly as the development of new products, services or processes, that are either **embodied on IT or enabled by IT**, whose goal is to **meet social needs or stimulate social change**."
Dong and Götz (2021, p. 673)	"Open source software (OSS) is a typical digital social innovation […] OSS is a **combination of digital innovation and social innovation**, or digital social innovation."
Buck et al. (2023, p. 4)	"In the context of incumbents, we define DSI as the **leveraging of DT to address societal challenges through commercially viable innovation.**"

Table 3 Definitions of DSI

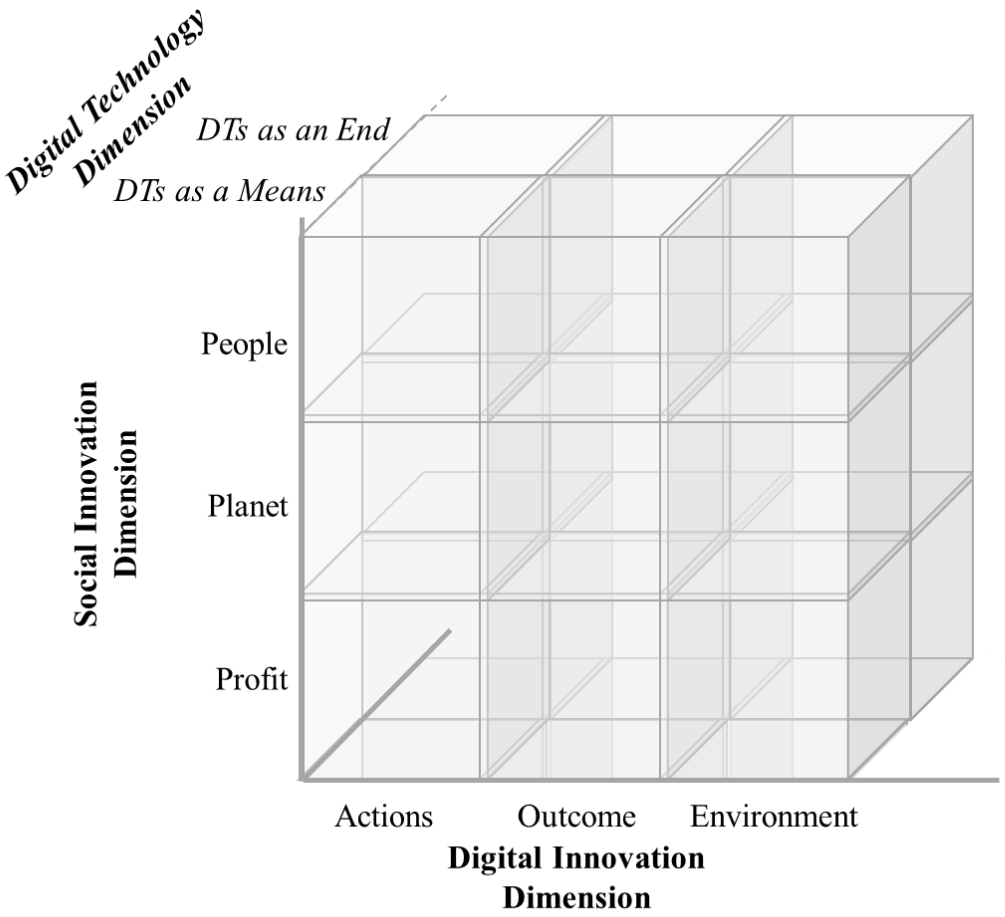


Figure 4 DSI Analysis Framework

The authors conduct a two-phase research approach. The first phase involves a systematic literature review of a final set of 135 studies (depicted in Figure 5) identified through the

databases Web of Science and the AIS eLibrary. This phase aims to synthesize existing contributions and identify research gaps using coding techniques inspired by Wolfswinkel et al. (2013). The second phase includes expert interviews with IS scholars to validate and refine the initial research agenda. Thereby, Research Article # 2 identifies six research clusters based on the intersection of the three DSI dimensions. Each cluster is further analyzed concerning the characteristics of DT (DT as a means or an end), DI (i.e., actions, outcome, and environment), and social innovation (i.e., people, planet, and profit). The clusters represent different research focuses, such as leveraging DT for innovation actions, fostering stakeholder involvement, and addressing the dependencies between sustainability dimensions.

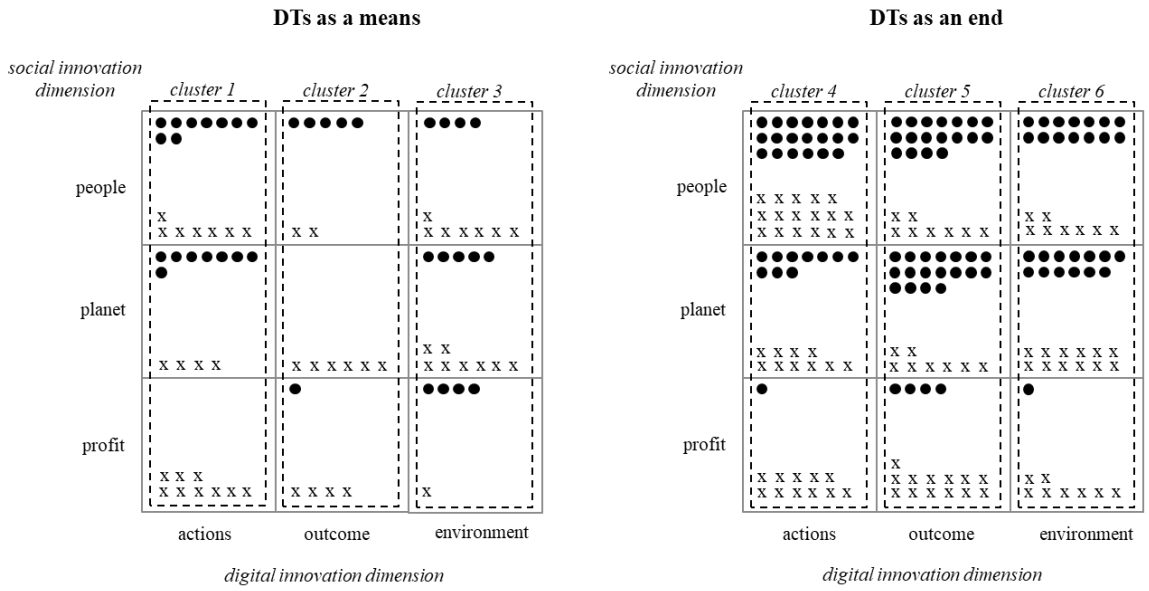


Figure 5 DSI Clustering Results

Finally Research Article #2 presents a research agenda comprising 12 pathways (depicted om Table 4) for future DSI research. These pathways address critical areas such as the role of DT in DSI actions, the measurement of DSI impact, and the interplay between sustainability dimensions. The agenda is designed to guide researchers and practitioners in exploring the potential of DSI to tackle societal challenges effectively. The discussion highlights central topics driving DSI research, including the importance of ecosystems, the role of data, and the assessment of DSI success. The paper emphasizes the need for interdisciplinary approaches and context-specific solutions to enhance the impact of DSI initiatives. Hence, Research Article #2 contributes to the understanding of DSI by synthesizing existing research and identifying future research pathways. It calls for a more structured approach to DSI research, encouraging collaboration across disciplines to address sustainability challenges. The findings have implications for both theory and practice, providing a roadmap for advancing DSI research and enabling practitioners to leverage DT for sustainable development.

Cluster	Research Pathway	Goal
Cluster 1	RP1: What are the affordances of different DT for DSI actions?	Supporting informed decision making regarding the selection and application of DT during DSI actions.
	RP2: Which design principles best facilitate DSI actions in digital platform ecosystems?	Assessment of design principles for DSI ecosystems and development of recommendations for different DSI scenarios.
Cluster 2	RP3: How does the application of DT within DSI actions change DSI outcomes?	Understanding how DSI outcomes change when integrating DT in innovation processes and whether it positively affects sustainability goals in the DSI outcomes.
	RP4: How can DT be used to measure the impact of DSI initiatives?	Gain transparency on social impact and on how to measure DSI success.
Cluster 3	RP5: Which stakeholder groups participate in DSI ecosystems and what are their motives?	Identification of the different groups participating in DSI ecosystems, their motives, and suitable incentivation strategies for each group.
	RP6: How can DT improve stakeholder involvement in DSI?	Analysis of the potential of different types of DT for increasing stakeholder involvement in DSI initiatives across different stakeholder groups.
Cluster 4	RP7: How can DSI initiatives be designed to avoid potential downsides of DT?	Assessment on how to best design a DSI initiative to harness its positive impact and subsequently avoid negative consequences.
	RP8: How can DSI actions ensure the DSI's technical interoperability with existing DT landscapes and workflows?	Assessment on how it can be assured within DSI actions that the DSI outcome is compatible with the existing DT landscape and the existing workflows.
Cluster 5	RP9: How can DSI initiatives address the dependencies and conflicts between sustainability dimensions?	Identification of relevant positive and negative dependencies between different sustainability dimensions and assessment of the role of DT in causing, increasing, or reducing these dependencies.
	RP10: How do DT enable the scaling of DSI initiatives?	Examination of the potential of DT and associated characteristics for increasing the scaling success of DSI initiatives.
Cluster 6	RP11: How to leverage interdisciplinarity among stakeholders in DSI?	Establishment of specific actionable requirements regarding interdisciplinarity (e.g., disciplines involved, communication formats) or understanding the role of interdisciplinarity within DSI.
	RP12: How can DSI succeed in resource-limited environments?	Investigation on how to adapt to constraints within a DSI ecosystem.

Table 4 Overview of DSI research pathways

In conclusion, the paper underscores the potential of DSI in addressing global sustainability challenges, providing research agenda to guide future research in this emerging field.

Research Article #3: The SmartSI Compass: A Method for generating Smart Service Innovation Ideas.

Research Article #3 provides a structured approach to generating SmartSIs, which are increasingly critical for organizations seeking to maintain a competitive edge in a digital market (Kuch et al. 2024). SmartSIs leverage connected physical products to create enhanced value propositions that blur the boundaries between digital and physical services, facilitating value co-creation (Allmendinger and Lombreglia 2005; Yoo et al. 2010). However, the complexity involved in generating SmartSI ideas has posed challenges for many established organizations (Beverungen et al. 2018; Marx et al. 2020).

The SmartSI Compass depicted in Figure 6 was developed to address these challenges by synthesizing existing methods in smart service research and anchoring the method in technological, value creation, and systems perspectives (Kuch et al., 2024). The researchers collaborated with four manufacturing organizations that were actively pursuing digital transformation and smart service development. This partnership was particularly important, as manufacturing firms face unique challenges in transitioning from traditional product-focused operations to integrated smart service offerings. The consortium approach enabled the researchers to combine theoretical rigor with practical insights, ensuring that the developed method would be both academically sound and practically applicable in real-world business contexts. This method comprises five key dimensions—customer, service, product, organization, and digital infrastructure—that guide practitioners in systematically generating SmartSI ideas.

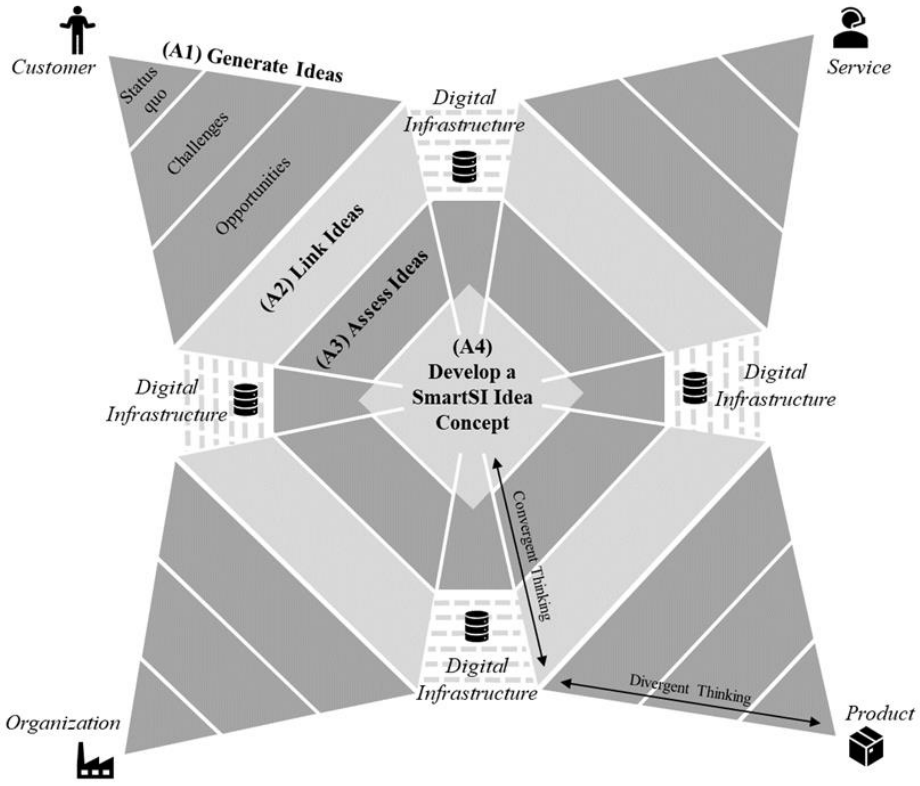


Figure 6 Overview of the SmartSI Compass

The method consists of four main activities: (1) generating ideas based on the identified dimensions, (2) linking these ideas through the digital infrastructure, (3) assessing and prioritizing ideas based on established evaluation criteria, and (4) developing comprehensive SmartSI idea concepts. The activities (depicted in Table 5) foster both divergent and convergent thinking, ensuring a thorough exploration of potential SmartSIs while allowing for iterative refinements (Kuch et al., 2024).

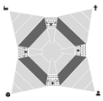
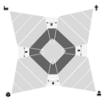
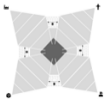
Activities (i.e., tasks of the method)	**Techniques** (i.e., detailed instructions how to execute activities)	**Tools** (i.e., means supporting execution of activities)	**Roles** (i.e., actors executing activities)	**Outputs** (i.e., results of activities)
Activity 1: Generate Ideas 	- Derive ideas along the dimensions customer, product, service, and organization - Consider the status quo, challenges, and opportunities for each dimension	- SmartSI dimensions - Guiding questions - (Online) Whiteboard and template	- Project team, i.e., project leader and project members - (Optional: external experts)	Compilation of information and longlist of ideas based on existing resources, products, services, and customer's needs
Activity 2: Link Ideas 	- Reconsider the ideas of A1 - Develop ideas based on the digital infrastructure dimension - Find linkage opportunities between these ideas with the help of the digital infrastructure dimension - Identify connected and comprehensive SmartSI ideas	- Guiding questions - (Online) Whiteboard and template	- Project team - (Optional: external or internal IT experts or members of digitalization initiatives)	Shortlist of comprehensive ideas
Activity 3: Assess Ideas 	- Select criteria appropriate for the organization - Assess to which extent the comprehensive ideas of A2 fulfill the criteria - Create a ranking and select the most promising idea(s) for further development	- Guiding questions - Assessment template - Evaluation criteria	- Project team - (Optional: Controlling, Senior Executive)	Assessed and prioritized shortlist of comprehensive ideas
Activity 4: Develop a SmartSI Idea Concept 	- Create an initial idea concept for the idea(s) selected in A3 including a summary, next steps, and definition of responsibilities	- Guiding questions - SmartSI dimensions - Idea concept template	- Project team - (Optional: Senior Executive)	Idea concept as structure to pursue (i.e., develop and implement) the idea(s) selected in A3

Table 5 Overview of the SmartSI Compass' activities

Validation of the SmartSI Compass was conducted through real-world applications, demonstrating its practical utility and effectiveness in guiding organizations toward innovative SmartSI ideas. Feedback from practitioners highlighted the method's user-friendliness and its capacity to facilitate structured idea generation, making it a valuable tool for organizations aiming to enhance their DDI outcomes and value delivery.

In conclusion, the SmartSI Compass contributes to the body of knowledge on smart service

innovation by providing actionable insights for practitioners navigating the complexities of DI. The findings underscore the importance of integrating technological advancements and customer needs in the ideation process, ultimately fostering the development of SmartSIs across various organizational contexts (Baskerville et al., 2020; Oberländer et al., 2021). Future research should explore the application of the SmartSI Compass in different industries and investigate its integration into organizational routines to further enhance its effectiveness.

Conclusion of Understanding Digital Innovation Processes across various Digital Innovation Types

The research articles in this section collectively examine the challenge of systematically managing DI processes in established organizations. The research articles highlight several key insights: First, they demonstrate that the initiation phase of DI requires structured approaches while maintaining flexibility to accommodate its emergent nature. Second, they emphasize that different types of DI - from SmartSI to DSI - need tailored methods during the ideation and opportunity recognition stages. Third, they reveal that successful DI requires organizations to balance systematic guidance with space for creativity and adaptation. The articles make important contributions by developing frameworks and a method to support organizations in navigating these challenges while acknowledging that DI processes cannot be fully controlled but rather need to be carefully cultivated - much like a garden requires both systematic care and room to grow naturally. This understanding provides an important foundation for organizations seeking to effectively manage different types of DI within their evolving technological landscape.

II.2 Examining Digital Innovation Outcomes and Value Delivery

"The most difficult thing is the decision to act. The rest is merely tenacity. The fears are paper tigers. You can do anything you decide to do. You can act to change and control your life and the procedure. The process is its own reward." **Amelia Earhart**

The second objective - examining DI outcomes and value delivery- embodies Earhart's spirit of decisive action and persistence in the face of challenges. Just as her pioneering achievements required both courage to act and systematic preparation, organizations must develop structured methods to transform data into valuable DI outcomes. This objective specifically examines how organizations can systematically leverage data to create and deliver value through DI, moving beyond initial hesitation to establish robust frameworks for DDI. The focus lies on developing frameworks that enable organizations to deliver value through DDI, turning the abstract potential of data into valuable outcomes.

Within this context of DDI outcomes, SmartSI are a specific outcome of the DI process, characterized by their ability to leverage data for enhanced value creation. This DI outcome not only improves customer satisfaction but also optimizes resource usage and operational processes (Beverungen et al. 2019c; Gimpel et al. 2018).

To fully understand the implications of SmartSI, service is inherently interdisciplinary and manifests in various contexts, making it challenging to establish a single definition (Alter 2012; Rai and Sambamurthy 2006). Most definitions highlight the collaborative and interactive nature of service, involving service providers and customers who co-create value through resource integration (Vargo and Lusch 2016). The emergence of DT has further transformed traditional service models, giving rise to SmartSIs that blur the boundaries between the physical and digital realms (Barrett et al. 2015).

Organizations require structured frameworks and practical guidance to address these transformative changes in value delivery and harness the potential of DT. Understanding different types of DDI and their value delivery mechanisms becomes crucial for successful DI. Against this backdrop, Section II.2 of this dissertation addresses DDI and its implications for value delivery by presenting insights from research articles on DDI archetypes and the application of the ENVELOPE framework at ZEISS. This framework illustrates how organizations can effectively integrate DT into service delivery and provide a structured framework for intrapreneurs to drive innovation from within their organizations. By focusing on these aspects, the dissertation aims to equip established organizations with the necessary tools to leverage data-driven outcomes and enhance their positioning in the digital landscape.

Research Article #4: Leveraging Data for Innovation – Archetypes of Data-Driven Innovation.
The investigation into DDI archetypes addresses the critical need for organizations to harness data effectively as a means of enhancing service delivery and creating value. As organizations increasingly rely on data-driven strategies to adapt to competitive pressures, understanding the various archetypes of DDI becomes essential for optimizing DI processes and outcomes.

The motivation for exploring DDI stems from the recognition that effective use of data can significantly improve organizational performance and customer engagement. As businesses face complex challenges in rapidly evolving markets, they require frameworks that facilitate the categorization and application of data-driven strategies (Vega and Chiasson 2019). A structured taxonomy of DDI archetypes provides a means for organizations to identify and implement effective data initiatives.

	Dimension		Characteristics						
Data Analytics	Analytics perspective	NE	Descriptive	Diagnostic	Predictive	Prescriptive	Cognitive		
	Data value chain	NE	Generation	Acquisition	Processing	Aggregation	Analytics	Visualization	Distribution
	Data purpose	NE	Explorative		Validative		Generative		
	Innovation Cycle	NE	Idea generation	Define	Develop	Test	Launch	Outcome	
Value Creation	Value Proposition	NE	Hedonic Value		Functional Value		Social Value		
	Offering	E	Data-as-a-product	Data infrastructure solutions		Data-driven Services (DDS)		Bundle of BMPPS and DDS	
	Customer Focus	NE	Connecting	Monitoring	Controlling	Optimizing	Securing		
	Digital Value	NE	Personalization	Engagement	Community Building	Automation	Augmentation		
	Monetization	E	Frontstage		Backstage		Frontstage and Backstage		

NE = Non-exclusive; E = Exclusive

Table 6 Taxonomy of DDIs & relative frequencies of the sample data

The theoretical foundation of this research is rooted in existing literature on service innovation and data utilization. Key concepts such as service co-creation (Vargo & Lusch, 2016) and resource integration (Oberländer et al. 2021) inform the understanding of how data can be leveraged to enhance service offerings. This framework emphasizes the interplay between DT and value creation processes, highlighting the importance of categorizing DDI initiatives to better understand their impact on organizational success.

The research method employed involves a systematic approach to taxonomy development. Initially, 115 DDI cases were identified from a diverse range of organizations, including both established organizations and startups. Utilizing a two-fold clustering technique, the analysis revealed 22 distinct clusters of DDI initiatives, ultimately leading to the identification and validation of 18 archetypes that represent various strategies for leveraging data. This iterative process incorporates literature reviews and interviews with IS researchers, ensuring a comprehensive understanding of the DDI landscape.

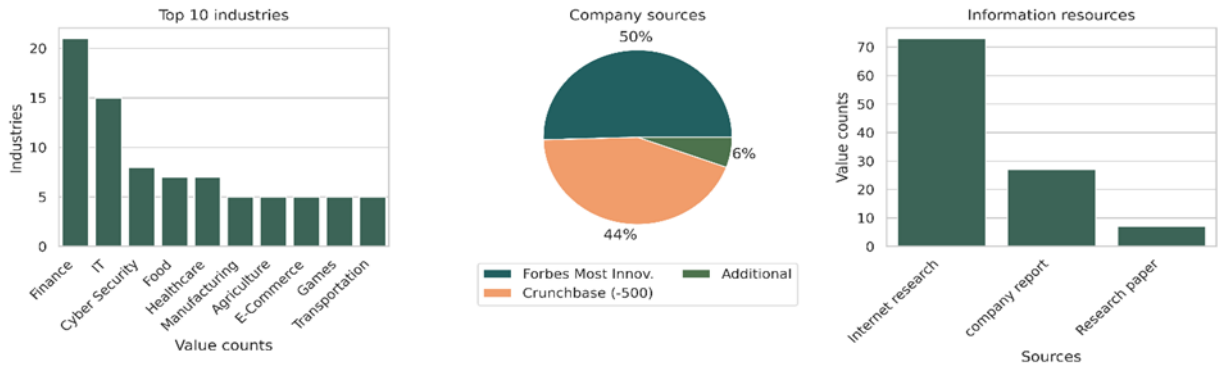


Figure 7Description of underlying dataset

The findings illustrate the significance of DDI archetypes as frameworks for categorizing organizational data initiatives. Each archetype is characterized by unique features that state how organizations can effectively utilize data to innovate and enhance service delivery. The taxonomy not only aids organizations in identifying their current approaches but also highlights areas for potential improvement.

Based on our data sample and the categorization within the characteristics of the taxonomy, 18 archetypes of DDI were derived as main artefacts. The archetypes can be categorized into two main categories. The first category embraces archetypes using data to enhance the innovation process (means), and the second category of DDIs uses data to enable new commercially viable value (end). The DDI archetypes are displayed in Figure 8 (data as a means) and Figure 9 (data as an end). The research identifies and categorizes 18 DDI archetypes, within the innovation process. These archetypes are mapped across a five-phase innovation process (idea generation, define, develop, test, and launch) and are classified according to data analytics maturity levels (descriptive to cognitive) (Gruner and Homburg 2000; Yoo et al. 2012).

The first category comprises archetypes that use data as a means to enhance the innovation process itself, structured along five phases (idea generation, define, develop, test, and launch) with varying levels of data analytics maturity from descriptive to cognitive (Gruner & Homburg, 2000; Yoo et al., 2012). These process-oriented archetypes include examples like augmented ideation and data-driven marketing, serving primarily to improve existing innovation processes.

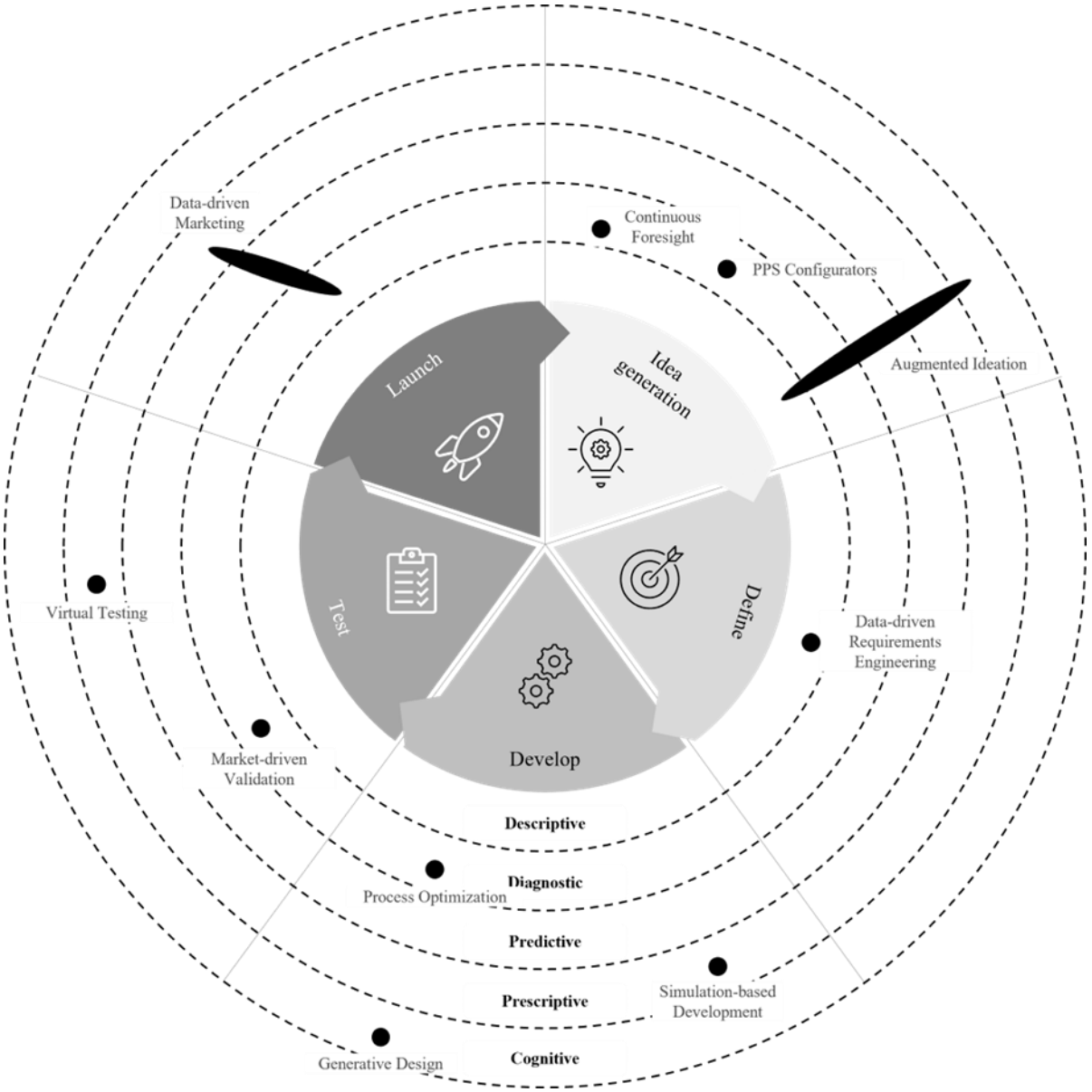


Figure 8 DDI archetypes (Innovation Process)

In contrast, the second category encompasses archetypes where data serves as an enabler and key resource for creating new commercial value through Business Model Product Process Services (BMPPS) depicted in Figure 9. This category includes eight distinct archetypes such as Personalization, digital twin, and decision support systems, as exemplified by Intuitive Surgical's My Intuitive app (My Intuitive). A unique characteristic of this second category is that its outcomes can simultaneously serve as both end products and enablers for new innovations, creating a cyclical relationship between data as means and end. This dual categorization highlights the comprehensive role of DDI outcomes, serving both as a process enhancer and as a foundation for new value creation.

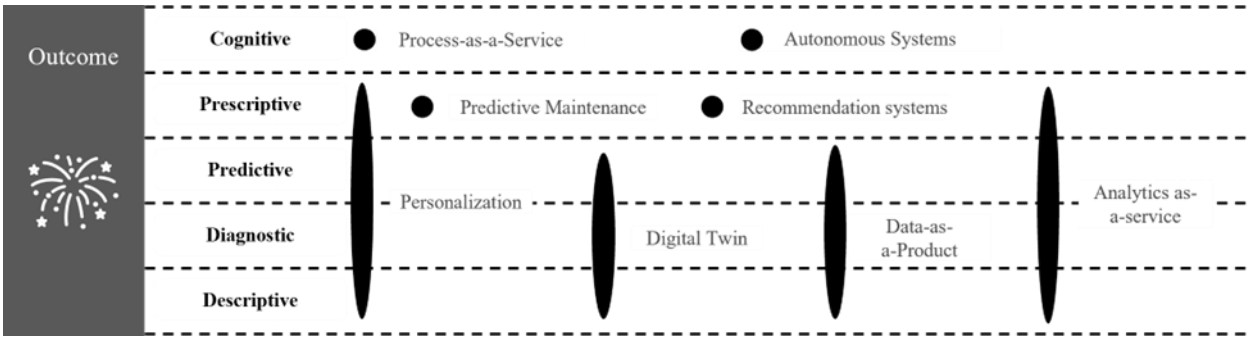


Figure 9 DDI archetypes (Innovation Outcome)

In conclusion, exploring DDI archetypes contributes to understanding how organizations can implement data-driven strategies to create value. The research emphasizes the importance of adopting a data-centric approach to service innovation, which is exemplified by real-world applications (Gimpel et al., 2018).

Despite the growing relevance of DDI, research in this area remains nascent, indicating the need for a focused structure. Future research should aim to deepen the understanding of these archetypes and their implications for value delivery, providing organizations with the necessary frameworks to navigate the complexities of DI. By clarifying the characteristics of DDI and exploring the operationalization of smart services, this research offers valuable insights for practitioners and scholars interested in the intersection of data analytics and service innovation.

Research Article #5: The ENVELOPE Framework: Navigating Smart Service Value Delivery at ZEISS.

Digital servitization has fundamentally transformed how manufacturing organizations deliver value through smart services (Paschou et al. 2020; Raddats et al. 2019; Raddats et al. 2022). As organizations increasingly integrate DT into their product offerings, the mechanisms behind smart service value delivery remain underexplored, creating challenges for effective implementation (Kohtamäki et al. 2019; Sklyar et al. 2019). Through a clinical research collaboration with ZEISS, a leading healthcare device manufacturer, this study introduces the ENVELOPE framework to guide smart service value delivery in healthcare settings.

The research employs a structured clinical research approach (Baskerville et al. 2023) through five real-world interventions to develop and validate the framework. ZEISS's transformation from traditional manufacturing to smart service provision offers valuable insights into how organizations can effectively leverage DT for value delivery (depicted in Figure 10). The ENVELOPE framework encompasses four key dimensions - individual actor, resource, market, and enabler - each comprising essential actions that ensure comprehensive smart service value delivery (Barrett et al. 2015; Vargo and Lusch 2011, 2017). For instance, the individual actor dimension emphasizes the importance of engaging end-users and ensuring proactive communication through data-driven insights. The resource dimension focuses on leveraging ZEISS's internal capabilities, such as data analytics and service expertise, to enhance service

performance. The market dimension considers external factors, including regulatory compliance and ecosystem partnerships, which impact service delivery.

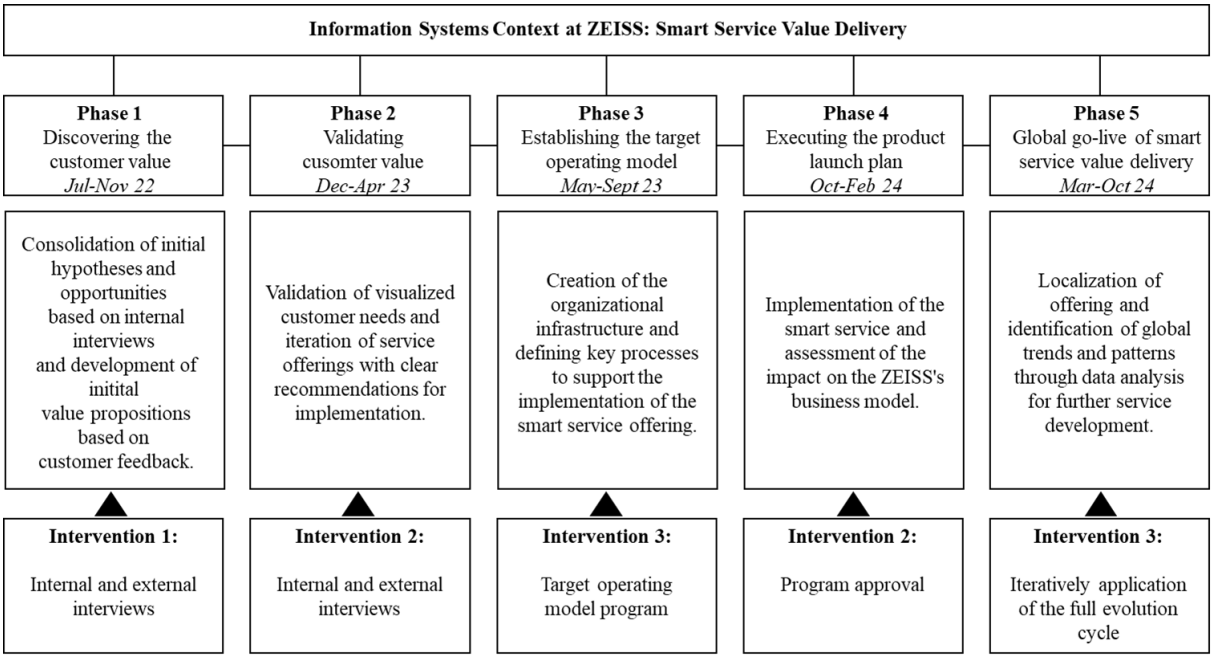


Figure 10 Interventions at ZEISS

The framework's implementation at ZEISS demonstrates how organizations can systematically approach smart service value delivery through eight key actions: Engage, Notice, Visualize, Enhance, Leverage, Orchestrate, Partner, and Evolve (ENVELOPE) depicted in Figure 11. These actions enable organizations to balance technological capabilities with human elements while ensuring regulatory compliance and operational efficiency (Bustinza et al. 2015; Coreynen et al. 2017). The study confirms that successful smart service value delivery requires iterative refinement, cross-functional collaboration, and careful consideration of stakeholder needs (Forkmann et al. 2017; Goduscheit and Faullant 2018).

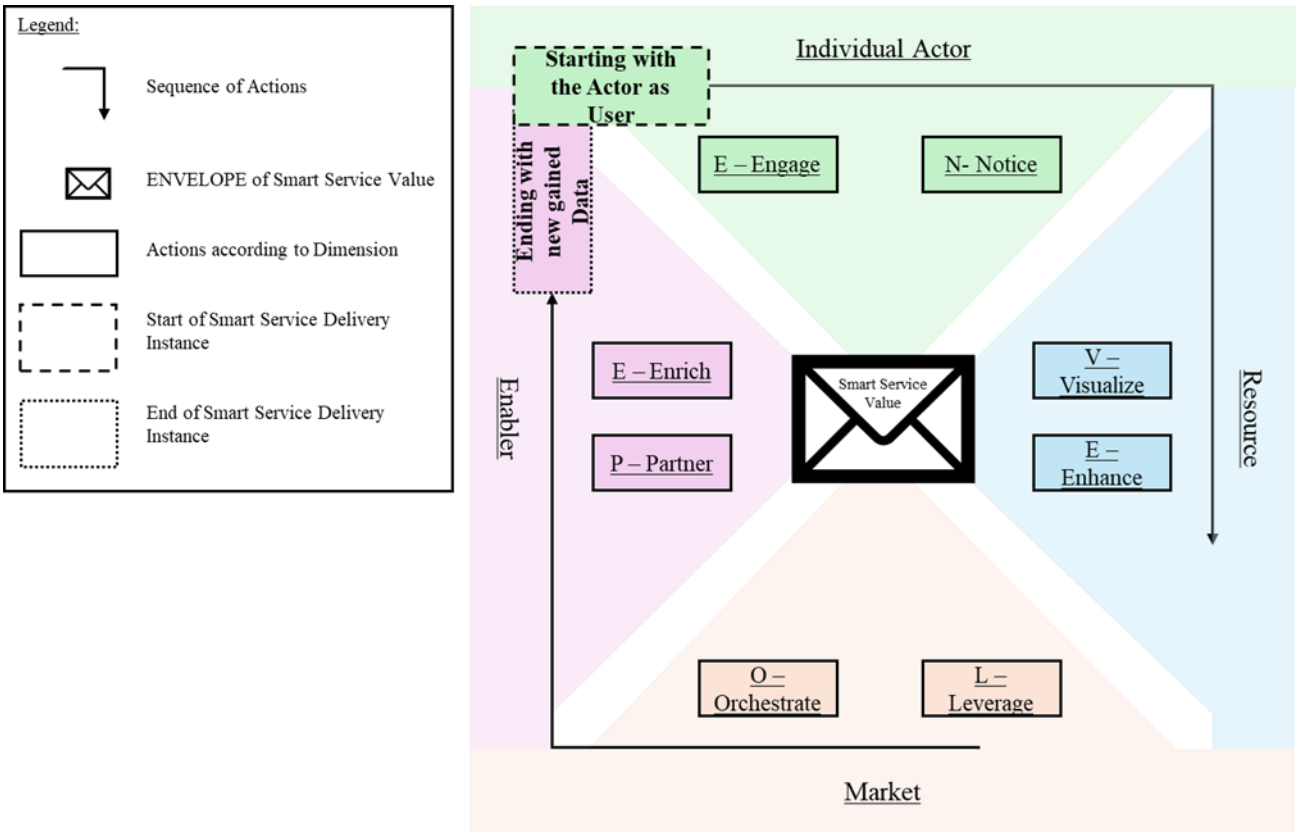


Figure 11 ENVELOPE Framework

Building on service-dominant logic (Vargo and Lusch 2004), the research contributes to both theoretical understanding and practical application of digital servitization. The findings emphasize how organizations must evolve from product-centric to service-oriented business models while maintaining regulatory compliance and customer focus (Beverungen et al. 2019a; Kohtamäki et al. 2019). The framework provides actionable guidance for healthcare manufacturers navigating the complexities of smart service implementation, while also advancing theoretical knowledge in digital servitization research (Paschou et al., 2020; Raddats et al., 2022).

The study's limitations include its focus on healthcare manufacturing and reliance on a single case organization. Future research opportunities include exploring the framework's applicability across different industries and investigating the integration of emerging technologies such as AI and IoT into smart service models (Vendrell-Herrero et al. 2021; Sklyar et al. 2019). Despite these limitations, the ENVELOPE framework represents a significant contribution to understanding how organizations can effectively deliver value through smart services in an increasingly digital healthcare landscape.

This research ultimately demonstrates that successful smart service value delivery requires a balanced approach that considers both technological capabilities and human factors, while ensuring alignment with regulatory requirements and market demands (Kohtamäki et al., 2019; Vargo et al., 2024). The ENVELOPE framework provides a structure for organizations to achieve this balance, offering both theoretical insights and practical guidance for the digital transformation of healthcare manufacturing.

Conclusion of examining Digital Innovation Outcomes and Value Delivery

The research in this section explores the evolving landscape of DDI and SmartSI value delivery, highlighting insights for organizations navigating DI outcomes. Two research articles provide complementary perspectives on how organizations can systematically leverage data to deliver value. Research Article #4, develops a taxonomy of DDI archetypes across different innovation process stages. Research Article #5, presenting the ENVELOPE framework, focuses specifically on SmartSI value delivery in the healthcare sector. The framework emphasizes the importance of continuous adaptation in delivering smart services. Together, these research articles underscore a shift in how organizations approach DI. By providing both theoretical insights and practical guidance, these research articles contribute to a deeper understanding of how organizations can effectively leverage data to deliver value with DI outcomes.

III Conclusion[2]

III.1 Summary

DI are indispensable for organizations of all sizes and industry branches (Nambisan et al. 2017; Vial 2019). In the digital age, customers expect digital access (e.g., to SmartSI) anywhere and anytime, demanding a seamless experience (Barrett et al. 2015; Beverungen et al. 2019b). Organizations must, therefore, shift their mindset from product solutions to customer-oriented DI solutions to meet these evolving needs. Given this context, this dissertation analyzes the DI process and outcomes, thereby addressing the shift in customer interaction from products to digital solutions (e.g., SmartSI). SmartSI further bridges the gap between physical and digital worlds (Beverungen et al. 2019b; Kohli and Melville 2019). Although knowledge of DI processes and outcomes has matured, organizations face challenges in creating DI. Innovation processes tend to be time-consuming and risky leading to unpredictable outcomes. In particular, research and practice demand descriptive and prescriptive knowledge on supporting DI processes and specifying DI outcomes (Hund et al. 2021; Kohli and Melville 2019). Given the presented research articles, this dissertation contributes to understanding and managing DI processes and outcomes. This dissertation draws on five research articles to better understand DI, focusing on two key objectives: "*understanding DI processes across various DI types* " and "*examining digital innovation outcomes and value delivery*."

Concerning the first objective of guiding the DI process, Section II.1 presents three research articles that build on various conceptual lenses that support organizations and research in

[2] This section uses some content from the research articles in this dissertation. I have left out the usual citation labels to make the text easier to read.

understanding the DI process. The dimension of DI focus differentiates between the process and outcome of DI. Process-oriented DI involves managing the stages of initiation, development, implementation, and exploitation (Kohli & Melville, 2018). Outcome-oriented DI, on the other hand, focuses on the value delivery of DI outcomes such as new products, services, or business models (Fichman et al., 2014).

Research Article #1 emphasizes the importance of systematic approaches to leverage opportunities for DI. The article examines how DTs are influencing opportunity recognition. DTs extend traditional approaches of opportunity recognition by blurring the boundaries between customers, organizations, products, and industries. The article identifies three direct and three indirect effects of DT on opportunity recognition. These effects are driven by digital phenomena such as increasing digital invasiveness and the dissolution of product, industry, and organization boundaries. The results help to improve the understanding and management of the processes and outcomes of DI and provide valuable insights for the further development of digital entrepreneurship research.

Research Article #2 introduces a comprehensive research agenda demonstrating how DSI emerges as a synthesis of two critical research streams—DI and social innovation—with the aim of constructing a knowledge foundation on DSI by leveraging DT to address complex societal challenges (Qureshi et al., 2021; Tim et al., 2021). Through a structured literature review, the study systematically identifies multiple dimensions of DSI, providing a conceptual framework that captures well-researched themes and delineates pathways for future investigation (Webster & Watson, 2002; Boell & Cecez-Kecmanovic, 2015). The study addresses the grand societal challenges by synthesizing diverse perspectives and building upon existing theoretical foundations from DI, and social innovation (Walsham 2017). The findings offer a synthesis of six research clusters and twelve research pathways designed to guide future research. Moreover, the research contributes to both theoretical understanding and practical application of DSI by bridging previously isolated research streams, identifying research gaps, and introducing a research agenda. Through this agenda, the study aims to advance DSI research and empower practitioners to address societal challenges.

Research Article #3 explores the "SmartSI Compass," a method for SmartSI idea generation that addresses the methodological gaps in the DI process (Kohli & Melville, 2019; Marx et al., 2020). The research confronts organizations' inherent complexity when generating SmartSIs by synthesizing insights from technological, value creation, and systems perspectives (Beverungen et al., 2019; Ciriello et al., 2018). Developed through DSR and consortium research (Peffers et

al. 2007; Österle and Otto 2010), the method provides practitioners with a, step-by-step guidance framework. The research emphasizes digital infrastructure's dual role as an innovation initiator and connector, facilitating an approach to SmartSI idea generation (Fichman et al., 2014; Nambisan, 2017). The SmartSI Compass enables organizations to generate SmartSI ideas by aligning them with existing organizational resources and evolving customer needs (Vargo & Lusch, 2004; Beverungen et al., 2019). By providing a method, the research contributes prescriptive knowledge to the often understudied initiation phase of DI (Kohli & Melville, 2019), supporting organizations in leveraging DT to enhance value propositions. This research advances the scholarly discourse on DI by offering a theoretically grounded, practically applicable method for SmartSI idea generation (Gregor and Hevner 2013). The findings expand the theoretical understanding of DI processes and provide guidance for practitioners navigating the complex landscape of SmartSI (Teixeira et al. 2019).

The second objective focuses on DI outcomes. Section II.2 presents two research articles that examine data-driven DI outcomes and the value delivery of SmartSI.

Research Article #4 presents a taxonomy for understanding DDI, offering an understanding of how organizations can leverage data to generate value (Kohli & Melville, 2019; Yoo et al., 2012). The research examines the transformative potential of data analytics and DTs in reshaping traditional business models, products, processes, and services (Henfridsson et al., 2018; Nambisan et al., 2017). By developing a taxonomy with nine distinct dimensions and 41 characteristics, the study provides a framework for understanding DDI across two primary layers: data analytics and value creation (Kundisch et al. 2022; Nickerson et al. 2013). The research identifies distinct DDI archetypes, demonstrating the multifaceted nature of DDI and its potential to create value (Hunke et al. 2022). Critically, the study addresses a significant research gap by offering a holistic perspective that considers data as both a means and an end in the innovation process (Engelbrecht et al. 2016). This approach distinguishes the research from previous research focusing on DI processes and outcomes in isolation (Trabucchi and Buganza 2019). The taxonomy and archetypes provide a theoretical contribution and offer practical guidance for organizations seeking to leverage data. By mapping DDI archetypes along the DI process and assigning them to data analytics maturity levels, the research provides a valuable tool for researchers and practitioners to understand DDI (Cavanillas et al. 2016).

Research Article #5 The ENVELOPE framework illuminates SmartSI through the theoretical lens of digital servitization, exploring how advanced DTs enable organizations to transform traditional product-centric models into, dynamic service ecosystems (Kohtamäki et al., 2019;

Paschou et al., 2020). Developed via a clinical research method in collaboration with ZEISS, the framework offers an approach for organizations to strategically navigate the complex landscape of SmartSI value delivery, addressing the critical challenges of integrating DT, resource reconfiguration, and value co-creation (Baskerville et al., 2023; Coreynen et al., 2017; Raddats et al., 2019). By providing a structured model that emphasizes the interplay between technological capabilities, organizational actors, and market dynamics, the ENVELOPE framework serves as a pivotal theoretical and practical instrument for understanding and implementing digital servitization strategies in increasingly digitalized business environments (Beverungen et al., 2019b; Vargo & Lusch, 2016;).

These articles contribute to understanding the dual dimensions of DI focus and DI type, providing a better understanding of DI (i.e., processes and outcomes). By integrating insights from DSI, DDI, and SmartSI this dissertation supports research and organizations leveraging DT to facilitate DI.

III.2 Limitations and Future Research

Like any research endeavor, this dissertation is beset with limitations that stimulate further research. This section offers an aggregated view of the overall limitations of the dissertation, while the specific limitations of each research article are discussed within the articles themselves (see Appendix). Additionally, this section presents suggestions for future research advancing the knowledge to meet customer needs in the digital age, especially in the field of DI.

A key limitation across Research Articles #1, #2, and #4 is the gap between theoretical frameworks and practical application in DI. Many existing models and approaches remain abstract and lack practical guidance for organizations seeking to implement them effectively. While all three research articles rely on literature reviews and expert interviews (i.e., Research Articles #1, and #2), this may not fully capture the latest empirical developments. This reliance could limit the depth of insights regarding how DTs influence DI processes and their outcomes across different contexts. In addition, the research articles acknowledge the emerging nature of DI and the importance of understanding its evolving landscape about DT. However, they do not address the potential biases or ethical considerations associated with using DT, which could impact their effectiveness and social value. Studies reveal that gender differences play a crucial role in entrepreneurial activities and intentions (Haus et al. 2013). Future research should understand potential biases, including gender-based differences in DI for creating inclusive DI. Hence, future research should aim to deepen the understanding of these dynamics, ensuring that

insights are descriptive and prescriptive, thereby supporting organizations in navigating the complexities of DI processes across various DI types. Future research could focus on longitudinal studies exploring DTs' evolving impact. Furthermore, a mixed-methods approach would be beneficial, combining quantitative surveys with qualitative case studies to capture broad trends and contextual nuances. This method provides valuable insights into how DT can be effectively leveraged to better address the DI process, leading to valuable outcomes.

Another limitation is the focus on manufacturing organizations in Research Articles #3 and #5. However, DIs have vast potential in other industries, education, and the public sector. Future research should expand to examine how DI processes apply to other sectors and develop context-specific insights that go beyond manufacturing applications. Longitudinal studies could provide insights into how organizations adapt the method over time. Additionally, incorporating diverse stakeholders in the research process can facilitate a deeper understanding of the dynamics involved in SmartSI idea generation and implementation. Firstly, while the SmartSI Compass and ENVELOPE were developed in collaboration with manufacturing organizations, their applicability in other sectors remains untested. The challenges related to both may vary across different industries, and future research should explore how the methods can be adapted for diverse contexts, including the public sector, and startups. Secondly, both focus primarily on one phase of the DI process (e.g., SmartSI focuses on initiation, and ENVELOPE focuses on the outcome), which may overlook critical considerations related to subsequent phases such as development, implementation, and exploitation. Future research should investigate the necessary methods for these stages.

The insights of this dissertation (i.e., Research Articles #4 and #5) are the foundation for further theory development endeavors. Quantitative research approaches seem promising for validating the results. Furthermore, addressing the ethical considerations of data usage in DI processes and outcomes is crucial. Drawing on key privacy and data ethics literature, future research must prioritize responsible innovation frameworks. Scholars like Acquisti et al. (2015) and Bélanger and Crossler (2011) have highlighted the complex relationship between privacy, trust, and technological innovation. Especially, ethical implications of data usage in DI have become paramount. Future research should examine how organizations implement DDI while ensuring compliance with privacy regulations and maintaining customer trust (Baumann et al. 2019). Thereby, future research must focus on three key areas: First, developing privacy-aware DI frameworks that integrate privacy-by-design principles, as Cavoukian (2012) outlined. Second, designing efficient data collection mechanisms that protect user privacy while enabling DI (Dinev et al. 2015; Gregory et al. 2021). Third, examining regulatory aspects requires specific

attention. Analyzing the implications of regulations such as the General Data Protection Regulation and the California Consumer Privacy Act on innovation strategies is important (Islam et al. 2024). In addition, future research should investigate the impact of European regulations like the General Data Protection Regulation on DI (Martin et al. 2019).

In conclusion, this dissertation advances the existing body of knowledge on DI by providing an understanding of how DTs influence the processes and outcomes of various DI types. While DTs are expected to evolve rapidly, the core principles of DI will remain constant. Organizations across various sectors must adapt to the dynamic environment to maintain their competitiveness and, more importantly, to deliver value to their customers. The findings presented in this dissertation contribute to addressing the challenge of continuous transformation through DI, equipping organizations with the necessary methods and frameworks to navigate the complexities of DI. The insights gained will guide future research and serve as a foundation for understanding DI processes and outcomes to achieve sustainable competitive advantage in an increasingly digital landscape.

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During the preparation of this work the author used Artificial Intelligence (AI)-based writing assistance for linguistic optimization, final text review, spelling correction and readability enhancement. After using AI assistance, the author reviewed and edited the content as needed and takes full responsibility. The use of these tools (e.g. Grammarly, Claude) was conducted in accordance with the University of Bayreuth's guidelines for good scientific practice.

VII Appendix

VII.1 Index of Research Articles

Research Article #1 The effects of digital technology on opportunity recognition.
Kreuzer, T., Lindenthal, A. K., Oberländer, A. M., & Röglinger, M. (2022). The effects of digital technology on opportunity recognition. Business & Information Systems Engineering, 64(1).
(VHB-Jourqual 3: Category B | VHB Rating 2024: Category B | Impact Factor (2023): 7,4)
Research Article #2 Digitally Social: Review, Synthesis, and Future Directions for Digital Social Innovation.
Krombacher, Anna; Lindenthal, Anna-Katharina; Oberländer, Anna Maria; Schäfer, Ricarda (2024). Digitally Social: Review, Synthesis, and Future Directions for Digital Social Innovation. Under revision: Outlet hidden due to double-blind review process.
(VHB-Jourqual 3: Category B | | VHB Rating 2024: Category B | Impact Factor (2023): 6.9)
Research Article #3 The SmartSI Compass: A method for generating smart service innovation ideas.
Kuch, F., Lindenthal, A. K., Oberländer, A. M., Cortenraad-Wenninger, A., & Buck, C. (2024). The SmartSI Compass: A method for generating smart service innovation ideas. Information & Management, 61(5).
(VHB-Jourqual 3: Category B | | VHB Rating 2024: Category B | Impact Factor (2023): 8,2)
Research Article #4 Leveraging Data for Innovation – Archetypes of Data-Driven Innovation.
Leveraging Data for Innovation – Archetypes of Data-Driven Innovation. Submitted to: Outlet hidden due to double-blind review process.
(VHB-Jourqual 3: Category C | | VHB Rating 2024: Category B | Impact Factor (2023): 2,5)
Research Article #5 The ENVELOPE framework: Navigating Smart Service Value Delivery at ZEISS.
Lindenthal, Anna; Adler, Leon Marcel; Kuch, Felicitas; Lindenthal, Anna; Gebauer, Heiko, and Oberländer, Anna Maria (2024). The ENVELOPE framework: Navigating Smart Service Value Delivery at ZEISS. Submitted to: Outlet hidden due to double-blind review process.
(VHB-Jourqual 3: Category B | VHB Rating 2024: Category B | Impact Factor (2023): 7,1)

Table Appendix 1. Index of research articles

Further, I also co-authored the following research papers. These papers are not part of this dissertation.

Research Article #6 DIGITALLY SOCIAL: REVIEW, SYNTHESIS, AND FUTURE DIRECTIONS FOR DIGITAL SOCIAL INNOVATION.
Graf-Drasch, Valerie; Krombacher, Anna; Lindenthal, Anna; Oberländer, Anna Maria; and Schäfer, Ricarda, "DIGITALLY SOCIAL: REVIEW, SYNTHESIS, AND FUTURE DIRECTIONS FOR DIGITAL SOCIAL INNOVATION" (2022). *ECIS 2022 Research Papers*. 39. https://aisel.aisnet.org/ecis2022_rp/39 (VHB-Jourqual 3: Category B | VHB Rating 2024: Category A)
Research Article #7 Navigating Value — A Servitization Pathway for the Value Delivery of Smart Services.
Adler, Leon Marcel; Kuch, Felicitas; Lindenthal, Anna; and Gebauer, Heiko, "Navigating Value — A Servitization Pathway for the Value Delivery of Smart Services" (2024). ECIS 2024 Proceedings. 6. https://aisel.aisnet.org/ecis2024/track11_dss/track11_dss/6 (VHB-Jourqual 3: Category B | VHB Rating 2024: Category A)

Table Appendix 2. Further research articles

VII.2 Individual Contribution to the Included Research Articles

In this cumulative thesis, five Research Articles build the main body of this work. All Research Articles were developed in teams with multiple co-authors. Thus, this section details the respective research settings and highlights my individual contribution to each Research Articles.

Research article #1 (Kreuzer et al. 2022) was developed together with three co-authors (i.e.: Thomas Kreuzer, Anna Maria Oberländer, Maximilian Röglinger), with all authors jointly developing the opportunity-led ideation method. Together with one co- author, I took a key role in conducting the research project and collecting research data. Moreover, I was primarily responsible for the underlying literature work, the data collection and analysis, and the application and evaluation of the method. I also took a key role in revising the article for re-submission. In sum, I was involved in each part of the project.

Research article #2 (Krombacher et al. 2024) was developed together with three co-authors (i.e.: Anna Krombacher, Anna Maria Oberländer, Ricarda Schäfer). A former version has been presented at the 30th European Conference on Information Systems, 2022 after which we incorporated the reviewers' feedback to significantly advance our work. All co-authors jointly developed the analytical lens and the method, building on that foundation. I was particularly involved in the conduction of the literature review, the data coding and interpretation, the presentation of the research results as well as textual elaboration. I also took a key role in revising the article for re-submission.

Research article #3 (Kuch et al. 2024) was developed with four co-authors (i.e.: Felicitas Kuch, Annette Cortenraad-Wenninger , Anna Maria Oberländer, Christoph Buck). I contributed to this article by co-initiating and co-developing the entire research project. Moreover, I participated in research discussions and provided feedback on the paper's content and structure. In particular, I engaged in the further development of the research idea, the synthesis and presentation of the research results as well as textual elaboration. I also took a key role in revising the article for re-submission. Thus, my co-authorship is reflected in the entire research project.

Research article #4 (Dilger et al. 2025) was developed in a team of four co-authors (i.e.: Michael Bitzer, Philipp Dilger, Anna Maria Oberländer, Tim Meyer-Hollatz). I contributed to this article by co-initiating and co-developing the entire research project. I was primarily responsible for the underlying literature work. In addition, I took a key role in the taxonomy development, the evaluation, and the development of corresponding archetypes. Additionally,

I engaged in the further development of the research idea and textual elaboration of the entire manuscript. Thus, my co-authorship is reflected in the entire research project.

Research article #5 (Lindenthal et al. 2024) was developed together with four co-authors (i.e.: Leon Adler, Felicitas Kuch, Anna Maria Oberländer, Heiko Gebauer). A former version has been presented at the 32nd European Conference on Information Systems, 2024 after which we incorporated the reviewers' feedback to significantly advance our work. Being the leading author, I had the main role in initiating the research project and contributing by co-developing and driving the entire research project. I was primarily responsible for the underlying literature work, for compiling the ENVELOPE framework, and for conducting the evaluation. Although the research article represents to a large extent my work, the four co-authors were involved in all parts of the project and helped to advance our contribution.

VII.4 Research Article #1: The Effects of Digital Technology on Opportunity Recognition.

Authors: Kreuzer, Thomas; Lindenthal, Anna-Katharina; Oberländer, Anna Maria; Röglinger, Maximilian

Published in: Business & Information Systems Engineering (2022).

Abstract: Recognizing opportunities enabled by digital technology (DT) has become a competitive necessity in today's digital world. However, opportunity recognition is a major challenge given the influence of DT, which not only disperses agency across various actors, but also blurs boundaries between customers, companies, products, and industries. As a result, traditional entrepreneurship knowledge needs to be rethought and the effects of DT on opportunity recognition need to be better understood. Drawing from opportunity recognition theory – as one of the central theories in the entrepreneurship domain – this study builds on a structured literature review to identify and explain three direct as well as three transitive effects of DT on opportunity recognition. These effects have been validated with real-world cases as well as interviews with academics and practitioners. In sum, this study contributes to descriptive and explanatory knowledge on the evolution from traditional to digital entrepreneurship. As a theory for explaining, the findings extend opportunity recognition theory by illuminating how and why DT influences opportunity recognition. This supports research and practice in investigating and managing opportunities more effectively.

Keywords: Opportunity recognition, Digital entrepreneurship, Digital technology, Digital technology effects, Digital innovation

VII.5 Research Article #2: Sustainable through Digital – A Research Agenda for Digital Social Innovation

Authors: Krombacher, Anna; Lindenthal, Anna-Katharina; Oberländer, Anna Maria; Schäfer Ricarda

Submitted To: Outlet hidden due to the double-blind review process.

Abstract: Addressing today's pressing sustainability challenges requires the integration of digital innovation (DI) and social innovation (SI) research streams, which have largely evolved in isolation (Elkington, 1997; Kohli & Melville, 2019). Digital Social Innovation (DSI) emerges at this intersection, leveraging digital technologies to create social value and accelerate sustainable development in line with the United Nations Sustainable Development Goals (SDGs) (Purvis et al., 2019; United Nations, 2015). This study systematically reviews 135 DSI-related publications, synthesizing their contributions through a multidimensional framework that spans digital technology, digital innovation, and social innovation (Nambisan et al., 2017). The review reveals that DSI research is highly fragmented and scattered across disciplines and terminologies, impeding the formation of a cohesive knowledge base. To address this, the study develops and validates a research agenda comprising 12 research pathways, structured along three key dimensions: the role of digital technologies as means or ends, the core elements of the DI process, and the three pillars of sustainability embedded in SI (Schumpeter, 1934; Kohli & Melville, 2019). The agenda was further refined through expert validation, ensuring relevance for both academia and practice. By joining the forces of DI and SI, this work provides a foundation for advancing DSI research, guiding Information Systems scholars and practitioners in leveraging digital solutions to tackle real-world societal challenges and contribute meaningfully to sustainable development.

Keywords: Digital Social Innovation, Literature Review, Research Agenda, Sustainability

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VII.6 Research Article #3: The SmartSI Compass: A Method for Generating Smart Service Innovation Ideas

Authors: Kuch, Felicitas; Lindenthal, Anna-Katharina; Oberländer, Anna Maria; Cortenraad-Wenninger, Annette; Buck, Christoph

Published in: Information & Management (2024).

Abstract: Smart Service Innovations (SmartSIs) are crucial for future competitiveness, but established organizations often struggle with the complexity of generating SmartSI ideas. Thus, we propose the SmartSI Compass, a method for systematically generating SmartSI ideas drawing from current smart service research and being theoretically anchored in technological, value creation, and systems perspectives. We developed the method in collaboration with practitioners according to design science research. With the SmartSI Compass, we make a prescriptive contribution to the body of knowledge on the initiation phase of digital innovation and support practitioners in generating SmartSI ideas.

Keywords: Smart Service Innovation; Digital Innovation; Idea Generation; Design Science Research; Method Development; Consortium Research

VII.7 Research Article #4: Leveraging Data for Innovation – Archetypes of Data-Driven Innovations

Authors: Dilger, Philipp; Lindenthal, Anna; Meyer-Hollatz, Tim; Oberländer, Anna Maria; Bitzer, Michael

Submitted to: Outlet hidden due to the double-blind review process

Abstract: Although data is often referred to as the "oil of the 21st century," its value is only realized when organizations effectively leverage it to drive innovation (Sondergaard, 2011; Bai et al., 2016). Data-driven innovation (DDI) is defined as the purposeful use of data and analytics to enhance or create new business models, products, processes, and services (OECD, 2015). Despite the increasing importance of DDI, research and practice lack a unified understanding of its types and roles in the innovation process (Hunke et al., 2021; Engelbrecht et al., 2016). To address this gap, this study consolidates existing research, develops a comprehensive taxonomy, and identifies five archetypes of DDI based on an analysis of 108 real-world innovation cases. The taxonomy was systematically developed using established methods (Nickerson et al., 2013) and captures the role, type, data processing, and sustainability aspects of DDIs. The identified archetypes—such as Data Ecosystem Creation & Curation and Intelligent Process Automation—are mapped along the innovation process and assigned to maturity levels, providing a structured lens for both researchers and practitioners. The findings highlight that DDIs not only drive economic value but also contribute to ecological and social sustainability, as illustrated by cases like DeepMind's AI-driven energy optimization (DeepMind, 2025). However, challenges such as data quality, integration, and skill shortages remain prevalent. By offering a holistic overview and practical framework, this research advances the descriptive knowledge of DDI and supports organizations in leveraging data for sustainable innovation.

Keywords: Data-driven Innovation; DDI; Archetypes; Digital Innovation Process

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VII.8 Research Article #5: The ENVELOPE Framework: Navigating Smart Service Value Delivery at ZEISS

Authors: Lindenthal, Anna-Katharina; Adler, Leon; Kuch, Felicitas; Gebauer, Heiko; Oberländer, Anna Maria

Submitted To: Outlet hidden due to the double-blind review process.

Abstract: Digital servitization—the strategic transformation from product-centric to service-based business models enabled by digital technologies—has become a key imperative for manufacturers seeking to maintain competitive advantage (Porter & Heppelmann, 2014; Kohtamäki et al., 2019; Raddats et al., 2022). While the development of smart, connected products is well established as a foundation for smart services (Kuch et al., 2024; Vargo & Lusch, 2008), the mechanisms by which organizations deliver the value of these services in practice remain insufficiently understood (Kohtamäki et al., 2019; Raddats et al., 2019). This challenge is particularly acute in healthcare, where regulatory requirements, diverse stakeholder needs, and reliability demands add significant complexity (Adler et al., 2024; Paiola & Gebauer, 2020).

This research addresses the question: How can healthcare device manufacturers effectively deliver value through smart services? Using a clinical research approach (Baskerville et al., 2023), we collaborated with ZEISS—a global leader in medical technology—over 27 months to systematically investigate and address real-world challenges in smart service value delivery. The research was structured around five interventions: (1) 31 semi-structured interviews with internal and external stakeholders to uncover customer needs, (2) field validation through hospital site visits, (3) iterative service blueprinting, (4) co-development of information system capabilities, and (5) ten evaluative interviews to validate the resulting framework.

The outcome is the ENVELOPE framework, which synthesizes insights from both literature and clinical practice. It identifies four key dimensions essential for effective smart service value delivery in healthcare: (1) the Individual Actor Dimension, focusing on stakeholder engagement; (2) the Resource Dimension, emphasizing organizational and technological capabilities; (3) the Market Dimension, addressing ecosystem and regulatory context; and (4) the Digital Enabler Dimension, highlighting the role of information systems and digital infrastructure. The framework is grounded in Service-Dominant Logic (Lusch & Nambisan, 2015; Vargo & Lusch, 2004) and builds on recent work on smart service systems (Beverungen et al., 2017; Fischer et al., 2020).

The ENVELOPE framework was validated in the context of ZEISS's proactive care service for microscopes, demonstrating its practical applicability for guiding

organizations through the complexities of smart service value delivery. Theoretically, it advances the understanding of value delivery by integrating multiple interacting dimensions, rather than isolated factors, and practically, it provides actionable guidance for healthcare manufacturers seeking to realize the benefits of digital transformation.

Keywords: Digital Servitization, Value Delivery, Smart Services, Clinical Research

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