Location-Specific Service Systems

A Geographic Information Systems Perspective on Value Co-Creation

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Dekan	Prof. Dr. Jens Müller
Gutachter	Prof. Dr. Daniel Beverungen Prof. Dr. Guido Schryen
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Preface

Space is what makes places possible: This guiding idea reminds us that spatial relations do more than describe geography—they shape how we live, work, and co-create value. At a time when urbanization, digitalization, and the individualization of services are reshaping society, location-based information is gaining strategic importance. We must make use of spatial data to innovate and augment service, the cornerstone of prosperity in our society. Still, the notion of place reminds us that there is more to human experience than value co-creation and business alone. Perhaps more importantly, place is about making oneself at home, enabling social interactions, and defining purpose and meaning in human existence.

Jennifer Priefer's dissertation puts both perspectives at the heart of her scholarly work. She investigates the specific role of Geographic Information Systems within Information Systems Research and develops a coherent framework for integrating spatial data into digital service systems. A central intellectual contribution is her conceptualization of location-enabled service—a new class of service that focuses on the added value of spatial data in service and complements our classic understanding of location-based service. Equally important, Jennifer has designed and evaluated innovative digital services in both B2C and B2B settings, ranging from data-driven real estate valuation to predictive maintenance concepts for components of the medium-voltage distribution grid. This blend of conceptual advance and field-tested IT artifacts exemplifies the ambition of our research group: to connect profound theoretical insights with digital innovations that matter beyond academia.

Jennifer's dissertation fits seamlessly with our chair's research agenda on digital service. The seed for this direction was sown in our SmartMarket² project, where we analyzed customer footpaths in a city center—sparking the idea to examine the role and potential of spatial data in service contexts. On this basis, we created the research position to which Jennifer applied—an excellent match that she has filled with distinction. Particularly valuable were Jennifer's academic background in geodesy, as well as her professional work experience at a local company providing GIS-based services. Triangulating this background with new knowledge on Information Systems enabled her to design and evaluate results that bridge theory and practice, as well as disciplines.

Beyond her scholarly achievements, Jennifer has demonstrated that *place* can sometimes mean more than *space*. I appreciate her collegial spirit, social competence, and

her commitment to supporting and enabling others—qualities she demonstrated in our faculty's Peer Mentoring Program. She builds bridges, strengthens teams, and models the kind of academic citizenship that makes a research community thrive.

That Jennifer has now completed her doctorate in her hometown of Paderborn lends this dissertation on service in spaces and places a special resonance. Paderborn exemplifies the interplay of rootedness and innovation in digital services; in this tradition, her work points the way forward toward spatial data, information systems, and value co-creation.

Paderborn, September 2025 Prof. Dr. Daniel Beverungen

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List of Abbreviations

AHP Analytic Hierarchy Process

AI Artifical Intelligence

AR Augmented Reality

B2B Business-to-Business

B2C Business-to-Consumer

BPM Business Process Management

CAMA Computer-Assisted Mass Appraisal

CBCA Choice-Based Conjoint Analysis

CNN Convolutional Neural Network

DDR Data-Driven Research

DL Deep Learning

DP Design Principle

DSR Design Science Research

DSRM Design Science Research Methodology

DSS Decision Support System

EHV Extra-High Voltage

ERP Enterprise Resource Planning

EV Electric Vehicle

EVCS Electric Vehicle Charging Station

GDP Gross Domestic Product

GIS Geographic Information System

GNSS Global Navigation Satellite System

GPS Global Positioning System

HV High Voltage

INSPIRE Infrastructure for Spatial Information in Europe

IoT Internet of Things

IS Information Systems

ISDT Information Systems Design Theory

IT Information Technology

LBA Location-Based Advertising

LBS Location-Based Service

LCS Location-Contextualizing Service

LV Low Voltage

MCDM Multi-Criteria Decision-Making

ML Machine Learning

MV Medium Voltage

POI Points of Interest

S-D Logic Service-Dominant Logic of Marketing

SDI Spatial Data Infrastructure

SDSS Spatial Decision Support System

WTP Willingness-To-Pay

Part A
Research Overview

1 Exposition

1.1 Introduction and Motivation

Services represent a significant component of the global economy, accounting for more than two-thirds of the global Gross Domestic Product (GDP) and driving the majority of new job opportunities worldwide (Organisation for Economic Co-operation and Development (OECD), 2022). Over the past decades, services have become increasingly sophisticated, and the integration of location information has gained popularity, particularly in analytics and marketing (McKenna et al., 2014; Uphaus et al., 2021). The global Location-Based Service (LBS) market, a key segment of the service economy, is predicted to grow from $31.17 billion in 2024 to $129.71 billion by 2032 (Fortune Business Insights, 2025), showing how important location information have become for service delivery. As service systems evolve, the field of service science has emerged as a key research area within Information Systems (IS) research (Böhmann et al., 2014), focusing on the design, implementation, and evaluation of service systems that enhance value creation and efficiency (Maglio et al., 2009). Service science, as an interdisciplinary field, aims to understand and improve the complex systems that enable value co-creation between service providers and customers (Vargo and Akaka, 2012). This approach is particularly relevant in the context of smart service systems (Beverungen et al., 2019), where technology plays a crucial role in facilitating interactions and delivering value (Lim and Maglio, 2018). Among the innovations shaping this evolution are geospatial data and technologies that have become foundational for many modern services, from navigation systems to fitness tracking applications.

In recent years, services building on geospatial data, such as LBS, have gained popularity due to their ability to simplify everyday tasks (Reddy, 2018). Whether it is navigating by car, bike, or foot (Lehrer et al., 2011), locating friends (Eldin and Wagenaar, 2004), using dating applications (Ryschka et al., 2014), or tracking fitness

through wearables (Lehrer et al., 2011), LBS are now embedded in daily life. Geospatial data have transcended their role as only being location indicators to becoming a strategic good that enriches services, influences decision-making, and inspires innovative business models (Unrau and Kray, 2018; Rahman et al., 2024; Chinnaswamy et al., 2019).

Geospatial data have ever since been a highly valuable resource, enabling navigation, mapping, and land management, among various other applications that have shaped our understanding of Earth's structure, continents, and environments. Maps and territorial cartography, for example, have long constituted tools for spatial analytics and decision-making, benefiting applications such as land information management, environmental studies, and natural hazard assessments (Lemmens, 2011). These tools have not only deepened the comprehension of complex ecological systems but have also supported sustainable land management, resource recycling, and ecosystem service assessments (Goswami et al., 2024; Yi et al., 2024).

The evolution of geospatial data and its integration into service systems has been accelerated by several factors. First, the rise of open data policies, such as the Open Government Data Act and Infrastructure for Spatial Information in Europe (INSPIRE), has significantly increased access to free geospatial data in the last years (European Commission, 2007). Open data initiatives aim to make government-held data more accessible and usable for the public, fostering innovation and transparency. INSPIRE seeks to develop a European-wide infrastructure for spatial data to promote the interoperability and sharing of environmental geospatial information among public sector institutions (European Commission, 2007). This increased availability of geospatial data has lowered the barriers to entry for businesses and developers, fostering the creation of new and innovative geospatial services.

Second, simultaneously the emergence of digitally connected objects, driven by trends like the Internet of Things (IoT), has created new opportunities for capturing not only more location data but also context-specific data about objects and their surroundings (Ozaif et al., 2024). Geospatial data consist of location information, like coordinates, and attribute data, like names, types, or conditions (Dueker, 1987; Sun et al., 2019; Temiz, 2023; P. Kumar et al., 2024). These data enable to get a new understanding of the surroundings and the geospatial context of objects and services. Further, complementary attribute data, such as user-specific information, enrich the contextual understanding of service situations. Location-Based Advertising (LBA) exemplifies how the combination of geographic data (e.g., user location) and

attribute data (e.g., preferences or behavior) can be leveraged to offer relevant recommendations and personalized offers, e.g., in supermarkets (Molitor et al., 2016).[1] The spread of mobile devices and the omnipresence of GPS technology have further pushed the integration of geospatial data into everyday services. Smartphones, in particular, have become powerful tools for collecting and utilizing location data, enabling a new generation of mobile applications that leverage real-time positioning to deliver personalized and context-aware services (McKenna et al., 2014; Uphaus et al., 2021). This has not only transformed consumer experiences but has also opened up new avenues for businesses to engage with their customers and optimize their operations (Fortune Business Insights, 2025).

Smart service systems are a relevant application context for integrating geospatial data. These systems provide a comprehensible illustration of how service providers and customers interact through smart products, which act as boundary objects (Beverungen et al., 2019). These objects, like smart watches or smart industrial machinery, have properties like sensors, connectivity, and a unique ID, with location being a major component for service delivery (Beverungen et al., 2019). Smart objects play a crucial role as boundary objects in smart service systems by facilitating the transfer of information and knowledge between different stakeholders (Becker et al., 2013; Star and Griesemer, 1989). Smart products can be classified as physical boundary objects. However, boundary objects can also be virtual (Star, 2010; Bowker and Star, 1999; Becker et al., 2013). No matter if they are physical of virtual, boundary objects always exist at the interface of communities (Star and Griesemer, 1989; Vargo and Lusch, 2008b) and have two major characteristics. First, they are robust enough to maintain a shared identity across different stakeholders. Second, they are flexible enough to be locally useful for both service providers and customers (Beverungen et al., 2019; Star and Griesemer, 1989).

In services using location information, like LBS, a Geographic Information System (GIS) can serve as a non-physical boundary object (zur Heiden et al., 2023). LBS rely on devices being able to determine their geospatial position accurately (Junglas et al., 2008). Without location information, many innovative services would be infeasible, as services often rely on either dynamic or static customer positions (Bärsch et al., 2019). LBS have become omnipresent in everyday life, powering applications such

[1] This holistic view, which considers both geographic coordinates and complementary attribute data (e.g., user information), constitutes a foundational assumption of this dissertation and is reflected throughout the research design.

as ride-sharing platforms, food delivery services, and social networking apps with location-sharing features. GIS play an important role in supporting LBS, as the effectiveness of these services depends on devices being able to determine their geospatial position accurately (Junglas et al., 2008). Through the flexibility of GIS, they support value co-creation in service systems by being locally useful to service providers and customers while maintaining a shared identity between them (Beverungen et al., 2019; Star and Griesemer, 1989).

GIS can be defined as "a system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analyzing and disseminating information about areas of the earth" (Dueker and Kjerne, 1989, pp. 7-8). Their core functionalities include the acquisition, management, analysis, and presentation of geospatial data (Ehlers and Schiewe, 2012), which enable service providers and customers to interact with geospatial data individually and to co-create value based on location information. Data acquisition involves collecting information on real-world objects like buildings and roads through methods such as Global Positioning System (GPS), remote sensing, and laser scanning. With IoT-driven innovations, the scope of data acquisition has expanded, particularly in the context of smart cities, allowing for the collection of high amounts of geospatial and context-specific data (Ying et al., 2024). Data management focuses on efficiently storing and managing data using geodatabases, which handle both vector data (e.g., points, lines, and polygons) as well as raster data (e.g., aerial images) (Farkas et al., 2016).

Data analysis in GIS involves performing spatial analysis to extract insights and support decision-making processes (Chinnaswamy et al., 2019). This can range from simple distance calculations to complex predictive modeling using Machine Learning (ML) algorithms. Programs like INSPIRE further enhance the integration of geospatial data across borders, promoting interoperability and shared usability (European Commission, 2007). To be able to comprehensively show the results of geospatial data analysis to a broader audience, data presentation is used. Within GIS data presentation focuses on visualizing geospatial data through maps and other graphical representations to communicate information effectively (Lemmens, 2011). Advanced visualization techniques, including 3D modeling and Augmented Reality (AR), are increasingly being used to enhance the user experience and facilitate better understanding of complex spatial relationships. This is crucial for services that rely on user engagement and intuitive interaction with spatial information, such as navigation apps.

The application of GIS and geospatial data in services like LBS differs between Business-to-Consumer (B2C) and Business-to-Business (B2B) markets (Dotzel and Shankar, 2016; Chen, 2020). B2C services target individual consumers, emphasizing standardization, convenience, and personal satisfaction (Chen, 2020; Dotzel and Shankar, 2016; Chowdhury et al., 2023). In the B2C context, geospatial services often focus on enhancing user experiences through personalization and localization. For instance, retail companies might use location data to offer targeted promotions or customize product recommendations based on a customer's shopping history and current location.

In contrast, B2B services typically address other businesses and are more complex, often requiring customization and professional expertise to generate business value (Chen, 2020; Atanassova and Bednar, 2023). B2B services augmenting on geospatial data tend to be data-intensive, supporting complex decision-making processes and operational optimizations (Atanassova and Bednar, 2023). GIS can serve as boundary objects in both markets, B2C and B2B by facilitating value co-creation through their properties acquisition, management, analysis, and presentation. For example, they can enable service providers and customers to interact with location information of smart products or other geospatial objects, enhancing both the local usefulness for both sides of the service system, as well as the shared identity between the stakeholders. This mediation of information transfer further strengthens service system innovation and the ability to meet diverse market needs (Chen, 2020; Atanassova and Bednar, 2023).

Still, information systems involving the use of location information "largely remain a distant land of which little is known as far as IS research is concerned" (Keenan and Miscione, 2015, p. 8). The integration of GIS with other emerging technologies like IoT is opening up new frontiers in service innovation. The combination of GIS with Artifical Intelligence (AI) and ML algorithms is enabling more sophisticated predictive analytics and automated decision-making processes based on spatial data (Law et al., 2019; Yiorkas and Dimopoulos, 2017). However, despite the growing importance of geospatial data and GIS in service systems, there remains a significant gap in IS research regarding the use of GIS functionalities (Keenan and Miscione, 2015). The rapid advancement of geospatial technologies and the increasing availability of high-quality spatial data call for more comprehensive research into their impacts on service design, delivery, and evaluation. Additionally, there is a need for more research on the organizational and managerial aspects of implementing

GIS-based services. This includes understanding the challenges of data integration, the development of spatial data infrastructures, and the cultivation of geospatial skills within organizations. The impact of GIS on AI-driven business process automation and optimization as well as sustainable systems engineering also needs further exploration.

In conclusion, this dissertation is based on the observation that the integration of geospatial data through GIS and its properties acquisition, management, analysis, and presentation into service systems has fundamentally transformed how services are designed, delivered, and evaluated. By focusing on the role of GIS as boundary objects in both B2C and B2B contexts, the dissertation highlights the potential for geospatial data to enhance value co-creation and foster the development of novel types of services.

1.2 Problem Statement and Research Questions

While the literature acknowledges the relevance of GIS to IS research and service systems (Lemmens, 2011; Keenan and Miscione, 2015), a gap persists in understanding *how* GIS and their properties contribute to superior value co-creation between service customers and service providers. Recent studies have highlighted GIS as a key enabler for decision-making in areas such as food security (Li et al., 2024), urban infrastructure (Thongmak et al., 2024), and environmental risk management (Bouzari, 2024), demonstrating their growing importance in diverse application domains. While LBS are prominent (Fortune Business Insights, 2025; McKenna et al., 2014; Uphaus et al., 2021), the specific mechanisms through which GIS facilitate enhanced collaboration and value creation remain underexplored. Understanding these mechanisms is relevant because GIS functionalities—such as spatial analysis, visualization, and contextual interpretation—enable location information to be meaningfully integrated into service systems. Without this integration, location data remains underutilized, and its potential to enhance decision support and personalization in services is not fully realized. Investigating how GIS create value in service interactions contributes to closing this gap and supports more effective service design in IS research.

The Service-Dominant Logic of Marketing (S-D Logic) provides a foundation for understanding value co-creation (Vargo and Lusch, 2008a; Lusch and Vargo, 2014;

Lusch et al., 2008) with technologies enabling this integration (Breidbach and Maglio, 2016; Lim and Maglio, 2018; Beverungen et al., 2019), and the literature notes the growing need for data-driven service innovations (Lusch and Nambisan, 2015). Current research suggests that value co-creation strategies and outcomes differ between B2C and B2B contexts (Chen, 2020; Gligor and Maloni, 2021; Klimecka-Tatar, 2018), but it remains unclear how GIS act in B2C and B2B service systems. For instance, research on short-term rental platforms like Airbnb has shown that geospatial and socioeconomic factors influence participation in digital service markets (Sarkar et al., 2024), but there is little understanding of how these findings translate into broader service system design.

Moreover, it is unclear how these findings can lead to comprehensive GIS-enabled service systems in B2C versus B2B settings (Mingione and Leoni, 2019; Steinhardt, 2020). Similarly, current studies on GIS applications have illustrated how the creation of geospatial information exchange platforms for multiple stakeholders has improved decision quality through enhanced information sharing (Bazarah and Li, 2024) and how IoT-enabled behavioral data can enhance predictive analytics in demand forecasting (Zhang and Yang, 2024).

Yet there is a limited understanding of the role of GIS in service systems and how service systems can be designed around GIS with B2C and B2B users in mind. A better understanding is needed because location adds contextual depth to service systems, strengthening their relevance, sophistication, and ability to generate value for both service providers and consumers. GIS not only support the technical integration of spatial data, but also offer a lens through which location can be strategically aligned with service logic. For IS research, this creates an opportunity to explore how digital infrastructures can be designed to account for spatial complexity, heterogeneous actors, and the increasing importance of location-aware technologies. Thus, there is a need for research regarding the theoretical conceptualization of GIS within IS research, moving beyond their role as analytical tools to examining how they actively shape value co-creation in B2C and B2B contexts. Accordingly, the central research problem addressed in this dissertation is:

Research problem: *It is unclear what role GIS have in service systems and how their unique properties contribute to superior value co-creation between service providers and service customers. Particularly, there is a missing perspective on how these service systems can be conceptualized and how value is co-created in B2C and B2B location-specific service systems.*

To systematically address this problem, four research questions are derived that guide a detailed assessment of the different parts of the research problem. The research questions are described and justified based on research gaps in the current literature in the following.

GIS have been a part of IS research since the 1990s, initially recognized for their potential in decision support and strategic planning (Keenan, 1997; Murphy, 1996). Over time, the relevance of Spatial Data Infrastructure (SDI), such as geolibraries, became apparent to the IS community, further integrating GIS into research on data management and spatial analytics (Keenan, 2004). From their early applications in managing spatial data, GIS have evolved into sophisticated tools that support complex decision-making processes across multiple domains (Lemmens, 2011; Bazarah and Li, 2024). They have been employed for spatial analysis (Caceres and Osailan, 2018), predictive modeling (Law et al., 2019; Zhang and Yang, 2024), and the delivery of location-based insights, facilitating data-driven services.

More recently, the expansion of the LBS market, further pushed by advancements in GPS and mobile technologies, has highlighted the economic and practical significance of GIS in modern services (Fortune Business Insights, 2025). GIS applications now extend beyond traditional fields like urban planning to areas such as healthcare management (Chinnaswamy et al., 2019), disaster response (Rahman et al., 2024), and smart city development (Ying et al., 2024). Their integration into service systems has been particularly relevant in both B2C and B2B contexts, where they enhance decision-making, improve customer experiences, and optimize resource allocation (Chen, 2020; Atanassova and Bednar, 2023; Bazarah and Li, 2024).

The emergence of smart service systems further underscores the significance of GIS. These systems leverage data-driven insights to personalize and enhance services, positioning GIS as a critical component for managing location-based information and enabling context-aware service delivery (Beverungen et al., 2019). The rise of the IoT has pushed this trend, as GIS play a central role in aggregating, interpreting, and visualizing location-specific data from connected devices (Ozaif et al., 2024; Eldin and Wagenaar, 2004). Literature increasingly emphasizes the need for a data-driven understanding of smart service systems, where GIS contribute by extracting insights from service-related data (Lim et al., 2004).

From a theoretical perspective, service science provides a lens for examining the role of GIS within service systems. Concepts such as value co-creation, a core concept

of the S-D Logic, offer insights into how GIS facilitate interactions between service providers and customers (Maglio and Spohrer, 2008; Vargo and Lusch, 2008a; Vargo et al., 2020; Lusch and Vargo, 2014; Lusch et al., 2008). Technology-enabled value co-creation has been a recurring theme, with studies showing how digital tools integrate resources and engage stakeholders in service ecosystems (Breidbach and Maglio, 2016).

Despite these developments, existing research on GIS within IS remains fragmented and has not yet explored the role of GIS in service innovation or how location information can enable new forms of service design and delivery. While many studies focus on specific applications of GIS (McKenna et al., 2014; Chinnaswamy et al., 2019; Rahman et al., 2024; Ying et al., 2024; Goswami et al., 2024), a comprehensive understanding of how GIS are conceptualized in relation to service systems is still lacking. Although GIS have gained importance across various disciplines, especially in the context of LBS, they remain an underrepresented topic in IS research and service science. Furthermore, there is a need for a more holistic examination of the diverse roles GIS can play within service systems, moving beyond their treatment as black-box technologies. A deeper investigation is required to explore how GIS contribute to value co-creation, service innovation, and the structural dynamics of service systems. This is important for IS research, as GIS functionalities are often embedded in service systems without being fully understood in terms of their underlying logic and contribution to service effectiveness. By moving beyond the black-box perspective, IS research can investigate how GIS support resource integration as a boundary object as well as actor coordination, and shared understanding across organizational and user interfaces, especially in services where spatial context is a key element.

To address these gaps, the first research question is:

RQ1. *How are GIS considered in IS research and what is their role in service systems?*

The literature on service science emphasizes value co-creation as a fundamental principle of service systems, where both service providers and customers actively engage in resource integration and interaction to generate value (Vargo and Lusch, 2008a; Lusch and Vargo, 2014; Vargo et al., 2020; Lusch et al., 2008). The S-D Logic highlights that value is not simply delivered but collaboratively created through ongoing exchanges between actors. At the heart of this process lies service innovation, which enables new approaches to service design and delivery, often driven by emerging digital technologies (Lusch and Nambisan, 2015; Sandström et al., 2008).

With the increasing digitization of services, technology-enabled value co-creation has become a central theme in IS research, transforming service interactions and expanding the ways in which customers and service providers engage with digital resources (Breidbach and Maglio, 2016).

The emergence of smart service systems has further underscored the role of data-driven insights in services (Beverungen et al., 2019). Conceptualized as an integration of physical products, digital networks, and information systems, smart service systems rely on data to personalize and enhance service experiences (Beverungen et al., 2019). GIS are a critical component in these systems, providing the ability to collect, manage, and analyze geospatial data, which in turn enables context-aware service delivery and improved decision-making (Chinnaswamy et al., 2019; Rahman et al., 2024; Ying et al., 2024). The growing adoption of the IoT pushes this trend further, as GIS enable to aggregate and interpret location-specific data from IoT-connected devices (Ozaif et al., 2024; Eldin and Wagenaar, 2004). Here, the importance of GIS in B2B service ecosystems is particularly pronounced as businesses increasingly focus on value co-creation and service management strategies (Chowdhury et al., 2023).

However, much of the existing research has primarily examined GIS applications in specific use cases, such as urban planning, environmental studies, and location-based services (McKenna et al., 2014; Uphaus et al., 2021; Goswami et al., 2024; Yi et al., 2024), without fully exploring how GIS fundamentally contribute to value co-creation across diverse service contexts. GIS applications in decision-making processes demonstrate their potential to optimize service delivery, yet their usability and impact on different stakeholder groups remain underexplored (Unrau and Kray, 2018). While the market for LBS is expanding rapidly (Fortune Business Insights, 2025), understanding how these technologies translate into actionable benefits for both businesses and consumers is essential for maximizing their potential.

Despite these advances, a gap remains in understanding how GIS specifically contribute to superior value co-creation by enabling service providers and customers to leverage geospatial data within service systems. While prior research acknowledges the potential of GIS to improve decision-making and personalize services (Bazarah and Li, 2024; Keenan and Miscione, 2015), the specific mechanisms through which GIS facilitate enhanced collaboration and value creation remain underexplored. This is relevant because service value is not created in isolation but through dynamic interactions between service providers and users (Vargo and Lusch, 2008c). GIS have the

potential to enhance these interactions by contextualizing them spatially—enabling more informed decisions, better alignment of resources, and stronger engagement across actor groups. For IS research, unpacking these mechanisms provides the foundation for designing more responsive, adaptive, and location-aware service systems. Addressing this gap, the second research question is formulated as follows:

RQ2. *How can GIS contribute to superior value co-creation by enabling service providers and customers to leverage geospatial data in service systems?*

However, when analyzing the value co-creation in services based on GIS, a distinction between B2C and B2B contexts is needed, since there are fundamental differences in these services and their organizational contexts (Chen, 2020; Atanassova and Bednar, 2023). B2C services target individual consumers, necessitating user-friendly, personalized, and convenient design principles (Chen, 2020; Dotzel and Shankar, 2016; Mingione and Leoni, 2019). In contrast, B2B services involve complex relationships between businesses, requiring customized solutions grounded in deep industry knowledge (Chen, 2020; Atanassova and Bednar, 2023).

Recognizing these differences is crucial to investigate the value co-creation in service systems augmenting on GIS effectively. Viewing GIS as boundary objects can help promote collaboration in service systems (Star, 2010; Becker et al., 2013), but this perspective needs a more in-depth analysis. The goal is to move beyond treating GIS as a black-box tool and instead leverage their capabilities to foster value co-creation and enhance value within B2C and B2B service contexts. Since there is a need to distinguish between B2C and B2B markets for services augmenting on GIS, two more research questions are derived.

The third research question aims to analyze how value is co-created in location-specific service systems and this question focuses on B2C contexts:

RQ3. *How is value co-created in location-specific service systems in B2C contexts using GIS as a boundary object?*

The fourth research question raises the same issue but focuses on B2B contexts:

RQ4. *How is value co-created in location-specific service systems in B2B contexts using GIS as a boundary object?*

1.3 Structure of the Dissertation

This dissertation is structured in two parts. Part A establishes the overarching context for the publications presented in Part B, framing their contributions within a broader research perspective.

Part A is composed as follows: Section 2 provides the theoretical background, exploring three key areas. First, the fundamentals of service science are described, focusing on smart service systems and the co-creation of value in both B2C and B2B contexts. Second, the foundations of GIS and their integration into IS research are outlined. Third, this chapter highlights the application of GIS in services, with a specific focus on LBS. Section 3 describes the research design, detailing the methodologies employed in this dissertation, including literature review, conceptual research, Data-Driven Research (DDR), and Design Science Research (DSR). It also outlines the research process, providing a structured overview of how the research method was applied. Finally, Section 4 concludes Part A by summarizing the findings and discussing them in the context of existing literature. This section also highlights the contributions of the research to both academic knowledge and practical management, acknowledges its limitations, and offers an outlook on future research directions.

Part B consists of ten peer-reviewed publications.[2] These papers have been published or are under review in leading academic outlets, including the *Schmalenbach Journal of Business Research*, *IEEE Transactions on Engineering Management*, *Electronic Markets*, and *Journal of Service Management Research*. Furthermore, several contributions appear in the proceedings of conferences such as the *European Conference on Information Systems*, the *Hawaii International Conference on System Sciences*, and the *International Conference on Wirtschaftsinformatik*. According to the VHB-JOURQUAL 4 ranking for IS, all publications are either publicated or under review in journals or conference proceedings classified from A to C.

According to the four research questions, Part B is structured into four sections. An overview of the structure of this dissertation can be found in Figure 1.1. In the following, the publications included in this part, will be described according to the

[2] The papers included in Part B correspond to the published or submitted versions. Minor corrections, such as the rectification of spelling errors or source citations, may distinguish these versions. Additionally, the formatting has been adjusted to align with the structure of this dissertation, which may have altered the positioning of figures or tables.

research questions. A list of all publications included in this dissertation can be found in Table 1.1.

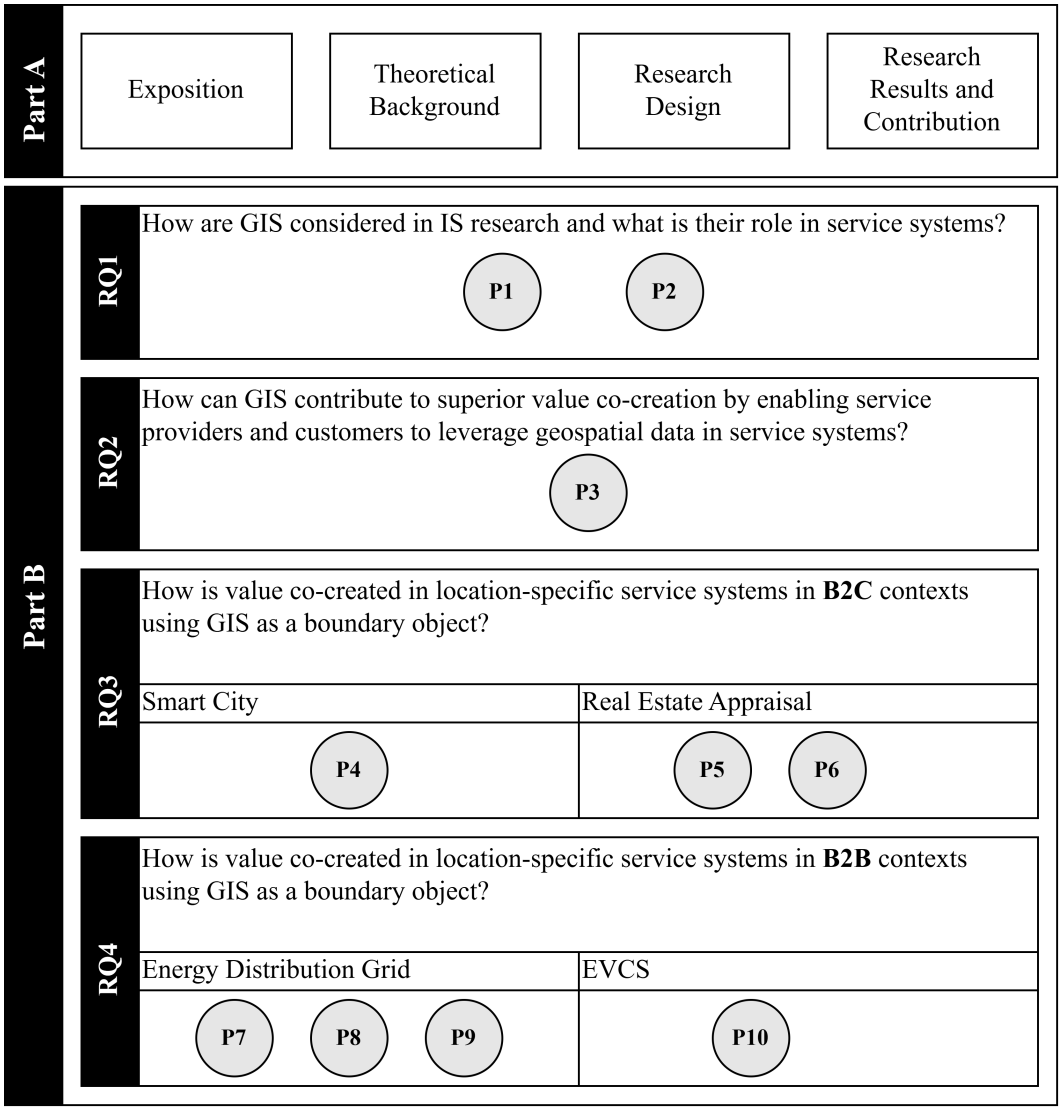

Figure 1.1: Structure of the dissertation.

P1. *Geographic Information Systems in Information Systems Research: Review and Research Prospects.* GIS have historically supported decision-making by enabling to analyze and visualize geospatial relationships through mapping and spatial analysis. Widely applied in fields such as urban planning and environmental management, GIS have gained importance in IS research due to new data becoming available through open data initiatives and the rising number of connected objects through the IoT. These developments allow for the integration of geospatial data into service systems, offering significant opportunities to enhance decision-making, service customization, and

value creation. Despite their potential, GIS remain underexplored within IS research. A systematic literature review of 97 publications reveals a lack of design-oriented and conceptual research as well as GIS-specific design theories and an examination of the role of GIS for value co-creation. To bridge these gaps, the paper proposes four research propositions, thus, partially answering RQ1 by identifying how GIS have been considered in IS research.

P2. *Location-Based Service and Location-Contextualizing Service: Conceptualizing the Co-creation of Value with Location Information.* LBS have gained popularity in the last years, enabling value co-creation through the real-time use of mobile objects' or users' location data. Common applications include navigation systems, location-based marketing, and location-aware recommendations. LBS rely on spatial proximity and the ability to track mobile entities, making them ideal for services that require dynamic interactions. However, this reliance on mobile data limits their application in scenarios involving immovable objects, such as buildings or energy grid infrastructure, where spatial contexts remain static. To address this gap, this paper introduces Location-Contextualizing Service (Location-Contextualizing Service (LCS)) as a complementary class of service that extends the utility of geospatial data beyond mobile contexts. LCS use static location information to enhance existing services by providing spatial context and supporting decision-making. For example, LCS can be applied in asset management, environmental monitoring, or urban infrastructure optimization, where fixed locations hold valuable contextual data. Through a conceptual comparison of LBS and LCS, the paper highlights several key differences, including the absence of spatial proximity requirements in LCS and their reliance on integrating geospatial data through GIS. LCS are particularly well-suited for B2B contexts, where decision-making often involves infrastructure, logistics, or resource allocation tied to specific, fixed locations. By bridging research between service science and GIS, the paper conceptualizes LCS as an emerging service model that integrates geospatial data into decision-making processes, particularly through GIS functionalities such as spatial analysis and data visualization. GIS play a central role in enabling both LBS and LCS by collecting, managing, and analyzing geospatial data, making them essential components of these service systems. This paper partially answers RQ1 by investigating how GIS contribute to different service systems and by proposing LCS as a new approach to leveraging static geospatial data for value co-creation.

P3. *Leveraging Geographic Information Systems for Value Co-Creation: A Conceptual Framework for Location-Specific Service Systems.* GIS are central to enabling superior value co-creation by integrating geospatial data into service systems, offering a means for service providers and customers to collaborate effectively through their unique tools to interact with geospatial data. This paper develops a comprehensive conceptual framework, grounded in six case studies across diverse domains, demonstrating how GIS serve as boundary objects within service systems. The conceptual framework highlights the four key GIS functionalities—data acquisition, management, analysis, and presentation—as integral to service design and value co-creation. The framework emphasizes that GIS contribute differently to B2C and B2B contexts due to their distinct service requirements. B2C services benefit from GIS improving user satisfaction and personalized service delivery. For example, GIS can enhance house price predictions on housing platforms or hotel searches. In contrast, in B2B settings, where service complexity and customization are critical, GIS help to enhance strategic planning and resource optimization. For example, GIS can be used for asset management to monitor the location and condition of critical infrastructure. By providing both parties—service providers and customers—with access to the same geospatial information, GIS foster transparency and alignment in decision-making processes. By showcasing how geospatial data can be embedded into service design and delivery through GIS, this paper fully answers RQ2.

P4. *City 5.0: Citizen involvement in the design of future cities.* Cities face growing challenges due to increasing populations, complex infrastructures, and diverse citizen needs. Many smart city initiatives have focused on technology-driven solutions, often overlooking citizen involvement. This paper introduces the City 5.0 paradigm, which shifts the focus to a citizen-centric approach by eliminating restrictions that hinder access to essential public goods and services. By involving citizens in the design process, City 5.0 aims to create more inclusive, sustainable, and responsive urban environments. A key aspect of City 5.0 is addressing spatial barriers to service access through the integration of geospatial data. These data allow cities to deliver location-specific services, ensuring citizens benefit from optimized solutions, such as improved mobility, better access to service locations, and public goods. GIS play a central role in acquiring, managing, analyzing, and presenting these data, helping city planners visualize infrastructure, allocate resources, and address service gaps. By integrating geospatial data into decision-making, GIS enable cities to adapt services dynamically to local needs, fostering greater inclusivity and efficiency. As

boundary objects, GIS facilitate collaboration between stakeholders, including citizens, service providers, and city planners. Although this paper does not directly introduce a B2C service using GIS, it lays the foundation for a location-specific service system, because it offers a perspective of geospatial data and citizen involvement reducing spatial restrictions. Thus, this paper partially addresses RQ3 by contributing to the investigation of value co-creation in location-specific service systems, particularly in smart city contexts where geospatial data are crucial for overcoming spatial restrictions.

P5. *Quantifying the Impact of Location Data for Real Estate Appraisal – A GIS-Based Deep Learning Approach.* Accurately appraising real estate is a complex task due to the heterogeneity of properties and the influence of factors such as physical attributes, location, and neighborhood characteristics. This paper investigates how combining geospatial data and image data can improve the predictive accuracy of Computer-Assisted Mass Appraisal (CAMA) systems. By analyzing 71,000 properties in Philadelphia using GIS and Convolutional Neural Network (CNN), the study explores how both hard information (structured data) and soft information (aesthetic and contextual information derived from images) contribute to automated real estate valuation. The findings indicate that integrating geospatial data—such as proximity to parks, schools, and noise levels—into appraisal models increases predictive accuracy by 12%, while incorporating image data further enhances accuracy by 16%. The combination of both data types provides robustness against extreme price outliers, although managing these data types requires significant preprocessing efforts. The study highlights the differing strengths of geospatial data (systematic spatial insights) and image data (contextual aesthetic information) and suggests that their integration can support future applications in areas like urban planning, insurance risk assessment, and sustainable land management. When viewed through a service lens, this paper presents a location-specific service system that leverages geospatial data to provide valuable insights to customers, who want to buy a house. By integrating spatial and contextual data into an appraisal system, the service delivers personalized information on property values, taking into account the specific neighborhood and spatial characteristics relevant to potential buyers. Although, this paper does not directly present a service system, the dynamic combination of GIS and Deep Learning (DL) enables the creation of data-driven, location-specific recommendations, improving decision-making for individual customers. Thus, this work partially answers RQ3.

P6. *Elucidating the Predictive Power of Search and Experience Qualities for Pricing of Complex Goods: A Machine Learning-Based Study on Real Estate Appraisal.* This paper enhances the concept of P5 by integrating the perspective of information asymmetries between sellers and buyers into real estate appraisal. Driven by the fact that properties possess both easily quantifiable attributes (Search qualities) and harder-to-evaluate characteristics (Experience qualities), this paper explores how GIS and ML can help bridge these asymmetries by transforming traditionally experiential attributes—such as noise levels, neighborhood safety, and visual appeal—into measurable data that enhance predictive models. Based on an analysis of 62,641 single-family homes in Philadelphia, the study finds that integrating Experience qualities with traditional Search qualities improves predictive accuracy by 15.4%, demonstrating the value of secondary-use data from geospatial and image sources. The paper employs GIS to extract spatial data, such as proximity to amenities and environmental conditions, while leveraging computer vision to analyze images of properties and their surroundings. The results reveal that combining geospatial data and image-based information reduces prediction errors and provides a holistic understanding of real estate valuation. Experience qualities alone, though useful, do not outperform models based solely on Search qualities. However, when combined, they offer significant gains in prediction accuracy, making them an essential component of modern appraisal systems. Viewed through a service lens, this paper presents a location-specific service system that integrates geospatial data into an appraisal framework, providing valuable insights for homebuyers in B2C contexts. By offering location-based property evaluations, this system enhances decision-making and reduces uncertainty for customers. While the paper does not directly introduce a service system, it lays the foundation for systematically integrating geospatial data into location-specific service systems and demonstrates how GIS-based appraisal systems can assist stakeholders by improving predictive accuracy. Therefore, this paper partially answers RQ3 by showcasing how GIS and ML can be effectively used to enhance personalized, location-specific appraisal services that support superior value co-creation.

P7. *Transitioning to Condition-Based Maintenance on the Distribution Grid: Deriving Design Principles from a Qualitative Study.* Energy grid operators face growing challenges in maintaining their distribution grids due to aging assets, the transition to renewable energy, and increasing demand from electric mobility. To address these challenges, this paper derives design principles for condition-based maintenance sys-

tems using a qualitative study involving six electric utilities. Condition-based maintenance, as an advanced strategy, relies on monitoring real-time asset conditions to predict and prevent failures, offering advantages over traditional maintenance strategies such as reactive and preventive maintenance. However, the study reveals that many utilities struggle with a lack of condition data, inadequate system integration, and manual processes that hinder their ability to fully transition to condition-based maintenance. The paper develops eight Design Principle (DP) categorized into high, medium, and low-priority groups, aimed at guiding the design of IT artifacts for condition-based maintenance. The DPs focus on essential elements such as predictive algorithms, system integration, and condition monitoring. The system design emphasizes integrating GIS with Enterprise Resource Planning (ERP) systems and condition monitoring tools to enable effective data analysis, failure prediction, and maintenance planning. This paper is a pre-study for the design of a condition-based maintenance system, that is designed in P8 and P9. The approach in this paper is a foundational step toward a location-specific service system that supports value co-creation by facilitating collaboration among energy grid operators and asset manufacturers by integrating GIS for asset monitoring and predictive maintenance, thus, partially answering RQ4.

P8. *Utilizing Geographic Information Systems for Condition-Based Maintenance on the Energy Distribution Grid.* This paper builds on the results from P7 and investigates the role of GIS in enhancing condition-based maintenance for the energy distribution grid. By integrating geospatial data with predictive maintenance models, GIS enables the visualization and analysis of location-specific factors affecting asset health, such as environmental conditions, humidity, and animal interactions. The system leverages real-time data from sensors and historical maintenance records to predict asset failures and plan maintenance activities efficiently. GIS enable mapping of critical grid components and identifying high-risk locations where external factors are likely to stress grid asset. By incorporating geospatial layers that visualize asset conditions and contextual risks, GIS provide actionable insights for maintenance, allowing to prioritize maintenance activities and repairs based on the location of the assets as well as location-specific risks. This spatial perspective helps utilities to optimize resource allocation and minimize downtimes. While not focusing directly on a service system, the paper's findings can be interpreted through a service science lens as laying the foundation for a location-specific service system. When seen as a whole application scenario for a B2B location-specific service system together with

P7 and P9, embedding geospatial data into a predictive maintenance system, this study partially answers RQ4.

P9. *Predictive Maintenance on the Energy Distribution Grid—Design and Evaluation of a Digital Industrial Platform in the Context of a Smart Service System.* Building on the foundations established in P7 and P8, this paper offers a more advanced perspective on predictive maintenance on the energy distribution grid. Together, the three papers address the same application scenario, but each focuses on a different aspect of predictive maintenance for energy grid assets. P7 served as a pre-study, identifying key challenges and objectives for condition-based maintenance, while P8 highlighted the use of GIS and geospatial data for such a system. P9 extends these perspectives by integrating them into a comprehensive smart service system integrating this solution with a digital industrial platform (DigiGrid). The system developed in this paper integrates data from various sources, including sensors, GIS databases, and ERP systems, allowing real-time condition monitoring and predictive maintenance. By enabling geospatial data to be visualized and analyzed alongside sensor data, GIS ensure that location-specific factors, such as environmental conditions or proximity to risk areas, are factored into maintenance decisions. Through this integration, the system enhances collaboration between stakeholders, supporting dynamic, location-aware decision-making and value co-creation. The design of the system follows a DSR approach and is evaluated through qualitative interviews and a Willingness-To-Pay (WTP) analysis with grid operators. The evaluation reveals a high interest in predictive maintenance capabilities, particularly in real-time data integration and geospatial analytics, which help operators prioritize maintenance tasks based on asset conditions and location-specific risks. The study derives five design principles that guide the development of predictive maintenance systems by emphasizing data integration, time-sensitive monitoring, and collaborative decision-making. By extending the functionality of condition-based maintenance through a smart service system, P9 partially answers RQ4 by providing a blueprint for integrating geospatial data and predictive maintenance tools into scalable and collaborative digital platforms. The insights gained from this paper highlight the critical role of GIS in enhancing the co-creation of value between key stakeholders, as well as the connection of location-specific service systems and smart service systems.

P10. *Designing a GIS-AHP-Based Spatial Decision Support System for Discovering and Visualizing Suitable Locations for Electric Vehicle Charging Stations.* The increasing adoption of Electric Vehicle (EV) demands well-planned charging infrastructure to sup-

port large-scale electric mobility. This paper presents a Spatial Decision Support System (SDSS) that integrates GIS with an Analytic Hierarchy Process (AHP) to identify and visualize optimal locations for Electric Vehicle Charging Station (EVCS). The system applies methodologies rooted in decision science, GIS, and operations research, using geospatial data and multi-criteria decision-making to evaluate factors such as proximity to users, accessibility, and environmental impact. An expert interview is used to weight these criteria and guide the spatial analysis. Using the Design Science Research Methodology (DSRM), the paper develops and demonstrates the SDSS through a prototype for the city of Paderborn. The GIS application provides visual outputs, classifying locations from "least suitable" to "most suitable," helping urban planners and decision-makers make informed decisions. The SDSS provides optimized spatial recommendations through spatial analytics and decision-making methodologies for long-term planning. However, viewed through a service science lens, this approach can be seen as a location-specific service system that delivers location-based insights to B2B stakeholders, such as city planners and EVCS operators. By integrating geospatial data and collaborative decision-making processes, the system enables dynamic interactions and value co-creation. Thus, this work partially answers RQ4.

No.	Authors	Title	Outlet	VHB JQ4	Points
RQ1: How are GIS considered in IS research and what is their role in service systems?					
1	Priefer	Geographic Information Systems in Information Systems Research – Review and Research Prospects	HICSS 2023	B	1
2	zur Heiden Priefer Beverungen	Location-Based Service and Location-Contextualizing Service: Conceptualizing the Co-creation of Value with Location Information	HICSS 2023	B	0.4
RQ2: How can GIS contribute to superior value co-creation by enabling service providers and customers to leverage geospatial data in service systems?					
3	Priefer Beverungen	Leveraging Geographic Information Systems for Value Co-Creation: A Conceptual Framework for Location-Specific Service Systems	SMR	C	0.8
RQ3: How is value co-created in location-specific service systems in B2C contexts using GIS as a boundary object?					
4	Becker et al.	City 5.0: Citizen Involvement in the Design of Future Cities	Electronic Markets	B	0.05
5	Kucklick Priefer Beverungen Müller	Quantifying the Impact of Location Data for Real Estate Appraisal – A GIS-based Deep Learning Approach	ECIS 2021	A	0.35
6	Priefer Kucklick Beverungen Müller	Elucidating the Predictive Power of Search and Experience Qualities for Pricing of Complex Goods: A Machine Learning-based Study on Real Estate Appraisal	SBUR	B	0.4

	RQ4: How is value co-created in location-specific service systems in B2B contexts using GIS as a boundary object?				
7	zur Heiden Priefer	Transitioning to Condition-Based Maintenance on the Distribution Grid: Deriving Design Principles from a Qualitative Study	WI 2021	B	0.5
8	zur Heiden Priefer Beverungen	Utilizing Geographic Information Systems for Condition-Based Maintenance on the Energy Distribution Grid	HICSS 2022	B	0.4
9	zur Heiden Priefer Beverungen	Predictive Maintenance on the Energy Distribution Grid – Design and Evaluation of a Digital Industrial Platform in the Context of a Smart Service System	IEEE TEM	B	0.4
10	Priefer Steiger	Designing a GIS-AHP-Based Spatial Decision Support System for Discovering and Visualizing Suitable Locations for Electric Vehicle Charging Stations	WI 2022	B	0.7
$\sum$					**5.0**

Table 1.1: List of publications in Part B.

2 Theoretical Background

2.1 Service Science in Information Systems Research

2.1.1 Foundations of Service Science

Service science has emerged as a key topic within IS research, focusing on the design, implementation, and evaluation of service systems. Being defined as “a dynamic value-co creation configuration of resources, including people, organizations, shared information (language, laws, measures, methods), and technology, all connected internally and externally to other service systems by value propositions” (Maglio et al., 2009, p. 399), the primary goal of service science is to enhance service quality, efficiency, and innovation by effectively coordinating these components.

Generally, service is defined as "the application of specialized competences (knowledge and skills) through deeds, processes, and performances for the benefit of another entity or the entity itself” (Vargo and Lusch, 2004, p. 2). The concept of service has been further developed within the context of service systems, which are socio-technical systems that integrate people, technologies, and other resources to create mutual value through interactions and shared information (Maglio et al., 2009; Spohrer et al., 2007). Within service science there is the term service (singular), as described above, and services (plural), being defined as "units of output" (Lusch and Vargo, 2006, p. 282).

Over the past few decades, the service science research field has evolved significantly. Initially, services were viewed as intangible products that were distinct from physical goods. However, with the emergence of the S-D Logic, a paradigm shift occurred, highlighting that value is co-created through interactions between providers and consumers rather than being delivered unilaterally (Vargo and Lusch, 2004). S-D Logic is based on eleven premises (Table 2.1), which include the idea that all economies are

service economies and that operant resources are more significant than operand resources in creating competitive advantage (Vargo and Lusch, 2016; Lusch and Vargo, 2014). Operand resources refer to tangible, static elements that an actor acts upon to obtain support, such as natural resources or infrastructure (Lusch and Nambisan, 2015). In contrast, operant resources are intangible and dynamic, including human skills and knowledge, which act on other resources to produce effects (Lusch and Nambisan, 2015).

No.	Foundational Premise / Axiom
1	Service is the fundamental basis of exchange (Axiom)
2	Indirect exchange masks the fundamental basis of exchange
3	Goods are distribution mechanisms for service provision
4	Operant resources are the fundamental source of strategic benefit
5	All economies are service economies
6	Value is co-created by multiple actors, always including the beneficiary (Axiom)
7	Actors cannot deliver value but can participate in the creation and offering of value propositions
8	A service-centered view is inherently beneficiary oriented and relational
9	All social and economic actors are resource integrators (Axiom)
10	Value is always uniquely and phenomenologically determined by the beneficiary (Axiom)
11	Value co-creation is coordinated through actor-generated institutions and institutional arrangements (Axiom)

Table 2.1: Foundational premises of the S-D Logic (Vargo and Lusch, 2016).

Since resources cannot create value in isolation, actors in service systems continuously integrate and recombine resources to achieve value co-creation (Lusch and Nambisan, 2015). Value co-creation is a fundamental concept in service science, emphasizing that value is not generated only by the provider but rather co-created through interactions between providers and consumers. This perspective shifts the focus from the traditional goods-dominant logic, where value is embedded in the product, to a S-D Logic that considers value as emergent through use and interaction.

The determination of a service's value is contingent upon its value-in-use, which depends on the customer's perception of the benefits received and the context in which the service is applied (Vargo and Lusch, 2008a). Value-in-use is understood as the consumer's subjective evaluation of their service experience, incorporating both functional and emotional outcomes. It highlights that value cannot be predefined by the service provider but is instead realized by the user throughout the consumption process (Sandström et al., 2008). Furthermore, value is created at the intersection of the provider and the customer, either through direct interaction or mediated by a tangible good, reinforcing the dynamic and reciprocal nature of service relationships (Lusch and Vargo, 2006).

A crucial element in service systems that supports value co-creation is the concept of boundary objects. These objects act as facilitators of communication and collaboration between service providers and customers, enabling the integration of diverse perspectives and knowledge. Boundary objects exist at the interfaces of different communities, serving as a shared reference point while allowing for localized interpretations to suit specific needs (Star and Griesemer, 1989; Vargo and Lusch, 2008b). They enable value co-creation and bridge the line of interaction in service systems, which separates the activities of service providers and customers (Star, 2010; Star and Griesemer, 1989; Vargo et al., 2008; Beverungen et al., 2019).

Their dual function lies in their robustness and flexibility (Beverungen et al., 2019). Boundary objects are robust enough to maintain a consistent identity across different groups, ensuring stability and coherence. Simultaneously, they are flexible enough to adapt to localized contexts, making them suitable for diverse applications. This adaptability is essential for fostering collaboration and bridging gaps between stakeholders, ultimately enabling mutual understanding and effective service delivery (Beverungen et al., 2019; Star, 2010). Boundary objects can take various forms, ranging from physical artifacts like prototypes or tools to virtual entities such as information systems or digital platforms (Star, 2010; Bowker and Star, 1999; Becker et al., 2013).

2.1.2 Smart Service Systems

Smart service systems build upon the concept of boundary objects by integrating smart products that enable the exchange of resources and activities between actors

to achieve mutual benefits (Beverungen et al., 2019). These smart products, such as smartphones and smartwatches, function as digitally networked physical goods that facilitate interactions between service providers and consumers. As boundary objects, they enable real-time data collection and analysis while fostering adaptive and personalized service experiences (Beverungen et al., 2019). Smart service systems represent an evolution of traditional service systems, offering increased interactivity, responsiveness, and value co-creation opportunities (Beverungen et al., 2019). They incorporate digital technologies to enrich the value co-creation process, emphasizing the strategic and operational significance of smart products within service ecosystems (Allmendinger and Lombreglia, 2005).

The evolution of smart service systems aligns with broader trends in service innovation, where businesses increasingly rely on smart products to drive customer engagement and operational efficiencies (Sun and Li, 2021; Polese et al., 2018). Smart service systems extend service systems by applying systems theory principles to foster resilience and continuous adaptation within service ecosystems (Barile and Polese, 2010). The ability of smart service systems to leverage real-time analytics and cognitive capabilities significantly enhances decision-making processes (Demirkan et al., 2016). These systems provide a dynamic environment that enables service providers to respond to customer needs proactively while ensuring scalability and adaptability across different service domains.

Thus, a crucial element of smart service systems is the active involvement of service providers and consumers in the value creation process. Service providers offer smart products and related services, while consumers interact with these products to obtain personalized and context-aware service experiences. This collaborative interaction between providers and consumers is fundamental to the success of smart service systems, as it enhances the overall service experience and fosters continuous improvement (Demirkan et al., 2016). The ability of smart service systems to facilitate this co-creation is crucial in building trust and long-term engagement with customers, ensuring alignment with their expectations and preferences (Kurtz et al., 2023).

The integration of smart products into service systems enables organizations to capture and analyze data in real-time, leading to more efficient resource allocation and improved service delivery (Barile and Polese, 2010). Smart products are physical goods equipped with sensors, connectivity, and computational capabilities (Beverungen et al., 2019). Examples of such products include smartphones, industrial

machinery, and smart home devices, all of which serve as boundary objects that connect various stakeholders within the service system and provide a shared platform for interaction and value co-creation (Beverungen et al., 2019). Smart products function as mediators, enabling organizations to deliver high-value services efficiently (Massink et al., 2010). In smart service systems smart products act as boundary objects by enabling the exchange of information and knowledge across organizational and user boundaries, thus fostering a shared understanding and collaboration within the service system (Star, 2010). This interaction ensures that service providers and consumers can derive mutual value from the smart products by leveraging their shared functionalities and capabilities.

The smart service systems framework proposed by Beverungen et al. (2019) provides a comprehensive model for understanding the role of smart products within service systems (Figure 2.1). The framework outlines several key elements that define the functionality and impact of smart service systems. In the back-stage, the service provider can perform activities like remote monitoring, data aggregation, or data analytics. In the front-stage, the service consumer operates the smart product and uses it in a physical surrounding. Within a smart service system, each one of these sides benefits from the service itself, which is called local usefulness. Here, smart products provide immediate, practical benefits to both service providers and consumers. For instance, smart industrial equipment can adjust operational settings based on real-time usage patterns, enhancing both productivity and sustainability (Massink et al., 2010). Another essential element within the framework is the shared identity. Maintaining a shared identity across communities ensures consistent interaction and value co-creation (Beverungen et al., 2019; Star and Griesemer, 1989). This shared identity allows service providers and consumers to derive benefits from smart products, that are only possible by their interaction, thereby strengthening their mutual value propositions, which are defined as "invitations from actors to one another to engage in service" (Chandler and Lusch, 2015, p. 6).

According to Beverungen et al. (2019), smart products have several properties, including *sensors* that collect data from the environment or user interactions, *connectivity* that facilitates communication with other systems or devices, and a *unique ID* that allows for tracking and makes the object identifiable. Additionally, *data storage and processing* capabilities support local or cloud-based analytics. *Actuators* empower smart products to take actions based on analyzed data, and *interfaces* facili-

tate seamless and user-friendly interactions between smart products and their users (Allmendinger and Lombreglia, 2005).

Another relevant property a smart product possesses is *location*. This capability allows smart products to be localized and traced by other devices and information systems, enabling seamless integration into smart service systems (Beverungen et al., 2019). By leveraging location data, services can be configured and delivered based on the specific locations of individual or groups of smart products, enhancing the contextual relevance and operational efficiency of these systems (Beverungen et al., 2019).

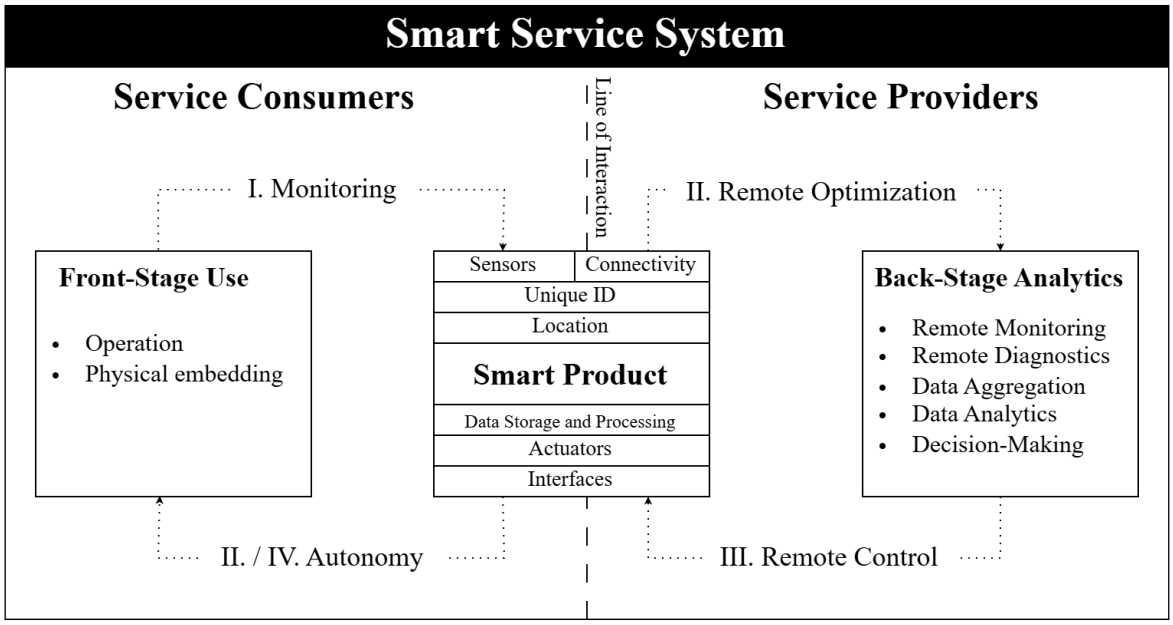

Figure 2.1: Smart service systems framework (Beverungen et al., 2019).

2.1.3 Location-Based Service

Besides smart service systems, there are other services using location information. The most common service in IS research is LBS. LBS are network-based, mobile information services that utilize positional data from mobile devices to provide value-added services building on users' geographic contexts and individual preferences. These services are location-sensitive, functioning by integrating geospatial data of users with contextual information about nearby products or services (Xu et al., 2009). This enables applications that combine location information with details about available offerings within a defined physical proximity (Mathew et al., 2004). LBS are

characterized by two critical features: spatial proximity and locatability. Spatial proximity ensures that the service is effective only when users are situated within a specific geographic range of the service location (Bärsch et al., 2019). Locatability, on the other hand, refers to the ability of a device to accurately determine its current geographic position, a capability that is foundational for functionalities such as navigation and location-sensitive billing (Junglas et al., 2008). These characteristics are supported by the provision of data in real time or near real time, which ensures users receive relevant information precisely when it is needed (Pei Chin and Siau, 2012).

LBS improve users' ability to make informed decisions by offering location-based insights in a timely manner (Junglas, 2005). Furthermore, they enable the co-creation of value by leveraging geospatial data, which makes services not only relevant but also personalized to individual users' needs (Küpper, 2005; Raper et al., 2007). To better understand the scope of LBS, it is useful to distinguish between static LBS, where the user's position remains unchanged during service use, and dynamic LBS, where users or entities move actively while utilizing the service (Lehrer et al., 2011). This differentiation reflects the adaptability of LBS in addressing various contexts and applications.

The value propositions of LBS span a range of service types, which integrate geospatial data in diverse ways. For instance, localized service provision involves dynamic customers interacting with static entities, as seen in systems like location-sensitive billing (Mathew et al., 2004; Pei Chin and Siau, 2012). Similarly, locating services track the positions of static or dynamic entities, enabling functionalities such as product location tracking (Pei Chin and Siau, 2012). Navigation services provide dynamic guidance for users to reach static destinations, exemplified by car navigation systems, while matching services involve dynamic interactions between customers and entities, as seen in applications like dating apps. Other examples include location analysis services, where static users analyze dynamic entities, such as fitness tracking apps, and management and monitoring services, which enable users to oversee dynamic entities, as seen in traffic monitoring systems (Lehrer et al., 2011; Ryschka et al., 2014).

2.1.4 Co-Creation of Value in B2C and B2B Services

In service science, B2C and B2B services have significant differences in their characteristics, focus, and impact. B2C services are directed at individual consumers, while B2B services involve transactions and relationships between businesses (Chen, 2020). In B2C services decisions are made by individuals who prioritize personal needs and preferences (Chen, 2020; Dotzel and Shankar, 2016). B2B services are characterized by complex organizational structures and decision-making processes (Y. Liu et al., 2023). The purchasing decisions in B2B contexts typically involve multiple stakeholders and extended decision cycles, needing thorough evaluations and strategic alignment before a decision is made (Chen, 2020; Atanassova and Bednar, 2023). The relationship dynamics also differ significantly. B2C relationships are more transactional and short-term, while B2B relationships are often long-term, collaborative partnerships built on trust and knowledge sharing (Atanassova and Bednar, 2023).

Furthermore, service complexity plays a crucial role in differentiating B2C and B2B services. B2C services are generally standardized to serve a broad customer base with common expectations. On the other hand, B2B services are often highly customized to meet specific business needs, requiring a deep understanding of the client's industry and operational challenges (Chen, 2020; Atanassova and Bednar, 2023). Despite these differences, both B2C and B2B services engage in value co-creation, although the processes, motivations, and outcomes differ according to the distinct nature of relationships in each context.

In B2C services, value co-creation primarily focuses on enhancing convenience and personal satisfaction (Chen, 2020; Dotzel and Shankar, 2016). The interactions in B2C contexts are often more informal and diverse, with consumers playing an active role in shaping their service experiences. Digital platforms and social media are extensively used to facilitate engagement, providing consumers with opportunities to personalize their interactions and express their preferences (Gligor and Maloni, 2021). The motivations for consumers to participate in value co-creation are often driven by personal benefits, such as improved product or service experiences and the feeling of being heard (Steinhardt, 2020). Emotional and social factors play a significant role in influencing consumer engagement, highlighting the importance of creating experiences that resonate with their personal values and social identity (Chowdhury et al., 2023). The outcomes of B2C value co-creation are frequently

intangible, focusing on aspects such as customer satisfaction, brand loyalty, and perception, which ultimately contribute to long-term engagement and business success (Gligor and Maloni, 2021).

B2B services emphasize value creation through professional expertise and business solutions. Value co-creation in B2B contexts is typically more structured and formal, with a strong focus on knowledge sharing and adaptive operational processes (Mingione and Leoni, 2019). The motivations for businesses to engage in co-creation activities are primarily strategic, driven by the potential for long-term partnerships, process improvements, and mutual growth opportunities (Chowdhury et al., 2023). Unlike B2C services, B2B interactions focus heavily on innovation and sustainability, aiming to deliver solutions that align with evolving industry demands and market dynamics (Mingione and Leoni, 2019). The outcomes of value co-creation in B2B settings are more tangible and measurable, including improvements in operational efficiency, cost reductions, and enhanced innovation capabilities (Chowdhury et al., 2023).

2.2 Geographic Information Systems in Information Systems Research

2.2.1 Foundations of Geographic Information Systems

When integrating location information into service systems, if it is a B2C or B2B service, specific tools are needed to enable working with these data. Being used since the early 1960s (Esri, 2020), GIS have become essential tools in various fields due to their ability to reveal spatial relations, patterns, and trends (Ehlers and Schiewe, 2012). GIS can be defined as "a system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analyzing and disseminating information about areas of the earth" (Dueker and Kjerne, 1989, pp. 7-8). GIS provide tools to interact with geospatial data, which can be represented in different formats and models, depending on the spatial scale and the specific application, such as ground, surface, underground, indoor, or outdoor environments (Breunig et al., 2020; J. Park et al., 2018). Geospatial data consists of two main components. The first is location information, which consists of coordinates that define the position of features on the Earth's surface, including e.g., latitude, longitude, and elevation.

The second component is attribute data, comprising descriptive information about the spatial features. Attributes can include characteristics such as names, types, conditions, and other relevant details that provide context to the location data (Dueker, 1987; Sun et al., 2019; Temiz, 2023; P. Kumar et al., 2024). For example, in the context of energy grids, geospatial data includes location information such as coordinates of transmission lines and substations, which are essential for mapping and maintenance. Further, it includes attribute data like the type of equipment, operational status, and capacity, which provide context and enhance the value of location-based services (Hoffmann et al., 2020).

GIS offer four core properties to work with geospatial data: acquisition, management, analysis, and presentation (Ehlers and Schiewe, 2012; Breunig et al., 2020) (Figure 2.2).

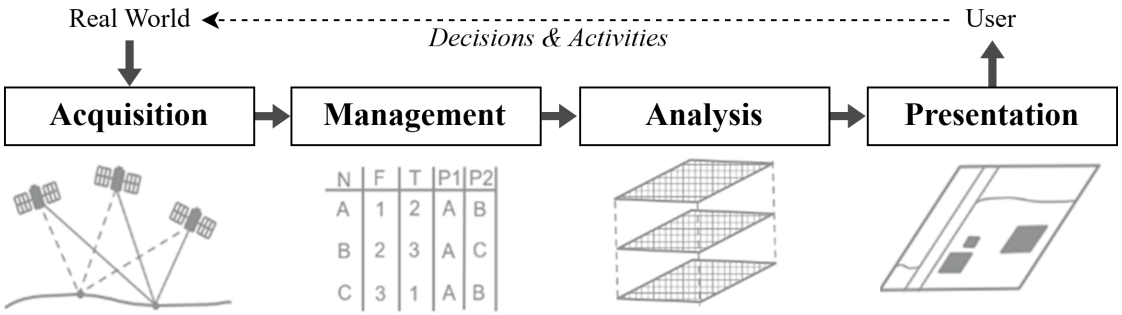

Figure 2.2: Properties of GIS (Ehlers and Schiewe, 2012).

Acquisition of geospatial data is a fundamental component of GIS. This process involves collecting data that represent real-world objects such as buildings, roads, or grid assets. Modern methods of data acquisition include GPS—a type of Global Navigation Satellite System (GNSS), which is a technology that works by using signals from a network of satellites to determine the precise location of a receiver on Earth. The system provides navigational coordinates in a three-dimensional space (X, Y, Z) and very precise time information (UTC). GPS devices determine their location by analyzing the time delays of signals transmitted by several satellites, allowing for accurate positioning and navigation (Dziadczyk et al., 2007). GPS offers precise data on position, velocity, and acceleration (Hahulina et al., 2019; Covaciu et al., 2011). Other methods of geospatial data acquisition are remote sensing techniques like aerial and satellite imagery, that enable capturing large-scale geographic data (Hahulina et al., 2019). Further, traditional surveying methods such as tacheometry

and laser scanning are used for high-accuracy data collection in smaller areas (Ehlers and Schiewe, 2012). Additionally, the growing number of IoT devices has led to an increase in available geospatial data from various sensors and smart devices (Cao and Wachowicz, 2019).

Once geospatial data is acquired, it must be organized and stored efficiently. GIS use geodatabases to manage large datasets of geospatial data. These databases facilitate the storage, retrieval, and manipulation of spatial data and its associated attributes (Ehlers and Schiewe, 2012). Geodatabases are structured to store different types of data. First, vector data, like points, lines, and polygons, are for representing discrete features and spatial relationships in a precise and structured way. Raster data, like aerial images, are gridded datasets consisting of cells or pixels arranged in a regular grid (Farkas et al., 2016). Each pixel in a raster dataset represents a specific area on the Earth's surface and is assigned a value corresponding to a particular attribute, such as elevation or temperature (Neteler and Mitasova, 2008). These data are widely used for spatial analysis and visualization, particularly for modeling continuous phenomena or displaying imagery. For example, raster data is integral to applications like land cover classification or environmental monitoring (Trapp and Döllner, 2009). Programs like INSPIRE promote the sharing of geospatial data across borders and organizations, enhancing data integration (European Commission, 2007). Effective data management ensures that geospatial data from different origins can be used together seamlessly. The INSPIRE directive requires European member states to offer spatial data services at no cost, including related services for search, presentation, and downloading. Standards and protocols are followed to maintain data quality and enable interoperability between different GIS systems (European Commission, 2007).

One of the most powerful features of GIS is its ability to analyze geospatial data. GIS analysis tools can process spatial data to uncover patterns, relationships, and trends that are not immediately apparent. Common types of GIS analysis include overlay analysis, buffer analysis, spatial interpolation, and network analysis (Srivas and Khot, 2018). Overlay analysis involves combining multiple layers of data to identify relationships between them. For example, overlaying housing data with noise level maps can provide insights into the impact of environmental factors on real estate values (Cohen and Coughlin, 2008). Another GIS analysis is buffer. This tool creates buffer zones around geographic features to analyze the impact or influence of these features (Srivas and Khot, 2018). For instance, creating buffers around rivers enables

to study flood risk areas for houses. Other GIS analysis methods include spatial interpolation, a method used to predict values at unsampled locations by referencing data from surrounding known points (Cressie, 1986). This technique is often used in environmental science to predict pollution levels at unmeasured locations (Hahulina et al., 2019). Further, network analysis examines the connectivity and flow within networks, such as transportation or utility networks, to optimize routes and improve infrastructure planning (Yu and Cai, 2004).

The final characteristic of GIS is their ability to present data visually through maps and other graphical formats. Effective data presentation is crucial for interpreting and communicating spatial information. GIS offer various tools for data visualization, including thematic mapping, 3D visualization, interactive maps, and dashboards (Huang and Lin, 2000; Zhu et al., 2014). Thematic mapping involves creating maps that highlight specific themes or patterns, such as population density or land use (Dennis and Carte, 1998). 3D visualization represents data in three dimensions to provide a more realistic view of the terrain and built environment, which is particularly useful in urban planning and landscape analysis (Srivas and Khot, 2018). Interactive maps allow users to interact with maps to explore data layers, query attributes, and customize views, enhancing the usability and accessibility of geospatial data (Ehlers and Schiewe, 2012). Dashboards integrate maps with other data visualization elements like charts and graphs to create comprehensive analytical dashboards, facilitating decision-making (Dennis and Carte, 1998). By presenting data effectively, GIS maps help users understand complex spatial relationships and make decisions based on provided and visualized data.

2.2.2 Information Systems Perspective on Geographic Information Systems

The ability of GIS to handle and process spatial information makes them indispensable in various fields, like urban planning or risk management (Thongmak et al., 2024; Bouzari, 2024). The integration of GIS in IS research has enhanced and transformed decision support, public services, and predictive analytics while playing an increasingly central role in data-driven service systems (Hess et al., 2004; Horita, 2016). Thus, understanding the characteristics and capabilities of GIS is crucial for leveraging their full potential in application scenarios of IS research, including urban planning, environmental monitoring, and resource management (Keenan and

Jankowski, 2019; Bouzari, 2024). GIS facilitate the handling of geospatial data, which is unique because it incorporates both location information (e.g., latitude and longitude) and attribute data that provide contextual insights, such as land use or environmental conditions (Cao and Wachowicz, 2019; Keenan and Miscione, 2015).

Several studies have explored the application and impact of GIS within IS. For instance, IS literature discussed the evolution and significance of SDSS, which integrate GIS functionalities to support complex decision-making processes in Decision Support System (DSS) (Keenan and Jankowski, 2019). DSS are an integral part of IS research and GIS offer support for decision-making, e.g. during crises by being used in disaster management with volunteered geospatial data (Horita, 2016). DSS that incorporate GIS can enhance decision-making through spatial data visualization, proximity analysis, and spatial pattern recognition (Dennis and Carte, 1998). Recent studies have also demonstrated how GIS facilitate predictive analytics in risk management, including environmental hazards such as dust storms (Bouzari, 2024), as well as demand forecasting based on geospatial and IoT-enabled behavioral data (Zhang and Yang, 2024). Further, the challenges and advantages of web-based SDSS have been explored, emphasizing their role in making spatial data and analytical tools accessible to a broader audience (Sugumaran and Sugumaran, 2007).

Additionally, the role of GIS in supporting large-scale infrastructure and urban development has been analyzed, providing insights into long-term spatial transformations (Thongmak et al., 2024). For instance, in retail site selection, GIS can analyze demographic data, traffic patterns, and competitor locations to identify optimal store locations (Aboulola, 2017). GIS can enhance marketing strategies by providing spatial insights into customer behavior and market trends (Hess et al., 2004). For example, GIS-driven socio-economic analyses of digital platforms, such as short-term rental markets, have revealed how spatial factors influence host participation and service accessibility (Sarkar et al., 2024). Moreover, GIS play a crucial role in enabling information exchange between multiple stakeholders in service systems, as evidenced by recent studies on geospatial information exchange platforms (Bazarah and Li, 2024).

Although GIS have been found to offer significant benefits, they are still underrepresented in IS research. With the rise of open data policies and the IoT, there is a plethora of geospatial data that can be leveraged through GIS (European Commission, 2007). This data provides richer insights and supports new application scenarios (Chen et al., 2018). In the past years, IS research started to analyze how

GIS can enhance value co-creation within service systems, particularly in the context of smart services and IoT (Beverungen et al., 2019; Cao and Wachowicz, 2019). However, GIS are often used as black-box tools without sufficient theoretical exploration (Keenan and Miscione, 2015). Further, it remains unclear what are specific design requirements of GIS to address emerging business problems involving spatial data (Klein et al., 2017).

3 Research Design

3.1 Research Paradigms and Research Approach

IS research is an interdisciplinary research field (Becker and Niehaves, 2007), that focuses on the "analysis, design, implementation, and use of information systems" (Hevner et al., 2004, p. 76). The goal is to "develop an understanding of how and why IT systems work or do not work" (March and Smith, 1995, p. 251). IS research examines socio-technical phenomena at the intersection of organizations, technology, and people (Peffers et al., 2007; Hevner et al., 2004). Therefore researchers aim to address complex and multidimensional challenges that require consideration of technical, organizational, and human factors (Mingers, 2001, p. 243).

The field is characterized by two complementary paradigms: behavioral science and design science (Hevner et al., 2004). Behavioral science seeks to explain and predict actions within human and organizational contexts, whereas design science focuses on developing innovative artifacts. Therefore, “the information systems field examines more than just the technological system, or just the social system, or even the two side by side; in addition, it investigates the phenomena that emerge when the two interact” (Lee, 2001, p. iii). Together, these paradigms form "a synergistic approach in which design science creates innovative artifacts for specific information problems and behavioral science meaningfully engages these artifacts in the development of theory" (Hevner and March, 2003, p. 113). The integration of these paradigms reflects their role as "complementary but distinct" (Hevner and March, 2003, p. 111), enabling IS research to contribute to both theoretical advancements and practical applications. This dual focus is captured in the principle that "truth informs design and utility informs theory" (Hevner et al., 2004, p. 80). Theoretical contributions in IS are organized into five interrelated types: theory for analyzing (Type I), theory for explaining (Type II), theory for predicting (Type III), theory for explaining and predicting (Type IV), and theory for design and action (Type V) (Gregor, 2006).

The IS research framework by Hevner et al. (2004) highlights how IS research bridges the gap between real-world challenges and theoretical development (Figure 3.1). On the left side of the framework lies the environment, or problem space, which encompasses people, organizations, and technologies as central elements that define the business needs identified by researchers. On the right side is the knowledge base, comprising foundations and methodologies that serve as the raw materials for conducting IS research. By leveraging this knowledge base, researchers ensure rigor through the appropriate application of existing theories and methods.

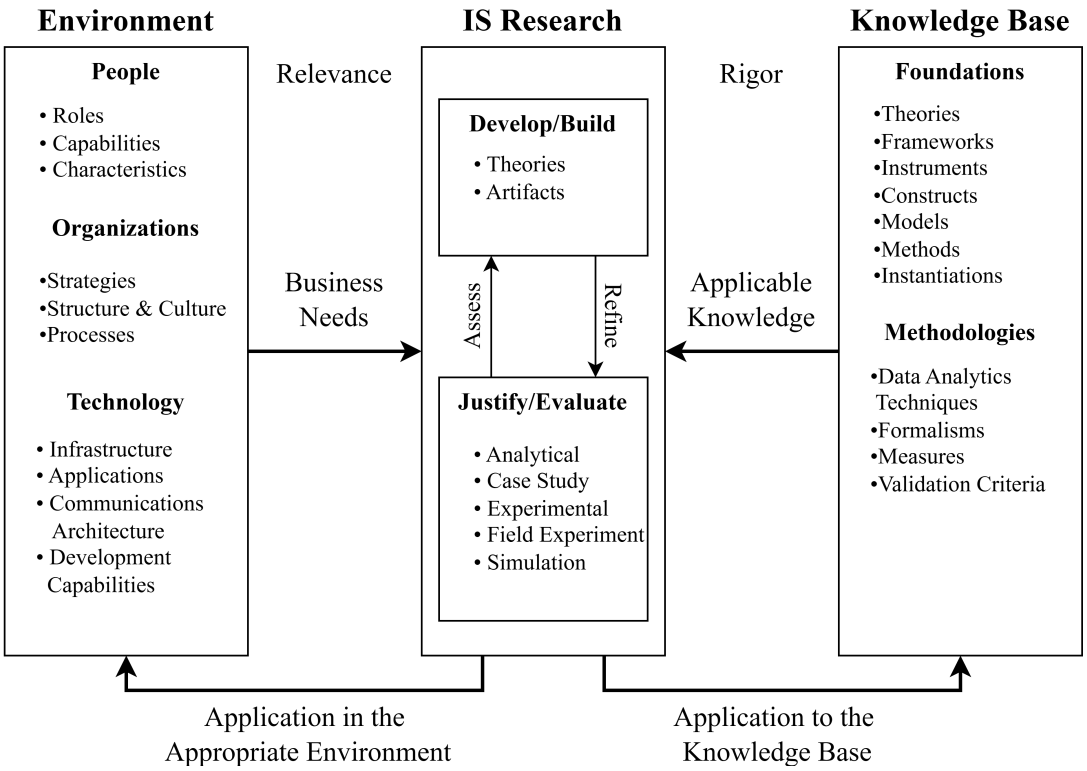

Figure 3.1: IS research framework (Hevner et al., 2004).

At the center of the framework is IS research itself, which integrates the environment and the knowledge base to address practical problems while contributing to academic understanding. DSR is one of the core paradigms in this framework, offering structured methodologies, such as the DSRM, which ensures that research is conducted in a systematic and effective manner (Peffers et al., 2007). This methodology balances relevance and rigor, aligning research outcomes with both practical needs and scholarly standards.

In this dissertation, a multi-method approach is adopted to address the various dimensions of the framework (Figure 3.3). By employing different methods, this research examines the problem space and the knowledge base to answer the research questions, ensuring a comprehensive investigation that advances theoretical insights while addressing real-world challenges. The methods utilized are described in detail in the following sections, illustrating how this approach contributes to the dual goals of theory and practice in IS research.

3.2 Applied Research Methods

3.2.1 Literature Review

A literature review is a common research approach in IS research, which aims at identifying, analyzing, and systematizing existing knowledge within a specific domain. Its primary goal is to offer a comprehensive research perspective by synthesizing prior studies, uncovering gaps in current knowledge, and suggesting future research directions. Literature reviews should go beyond summarizing existing work to critically evaluate and propose future research avenues (Rowe, 2014). This approach ensures that research efforts are not only grounded in past findings but also forward-looking, contributing to the continuous advancement of the field. Literature reviews play a vital role in forming a foundation for identifying weaknesses and poorly understood aspects, as well as challenging existing assumptions and theoretical perspectives (Boell and Cecez-Kecmanovic, 2014).

A structured methodology is essential to achieve these objectives effectively. Conducting a literature review requires a rigorous and transparent process that enhances the traceability and replicability of findings (Vom Brocke et al., 2015). Following established guidelines allows for a systematic aggregation of previous research (Webster and Watson, 2002). There are various types of literature reviews, including gap-spotting reviews, which focus on identifying research gaps and suggesting future directions rather than only addressing known issues (Schryen et al., 2015). This approach is particularly valuable in rapidly evolving fields such as IS, where continuous reassessment is essential. A well-structured review not only helps in the development of theoretical contributions but also in constructing new research mod-

els, thus facilitating a deeper understanding of the topic (Webster and Watson, 2002; Paré et al., 2015).

According to Webster and Watson (2002) the process of conducting a literature review typically involves several key phases. The first phase consists of defining the scope of the review, setting clear boundaries, and identifying relevant sources to ensure comprehensive coverage of the subject area. Following this, the identification phase involves searching for relevant literature using specific keywords and search strings. This phase requires careful selection to exclude irrelevant studies and previously conducted reviews, ensuring the inclusion of only relevant contributions. The final phase focuses on structuring the findings through the use of a concept matrix, which aids in organizing insights and establishing meaningful relationships among various themes identified in the literature.

3.2.2 Conceptual Research

Conceptual research is a non-empirical method that has been widely used in service research, with one well-known example being the development of the S-D Logic (Jaakkola, 2020; Vargo and Lusch, 2004). Unlike empirical research, which relies on data collection and analysis, conceptual research focuses on developing new ideas such as constructs, frameworks, methods, and systems by combining and organizing existing theories and concepts (Hirschheim, 2008; Jaakkola, 2020). This approach allows researchers to gain new insights by bringing together existing knowledge and offering new perspectives on complex topics.

Conceptual research usually starts with a topic that has not been well covered in current research or with theories that are seen as incomplete or insufficient in explaining a phenomenon (Jaakkola, 2020). Instead of collecting data, conceptual research builds arguments by carefully analyzing and integrating existing knowledge. A key part of this process is gathering knowledge within a discourse universe, which includes all elements that are relevant to the topic, even those that have not yet been fully considered (Weik, 2001).

Conceptual research can be divided into two main types: conceptual behavioral research and conceptual design research (Mora et al., 2008). Conceptual behavioral research focuses on topics that relate to real-world objects and seeks to explain their

interactions. Conceptual design research focuses on exploring and developing new artifacts, such as models, frameworks, and methods, to solve practical problems.

According to Jaakkola (2020), there are different types of contributions that conceptual research can make, depending on the structured of the arguments and the research goals. One type is theory synthesis, which brings together different theories or areas of research to improve the understanding of a topic. This type of research helps to connect different ideas and create a more complete picture. Another type is theory adaptation, where an existing theory is expanded or modified by adding new perspectives from other theories, making it more useful or applicable in different situations. Conceptual research can also result in typology papers, which classify different versions of constructs, frameworks, methods, or systems into specific types. These papers help to clarify concepts by showing their differences and unique characteristics. Lastly, conceptual research can produce model papers, which identify and describe relationships between concepts and create theoretical frameworks that can guide future research and practice.

3.2.3 Data-Driven Research

DDR has emerged in recent years as a new inductive and empirical research approach that enables researchers to analyze large volumes of data to answer complex research questions (Müller et al., 2016). Unlike traditional theory-driven methods, DDR begins by formulating a research question that can be addressed through the analysis of extensive data sets. DDR is characterized by its reliance on empirical data to inform research questions and methodologies, emphasizing the integration of data analytics and computational techniques to uncover patterns and insights from large datasets, often referred to as *big data* (Müller et al., 2016).

A key aspect of DDR is its ability to work with both structured and unstructured data, requiring systematic processes for data collection, analysis, and result interpretation (Müller et al., 2016). The data collection phase can involve various types and quantities of data, depending on the specific objectives of the research and the context in which it is applied. However, the rise of big data presents both opportunities and challenges for DDR. Researchers must navigate issues related to data quality, privacy, and the ethical implications of data usage while striving to maintain rigorous scientific standards (Berente et al., 2019). The subsequent analysis phase can

adopt different strategies, often based on statistical techniques, to identify patterns, correlations, or trends within the data (Müller et al., 2016). Finally, the interpretation of results relies on established methods, such as conceptual research, to explain findings and derive theoretical insights (Berente et al., 2019).

DDR offers significant advantages in terms of scalability and reliability compared to manual data analysis methods (Debortoli et al., 2016; Miner et al., 2012). It allows for the processing and analysis of big amounts of data that would otherwise be impossible to examine manually. Additionally, the potential for human bias, particularly in selecting relevant data sources, can be minimized by avoiding subjective decisions about rejecting specific data elements (Indulska et al., 2012). However, a comprehensive framework for DDR includes dimensions such as data sourcing, sensemaking, and data-driven decision-making, helping to understand how organizations can effectively utilize data to drive innovation and improve operational efficiency (Debortoli et al., 2016). A limitation of DDR is that it relies solely on the available data, making it difficult to draw retrospective conclusions based on contextual or historical factors that are not captured within the dataset (Müller et al., 2016).

According to Leek and Peng (2015), DDR involves different categories of statistical data analysis, each serving a unique purpose. For example, descriptive data analysis focuses on summarizing the characteristics of a single dataset without interpreting it further. Exploratory data analysis extends descriptive methods by searching for trends, relationships, or patterns within the data, often generating new hypotheses. Causal data analysis investigates the impact of one variable on another, seeking to determine the average effect of changes, and predictive data analysis leverages a subset of data variables to predict an outcome for an individual case.

Geospatial data analysis is a method of DDR, which adds a spatial dimension to the data being analyzed. Concepts and constructs can help structure variables in geospatial analysis, offering a way to operationalize abstract ideas by linking them to measurable data points (Lansley et al., 2018; Lech et al., 2018). GIS are used for geospatial data analysis to incorporate both spatial and attribute data, producing visualizations or data outputs that provide richer insights for research that considers location-specific factors (Farkas et al., 2016). Advancements in ML and big data technologies have further enhanced the capabilities of geospatial data analysis for both, vector and raster data (Bereta et al., 2018; Farkas et al., 2016). These technologies facilitate the efficient processing of extensive spatial datasets, allowing for real-time

analysis and dynamic mapping, which are crucial for applications in disaster management and urban development (Lansley et al., 2018).

3.2.4 Design Science Research

DSR has its roots in the field of engineering and has since evolved into a widely accepted research paradigm within the IS discipline (Hevner et al., 2004; Peffers et al., 2018). It focuses on the systematic design and evaluation of artifacts within organizational contexts, building on established foundations and methodologies from the existing knowledge base to ensure rigor and relevance (Hevner et al., 2004). The primary goal of DSR is to provide useful artifacts that address real-world challenges, fostering a process often described as “learning through building” (Kuechler and Vaishnavi, 2008, p. 396).

At the core of DSR lies the concept of Information Technology (IT) artifacts, which can be constructs, models, methods, and instantiations (March and Smith, 1995). Constructs are "the vocabulary of a domain" (March and Smith, 1995, p. 256). When constructs are combined, they form a model, which is "a set of propositions or statements expressing relationships among constructs" (March and Smith, 1995, p. 256). Constructs and models are the basis for methods, which is "a set of steps (an algorithm or guideline) used to perform a task" (March and Smith, 1995, p. 257). The most advanced type of IT artifact is an instantiation, which is "the realization of an artifact in its environment" (March and Smith, 1995, p. 258) and integrates constructs, models, and methods. IT artifacts are designed to provide practical solutions while advancing theoretical understanding. Design knowledge generated through DSR can be expressed in the form of design principles, which are prescriptive statements that guide how to achieve specific goals (Gregor et al., 2020).

The foundation for theoretical contributions in DSR is often framed within the Information Systems Design Theory (ISDT) (Gregor and Jones, 2007). The ISDT consists of eight essential components that structure design knowledge: purpose and scope, constructs, principles of form and function, artifact mutability, testable propositions, justificatory knowledge, principles of implementation, and expository instantiation (Gregor and Jones, 2007). The primary contribution of ISDT lies in the development of theory. Here, it is optional to integrate an instantiated artifact.

In contrast, the DSRM by Peffers et al. (2007) focuses on developing IT artifacts. This framework is widely adapted in the IS domain and outlines a structured process of six steps for developing design knowledge (Figure 3.2). The six steps include: (1) identifying the problem and motivating the research, (2) defining the objectives of a solution, (3) designing and developing the artifact, (4) demonstrating its application, (5) evaluating its effectiveness, e.g. through prototypical implementations, and (6) communicating the results (Peffers et al., 2007). This approach aims to balance practical applicability with theoretical generalizability, without explicitly requiring the development of theory.

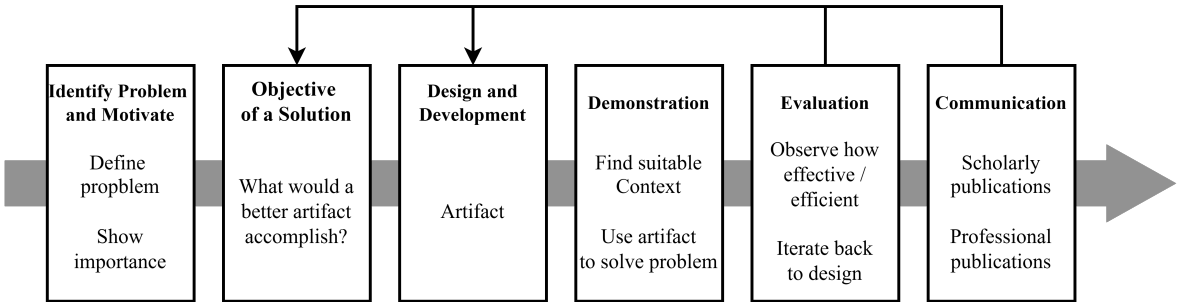

Figure 3.2: DSRM (Peffers et al., 2007).

The nature and maturity of the artifact, as well as the domain in which it is applied, influence the type of knowledge contribution a DSR study can achieve. According to Gregor and Hevner (2013), DSR contributions can be classified into four categories. The first is invention, which is "a clear departure from the accepted ways of thinking and doing" (Gregor and Hevner, 2013, p. 345). Here, the application domain as well as the existing solutions in this field have a low maturity. The second contribution is improvement, which aims to "create better solutions in the form of more efficient and effective products, processes, services, technologies, or ideas" (Gregor and Hevner, 2013, p. 346). Exaptations extend or refine "design knowledge that already exists in one field [...] so that it can be used in some new application area" (Gregor and Hevner, 2013, p. 347). The last category is routine design, meaning applying "known solutions to known problems" (Gregor and Hevner, 2013, p. 345).

By systematically designing, evaluating, and refining artifacts, DSR provides a robust methodological foundation for advancing IS research. Its iterative approach ensures that artifacts are not only rigorously tested within their intended contexts but also contribute valuable insights to the broader scientific community.

3.3 Research Process

To answer the research questions, a multi-method approach is applied, that includes all of the above mentioned research methods. Multi-method research is an approach that combines different research methods within a single study or research program to achieve a more comprehensive understanding of complex phenomena. This approach has been widely recognized in the field of IS as it allows researchers to leverage the strengths of multiple methods while mitigating their individual limitations (Mingers, 2001). Different research methods capture distinct aspects of reality, and integrating them enables a richer and more reliable understanding of the studied phenomenon (Mingers, 2001). Employing multiple methods helps link research questions across different levels of analysis, cross-referencing findings, and grounding research proposals in substantive cases (Zachariadis et al., 2010). This makes multi-method research particularly valuable in IS, where interactions between technology, organizations, and individuals create complex dynamics that cannot be fully captured by a single methodological approach.

A key distinction must be made between multi-method and mixed-methods research. While both involve the combination of multiple research techniques, mixed-methods research explicitly integrates qualitative and quantitative approaches within a single study (Gunasekare, 2015). Multi-method research, in contrast, more broadly refers to the use of different methods, which may or may not involve mixing qualitative and quantitative techniques. However, within literature the two terms are often used as synonyms, since the core idea behind these methods remains the same: by combining different perspectives and analytical approaches, the research gains depth, robustness, and broader applicability (Zachariadis et al., 2010).

According to Mingers (2001), several advantages of multi-method research have been identified in the literature. One of its primary benefits is triangulation, which enhances the validity of findings by enabling cross-validation across different methods. Additionally, it allows for expansion by enabling researchers to explore different dimensions of a phenomenon and extending the scope of analysis. The combination of methods also fosters creativity, uncovering congruent or even contradictory findings that lead to new insights and further research directions (Mingers, 2001). Another key benefit is contextualization, as multi-method research allows for a deeper understanding of both macro- and micro-level dynamics, ensuring that findings remain

applicable to real-world complexity (Zachariadis et al., 2010). By integrating multiple research approaches, findings become more robust, as the weaknesses inherent in any single method are mitigated (Petter and Gallivan, 2004).

According to Zachariadis et al. (2010), conducting multi-method research follows a structured process to ensure methodological rigor while maximizing its potential for theoretical contributions. The process begins with defining the research question, ensuring that the chosen methods contribute meaningfully to answering the central inquiry. The next step involves selecting and justifying the methods to be used. It is essential that researchers carefully choose complementary methods that align with the study's objectives, whether applied within a single study or across multiple related studies (Petter and Gallivan, 2004). The third phase involves data collection and integration, where data may be gathered sequentially or concurrently depending on the research design (Gunasekare, 2015). Integration is crucial to ensure that insights derived from different methods complement each other rather than remaining isolated findings. The analysis and interpretation phase involves evaluating each method independently before synthesizing the findings. Comparing patterns, reconciling contradictions, and generating new insights through synthesis ensures methodological rigor (Mingers, 2001). Multi-method research often follows an iterative approach, where findings from one method inform subsequent research phases, leading to continuous refinement and knowledge development (Mingers, 2001). Finally, effectively communicating the results is essential. Transparency in detailing how different methods were applied and integrated ensures credibility and allows for a clearer interpretation of the research findings (Zachariadis et al., 2010).

In this dissertation, different methods of behavioral and DSR paradigms are combined to address the research problem and to answer the four research questions (Figure 3.3). Through using a multi-method approach, different types of theories can be classified.

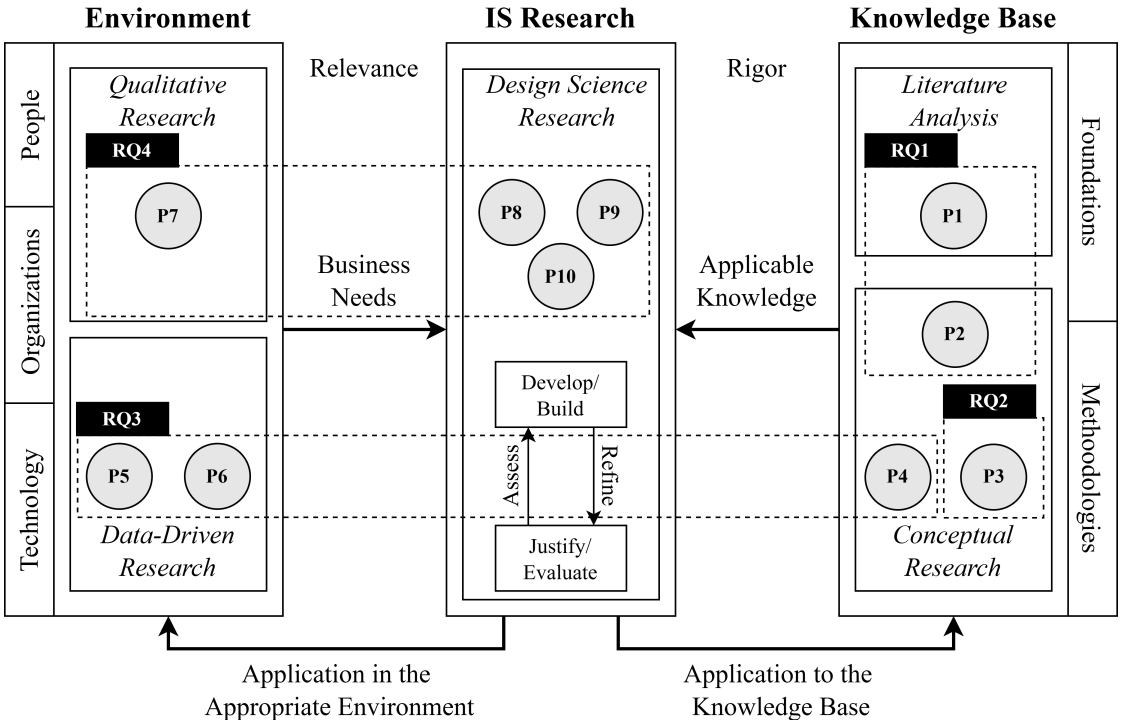

Figure 3.3: Research approach based on the IS research framework (Hevner et al., 2004).

To address RQ1 (*How are GIS considered in IS research and what is their role in service systems?*), a combination of literature analysis and conceptual research is used (P1, P2). First, a literature review is conducted (P1), that examines existing research in IS, particularly focusing on how GIS are considered in the IS discipline and what their role is in service systems. This method enables to identify, analyze, and systematize existing knowledge and to offer comprehensive research perspectives by synthesizing prior studies and exploring research gaps (Webster and Watson, 2002). Second, existing research on how geospatial data is used in LBS and LCS is examined (P2). Here, the role of GIS for these types of service systems is investigated. Both studies generate theory for analyzing (Type I) (Gregor, 2006), providing new insights for the knowledge base.

For RQ2 (*How can GIS contribute to superior value co-creation by enabling service providers and customers to leverage geospatial data in service systems?*), the knowledge base is further explored and expanded through a conceptual research study that develops new concepts for leveraging GIS in value co-creation (P3). In this paper, a framework for location-specific service systems is developed based on the prior results to examine the role of GIS for value co-creation in service systems and establishing a new

perspective on B2C and B2B services augmenting on geospatial data and GIS. Here, the focus is on theory for analyzing (Type I) (Gregor, 2006), as the framework seeks to provide a description of GIS-enhanced value co-creation among service providers and customers, without providing explanations. Thus, this research contributes to understanding "what is" (Gregor, 2006, p. 620).

For RQ3 (*How is value co-created in location-specific service systems in B2C contexts using GIS as a boundary object?*), a combination of DDR and conceptual research is used to integrate the knowledge base and the environment, creating new knowledge to both sides. First, the concept of City 5.0 is established, providing insights into what restrictions citizens face within cities and how GIS can enable overcoming or reducing spatial restrictions (P4). Here, the focus is on theory for analyzing (Type I) (Gregor, 2006), as it seeks to uncover the mechanisms through which geospatial data enhances intangible outcomes such as personalized experiences and consumer needs (Chen, 2020; Dotzel and Shankar, 2016; Gligor and Maloni, 2021). Second, in the context of GIS and ML-based real estate appraisal, two studies comprising this case apply DDR (P5, P6). Here, large datasets, including geospatial data, are analyzed to predict house prices, highlighting the practical applications of DDR in deriving actionable insights from real-world data. By leveraging predictive models and geospatial data, these studies provide empirical evidence on how location-specific service systems can support decision-making and improve service delivery for B2C service systems, further seeking to explain how the predictions are derived and which variables have the most impact. Thus, the outcomes of these studies can be classified as theory for explaining and predicting (Type IV) (Gregor, 2006). The combination of DDR and conceptual research enables this dissertation to address both the practical and theoretical aspects of designing B2C service systems. The integration of DDR and conceptual research fosters insights from the knowledge base and the environment to guide the analysis of value co-creation in location-specific service systems in B2C contexts.

For RQ4 (*How is value co-created in location-specific service systems in B2B contexts using GIS as a boundary object?*), a combination of qualitative research and DSR is applied. First, a qualitative study is performed (P7) within the research process of DSR to build the foundation for designing IT artifacts for condition-based maintenance on the energy distribution grid. Here, expert interviews are conducted within the domain to derive DPs. This study provides theory for analyzing (Type I) (Gregor, 2006) and establishes new knowledge especially for the environment, as it includes insights

from the real world. Afterwards, the DPs are used as a base for designing a system for condition-based maintenance on the distribution grid, utilizing geospatial data with location analytics and GIS for outage prediction (P8) and further advancing this system to a combination of a smart service system, managing critical assets, and a digital industrial platform augmenting on geospatial data and GIS (P9). Second, another B2B case is considered, designing a GIS-AHP-based SDSS for discovering and visualizing suitable locations for EVCS (P10). These two cases being portrayed through three studies, generate theory for design and action (Type V) (Gregor, 2006). The context of B2B services, characterized by structured interactions, knowledge sharing, and a focus on innovation and sustainability (Mingione and Leoni, 2019), is crucial to the analysis of value co-creation. Unlike B2C services, B2B interactions typically yield tangible and measurable outcomes, such as improvements in operational efficiency and the optimization of business processes (Chowdhury et al., 2023). Through the integration of qualitative research and DSR, this dissertation provides a comprehensive approach to investigate the value co-creation in location-specific service systems in B2B contexts. The iterative process of deriving design principles, building and refining artifacts based on methods from the knowledge base (DSRM), ensures that both practical applications and theoretical contributions are achieved.

4 Research Results and Contribution

4.1 Synopsis and Discussion of Findings

The complexity of IS research is widely acknowledged, as it involves technological and social dimensions (Sarker et al., 2019). In today's digital landscape, this complexity is further intensified by the expansion of global digital infrastructures, like the IoT. These developments create increasing interdependencies between human actors, technical artifacts, business processes, organizations, and institutions (Benbya et al., 2020). To manage this complexity, researchers often apply a decomposition strategy, breaking down complex problems into smaller, more manageable subproblems (Simon, 2019). This approach supports a structured investigation of IS phenomena and emphasizes the importance of systematically organizing research problems into distinct subproblems (Alexander, 1964).

A pluralist methodology is frequently used to address these subproblems, as it allows the combination of different research methods to provide a more comprehensive understanding (Mingers, 2001). Integrating multiple methods from different research paradigms can enhance the depth and reliability of findings through triangulation (Mingers, 2001). However, selecting and combining methods requires careful consideration of the underlying epistemological assumptions to ensure consistency in research design (Becker and Niehaves, 2007). Since key concepts such as rigor, validity, and research quality are shaped by these assumptions, aligning methodological choices with epistemological foundations is crucial (Becker and Niehaves, 2007).

To support this integration of methods, established principles for multi-method research designs provide guidance (Morse, 2003). Applying these principles in IS research enables a more structured approach to investigating complex research problems and fosters the integration of diverse perspectives. Ultimately, the combination

of decomposition and multi-method research strategies contributes to theory building by integrating insights from individual subproblems into broader theoretical frameworks, advancing the IS field (Weber, 2012).

The results of the publications comprising Part B address the research problem that it is unclear what role GIS have in service systems and how their unique properties contribute to superior value co-creation between service customers and service providers in location-specific service systems as well as how value is co-created in B2C and B2B contexts. Since the research problem is sufficiently complex, it has been decomposed into smaller parts, represented by four research questions. The results will be presented as decomposed parts as well as a whole addressing the overarching research problem, as proposed by Weber (2012). Therefore, the publications are organized in a conceptual framework, which can be found in Figure 4.1.

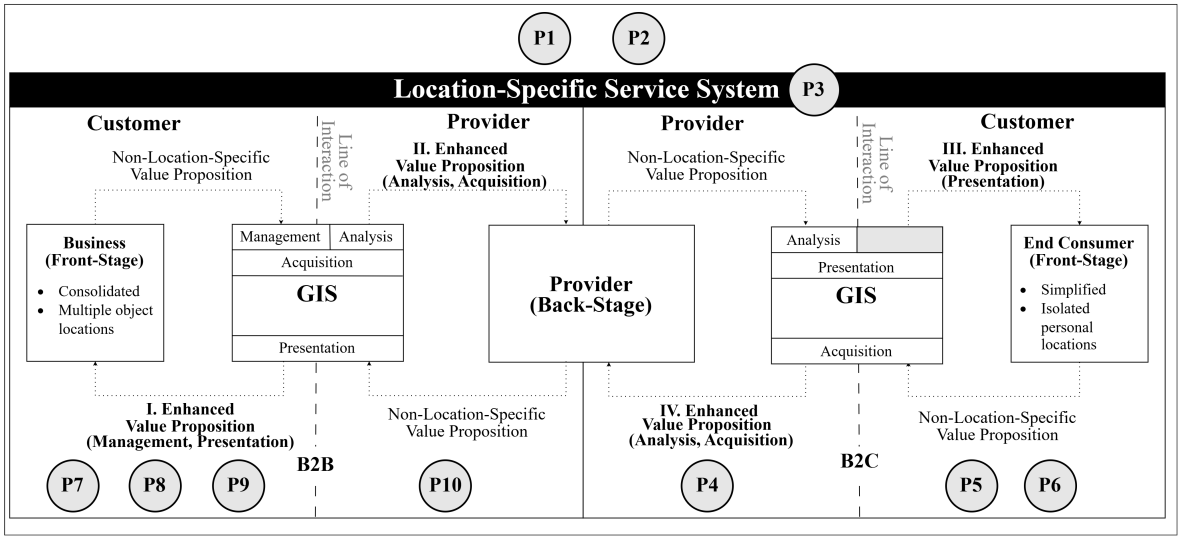

Figure 4.1: Location-specific service systems framework for B2C and B2B location-specific services.

The foundation of the conceptual framework is established through the findings of P1 and P2, which contribute to answering RQ1. These publications provide the necessary theoretical basis for understanding how GIS functions within service systems and how location-based data influence value co-creation processes. The framework itself plays a central role in answering RQ2, which is primarily addressed by P3. To ensure a comprehensive understanding of the framework's structure and implications, it will be explained in detail in the context of RQ2. The framework is designed

to capture the dual nature of GIS applications in service systems, distinguishing between B2C and B2B location-specific services.

The right side of the framework focuses on B2C location-specific services, which are investigated through RQ3. Within this context, two exemplary cases are included. The first application scenario is smart city, as explored in P4. The second scenario is real estate appraisal, examined in P5 and P6. The left side of the framework is dedicated to B2B location-specific services, which are subject of RQ4. Here, also two exemplary cases are included. The first case, addressed in P7, P8, and P9, is in the context of the energy distribution grid, focusing on predictive maintenance. The second case, covered in P10, explores EVCS placement.

To answer the first research question (*How are GIS considered in IS research and what is their role in service systems?*), a literature review is conducted to identify the current state of research on GIS in IS (Priefer, 2023) as well as a conceptual study to investigate the role of GIS in service systems (zur Heiden et al., 2023).

In P1 IS publications, that focus on GIS, are reviewed in a structured literature analysis, following a three-phase methodology as outlined by Webster (2002). The first phase involved defining the research boundaries, with the search conducted within the AIS eLibrary—a standard database for IS research—alongside eight additional journals from the Senior Scholars' Basket and five recommended by the AIS Special Interest Group GIS. The search was restricted to titles and abstracts to ensure a concentrated focus on GIS-related research. The second phase identified relevant literature, using search terms that captured various representations of GIS, such as "Geographic Information System" and "Geoinformationsystem". With forward and backward searches considered, the final selection included 97 relevant papers. In the third phase, the literature was systematically structured using a concept matrix, categorizing studies based on different concepts: research method (e.g., conceptual, empirical), relevance of GIS (e.g., technical design, usage of GIS functionalities), properties of GIS (acquisition, management, analysis, or presentation), and the research topic, which was either method-related (e.g., decision support, prediction) or domain-related (e.g., public services). The analysis revealed four significant research gaps, leading to corresponding research propositions.

First, despite GIS being a research subject in IS since 1995, its presence remains limited, with only a few publications per year. This underrepresentation persists despite the increasing availability of location-specific data, which presents growing

opportunities for data-driven insights. The first identified gap highlights the fact that GIS continues to be a niche topic, despite its potential to leverage open data policies and smart objects. Consequently, the first proposition is: *While substantially more location-specific data become available through open data policies and smart objects, GIS can provide richer insights and support new application scenarios, generating new opportunities for research.*

Second, GIS research in IS is predominantly under-theorized, with little conceptual or deductive work. GIS is still largely treated as a black box tool, used only for analyzing data rather than being conceptualized as a distinct class of information systems. This lack of theorization prevents a deeper understanding of how GIS are integrated within organizations beyond its function as a data analysis tool. The second research gap thus underscores the need for GIS to be analyzed, explained, and predicted within IS research as a class of information system. The corresponding proposition is: *GIS should be subjected to theorizing, to analyze, explain, and predict how they are used in organizations as a class of information systems.*

Third, while design-oriented studies on GIS exist, they primarily focus on DSR but fail to examine how GIS ought to be designed. Effective DSR requires the abstraction of findings to develop design theories, ensuring applicability across multiple contexts. However, IS research has not sufficiently derived such theories for GIS. Many studies consider GIS holistically without a dedicated focus on specific properties—acquisition, management, analysis, or representation. The third gap highlights that GIS has not been sufficiently explored from a design perspective. Thus, the third proposition is: *IS must be considered as an object of design, to implement new functionality and to theorize on how they ought to be designed to solve business problems that cover spatial data.*

Fourth, the integration of GIS in service systems remains conceptually underexplored. It is unclear why certain services operate more effectively with GIS than without it and the potential of GIS to enhance service systems for both providers and users has not been sufficiently examined. Thus, the fourth gap identifies a need for research on GIS-driven value (co-)creation in service systems. The corresponding fourth research proposition is: *We need to identify how GIS can contribute to superior value co-creation, as they are used by service providers and customers in service systems.*

To address the second part of the research question concerning the role of GIS in service systems, the conceptual study in P2 introduces the concept of Location-

Contextualizing Service (LCS) as a novel type of service, filling a gap in the literature on LBS. While LBS are characterized by dynamic interactions between mobile devices and geospatial data, LCS are designed for static customers and entities, using GIS to support decision-making through spatial contextualization. LCS are defined as services that utilize "location information of entities with a static position to co-create superior value-in-use and, ultimately, support customer decision-making by spatial contextualization" (zur Heiden et al., 2023, p. 5067). Unlike LBS, which rely on real-time location data and require proximity between the service user and service location, LCS operate independently of a user's real-time location. Instead, LCS rely on static coordinates of entities such as fixed infrastructure, allowing for service enhancement through geospatial analytics.

A fundamental distinction between LCS and LBS lies in their dependency on spatial proximity and locatability. While LBS require customers to be physically close to the service location and depend on mobile devices to determine their geospatial position, LCS function independently of these constraints. The core entities in LCS, such as assets or locations, are defined by static coordinates, eliminating the need for real-time location tracking. As a result, value co-creation in LCS is not based on a user's immediate location but rather on the added contextual insights derived from geospatial data. This makes LCS particularly relevant for applications where GIS provides supplementary analytical value rather than serving as the primary enabler of service delivery.

The underlying enabling technology for LCS is GIS, which facilitates the acquisition, management, analysis, and presentation of geospatial data without relying on mobile tracking. GIS allows static geospatial data to be combined with other datasets, enhancing service outcomes through a comprehensive spatial perspective and improving decision-making processes. LCS, therefore, presents a distinct approach to leveraging GIS in service systems. By integrating GIS, LCS extend the application of geospatial analytics beyond traditional LBS, allowing for enhanced service delivery in contexts where static geospatial data play a crucial role. This conceptualization introduces a new perspective on service system design, where GIS serve as a boundary objects between service providers and service customers and enhance value co-creation.

The introduction of LCS clarifies the role of GIS as boundary objects in service systems, highlighting their function in integrating data, facilitating interactions, and enhancing decision-making. However, as proposition 4 shows, there is still a need

to identify how GIS can contribute to superior value co-creation, as they are used by service providers and customers in service systems. Thus, the second research question (*How can GIS contribute to superior value co-creation by enabling service providers and customers to leverage geospatial data in service systems?*) is derived.

Building on the proposition from P1 and the findings from P2 on GIS as boundary objects in service systems, a conceptual framework is developed (Priefer and Beverungen, 2025). To account for the distinct characteristics of B2C and B2B markets, such as relationship dynamics and complexity (Chen, 2020; Atanassova and Bednar, 2023), the framework designed in P3 has two sides, ensuring a comprehensive perspective on GIS-driven value co-creation. The research follows a conceptual approach and the framework is developed iteratively through the analysis of six diverse LBS and LCS cases that illustrate how GIS enhance service outcomes across industries.

In the B2C domain, three cases demonstrate the impact of GIS on consumer-oriented services. A real estate platform leveraging LCS integrates environmental and location data to enhance price predictions (Kucklick et al., 2021). A hotel booking service employs LCS to help customers select accommodations based on proximity to Points of Interest (POI) (zur Heiden et al., 2023). Lastly, a public transportation planning system uses LBS to optimize bus tracking and routing in real-time (Lehrer et al., 2011).

For the B2B market, GIS plays a similarly crucial role. In condition monitoring for energy distribution grids, an LCS is employed to map static assets, integrate environmental data, and predict maintenance needs, enhancing infrastructure reliability (zur Heiden et al., 2022). Further, an LCS for EVCS placement helps decision makers to find suitable locations for charging infrastructure (Priefer and Steiger, 2022). Fleet management services integrate LBS for real-time vehicle tracking, predictive analytics, and dynamic dispatching (Küpper, 2005).

The conceptual framework is derived based on the smart service systems framework by Beverungen et al. (2019), extending it to location-specific service systems. It acknowledges the fundamental role of GIS as a boundary object that mediates interactions between service providers and service users. Structurally, GIS can be positioned in front of the smart object, enabling to act as a boundary object for services that have geospatial data in their core, e.g. acquired positions of smart objects within smart service systems. Further, the framework builds upon the concept of value

propositions in local usefulness and shared identity. Initially, non-location-specific value propositions exist without GIS, where services are designed based on generic user needs. However, the integration of GIS as a boundary object enhances local usefulness by providing spatially contextualized insights and strengthens shared identity by aligning service offerings with geospatial relevance. The enhanced value propositions can be found in Table 4.1 and will be explained in detail in the following.

	Enhanced value proposition	Local usefulness	Shared identity
B2B	**I.**	**Management** of multiple objects and their locations	Consolidated **presentation** of multiple objects and their locations (e.g., map)
	II.	Consolidated **analysis** of multiple objects and their locations	**Acquisition** of multiple objects and their locations (e.g., collecting data)
B2C	**III.**	(no use of GIS functionalities)	Simplified **presentation** (e.g., map)
	IV.	Consolidated **analysis** of multiple objects and their locations	**Acquisition** of isolated personal locations

Table 4.1: Local usefulness and shared identity in location-specific service systems.

For B2C services, the right part of the framework (Figure 4.2) is relevant. In this context, service customers are end consumers who engage in front-stage activities, such as searching for a hotel or public transportation. GIS functions as a boundary object, enabling interaction between service providers and consumers by facilitating the integration and analysis of geospatial data. However, within the B2C context, only three of the four core properties of GIS—analysis, acquisition, and presentation—are directly relevant for enhancing local usefulness and shared identity.

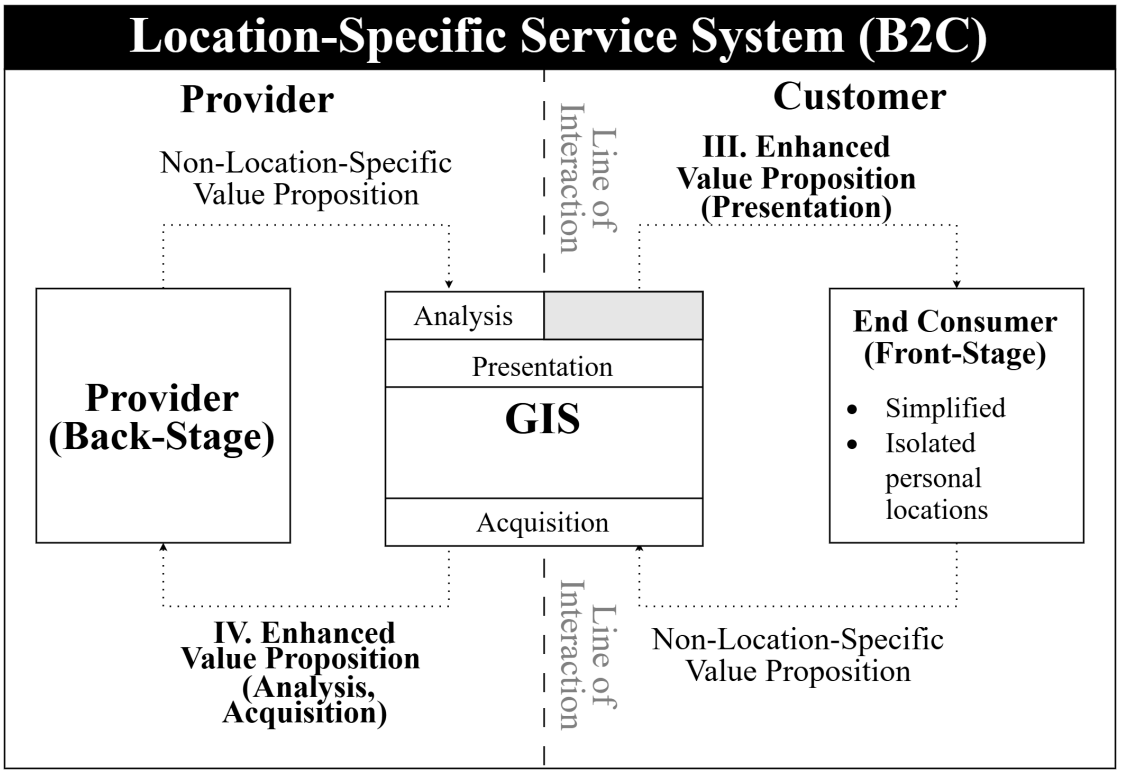

Figure 4.2: Location-specific service systems framework for B2C contexts.

This results in two enhanced value propositions on the B2C side. First, in enhanced value proposition III, local usefulness for service customers is limited, as end users primarily perform individual searches for location-based information rather than directly utilizing GIS functionalities for data acquisition, management, analysis, or presentation for themselves. However, GIS enhances shared identity among service providers and service customers by simplifying **presentation**. Through visual tools such as maps, service providers can present spatial data intuitively, allowing users to understand and interact with location-based information more effectively. For example, hotel booking platforms display accommodations on a map, enabling customers to assess their options based on proximity to POI.

In value proposition IV, GIS contributes significantly to local usefulness for service providers by facilitating the consolidated **analysis** of multiple objects and their locations. Service providers can leverage geospatial data to uncover spatial patterns and dependencies, improving their service offerings. For instance, real estate platforms integrate property data with location attributes to refine price predictions, providing more accurate market insights. Additionally, GIS enhances shared identity by

enabling the **acquisition** of isolated personal location data. For example, as consumers search for public transportation routes, they provide start and destination locations, allowing providers to analyze travel patterns and identify gaps in existing services. This supports demand-driven improvements in public transportation networks, benefiting both service providers and consumers through enhanced mobility solutions.

For B2B services, the left part of the framework (Figure 4.3) is relevant. In this context, service customers are businesses that operate in the front-stage, such as energy grid operators managing infrastructure or fleet management offices optimizing vehicle logistics. The interaction between service providers and these business customers is facilitated by GIS, which act as boundary objects. Unlike in the B2C context, all four core properties of GIS—analysis, management, acquisition, and presentation—play a crucial role in enhancing both local usefulness and shared identity.

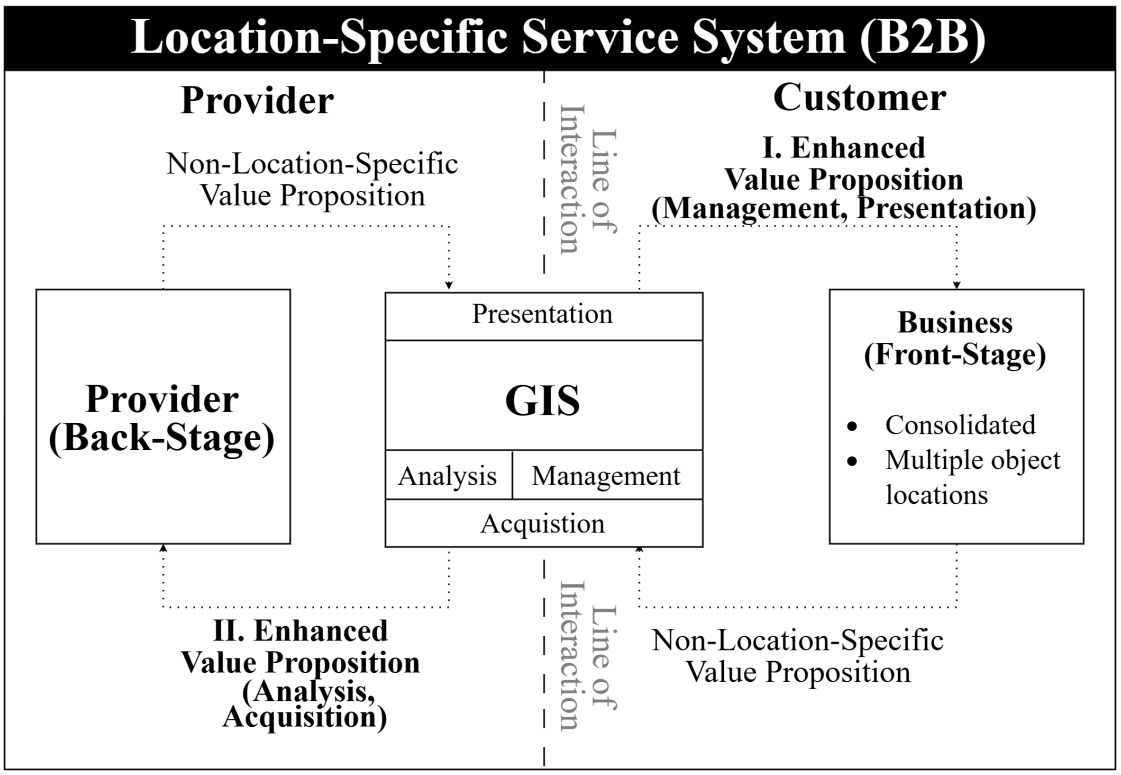

Figure 4.3: Location-specific service systems framework for B2B contexts.

This framework also includes two enhanced value propositions. First, in enhanced value proposition I, GIS significantly contribute to the local usefulness for service

customers by enabling the efficient **management** of location information for multiple business objects. By ensuring that geospatial data is stored and processed in a consistent and standardized format, businesses can optimize the interaction with their geospatial objects. Additionally, GIS strengthen shared identity by making location data, spatial relationships, and environmental conditions visible through consolidated **presentation** before any detailed analysis is conducted. This allows businesses to assess areas that may require expansion or identify locations with (in)sufficient service coverage. Through this exchange, service customers enhance the value proposition for providers by contributing valuable location data, while providers, in turn, gain insights into spatial relationships, enabling them to refine their services and generate higher business value.

Furthermore, GIS provide local usefulness for service providers by facilitating the consolidated **analysis** of multiple objects and their locations as stated in enhanced value proposition II. By uncovering spatial dependencies and relationships that were previously unrecognized, service providers can gain deeper insights into their own services and implement improvements that enhance business outcomes. Moreover, GIS reinforce shared identity by enabling service providers the **acquisition** of detailed location information about business objects from their customers. This exchange of geospatial data allows providers to develop new services that support customers in optimizing their asset placement or infrastructure decisions. For instance, service providers can offer strategic recommendations for asset distribution.

When analyzing value co-creation in B2C and B2B location-specific service systems, the framework acts as a starting point, that enables to understand how GIS act as boundary objects between service providers and service customers. However, to extend the conceptual knowledge from this high level framework, the question remains, how value is co-created within these service systems in specific B2C and B2B application scenarios. Thus, leading to RQ3 in B2C and RQ4 in B2B contexts.

For RQ3 (*How is value co-created in location-specific service systems in B2C contexts using GIS as a boundary object?*), two different exemplary cases are considered. The first case is described in P4 and is a conceptual study in the context of smart cities, focusing on citizen involvement in the design of future. Unlike traditional technology-driven smart city concepts, this approach emphasizes a citizen-centric perspective, addressing the challenges that individuals face in accessing essential public goods and services. A core element of this approach is the notion of constraints, which impact livability when citizens experience them as limitations. In this context, a constraint

is an abstract concept that becomes relevant only when a citizen group perceives it as a compromise to their quality of life.

Accessibility plays a crucial role in the City 5.0 concept, encompassing multiple dimensions such as economic, temporal, and spatial constraints. Spatial constraints, in particular, are highly relevant in the design of location-specific service systems, as they determine whether citizens can physically reach public services. A spatial constraint occurs when a public good or service is known to a citizen group but remains inaccessible due to its geographic location. For example, essential services such as healthcare, government offices, or educational institutions may be positioned in areas that certain communities cannot easily reach, limiting their ability to benefit from these services. Addressing spatial constraints requires leveraging geospatial data and GIS, which provide the analytical tools necessary to assess and improve accessibility.

While P4 does not explicitly introduce a location-specific service system, a closer examination of spatial constraints highlights the critical role of GIS in overcoming or mitigating these barriers. The concept of such a service system is illustrated in Figure 4.4. In this system, the city management acts as the service provider, responsible for generating and analyzing geospatial data of the city's facilities. This includes mapping public amenities such as citizen offices, acquiring data on urban infrastructure, and assessing citizen behavior to optimize service distribution. On the other side, the service customers are citizens who seek access to public goods and services, such as healthcare, infrastructure, and education. By integrating GIS as a boundary object into this system, city management can enhance accessibility and reduce spatial constraints, ensuring that essential services reach a broader population.

This location-specific service system highlights the role of GIS in facilitating interactions between service providers and citizens. On the right side of the framework, GIS enhances value proposition III. Although there is no local usefulness for service users, since citizens do not directly utilize geospatial data or GIS functionalities themselves, the city management can leverage GIS for **presentation** of geospatial data. Thus enhancing value propositions in shared identity. Through GIS-enabled presentation tools such as maps, the city management can visualize public goods and services, helping citizens understand the spatial infrastructure of their city, for example, by displaying the locations of healthcare facilities or administrative offices. Additionally, while the data provided by citizens is not inherently spatial, the inclusion of real-time location information allows for a more refined presentation of

services. By integrating real-time user data, city management can provide enhanced spatial representations, such as highlighting healthcare institutions within the user's immediate vicinity. This demonstrates how the GIS property of presentation enhances the value proposition.

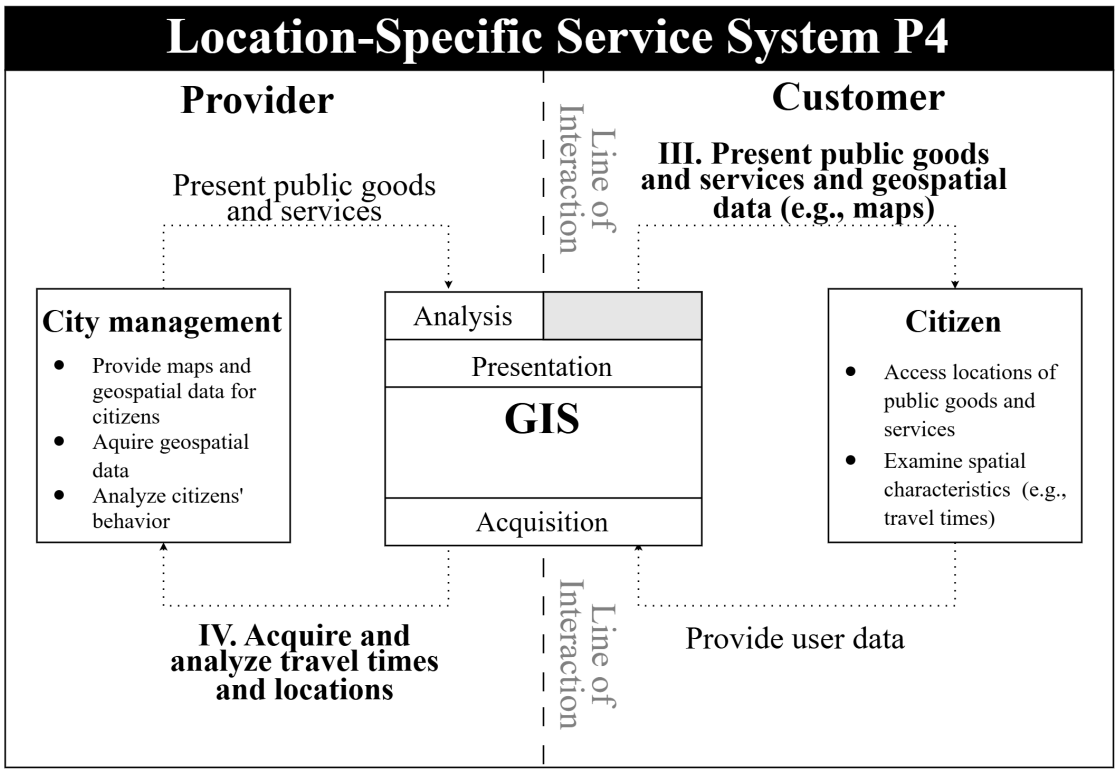

Figure 4.4: Location-specific service systems framework for smart city context (B2C).

On the left side of the framework, GIS enhances value proposition IV by strengthening the local usefulness of service providers. Although the city management can present public services without geospatial data, GIS significantly improves their analytical capabilities. Through the GIS property of **analysis**, service providers can examine city infrastructure to identify gaps in service accessibility. For example, they can detect areas where public goods and services are difficult to reach due to a lack of public transportation or pinpoint locations where amenities are missing and should be provided in the future. Furthermore, GIS facilitates a stronger shared identity by enabling the **acquisition** of citizen location data. By analyzing where citizens frequently search for or access public services, the city managers gain valuable insights into spatial demand patterns. This allows for the provision of more relevant service information to citizens, such as directing them to the nearest healthcare

provider based on their current location. Simultaneously, the city management can enhance their service offerings by aligning urban planning initiatives with actual citizen needs, ensuring that public services are optimally positioned.

The second case within the B2C context is a GIS-ML-based real estate appraisal system. Although P5 and P6 also do not explicitly introduce a location-specific service system, GIS plays a crucial role in the prediction of house prices and can serve as a boundary object within an appraisal service system. Houses are heterogeneous goods, characterized by a wide range of attributes that vary significantly from one property to another, including physical characteristics, condition, location, and neighborhood features (X. Liu et al., 2018). To estimate the value of a property accurately, it is essential to consider and combine all of these aspects. However, automated appraisal continues to be a challenging task for algorithms, as they must handle complex, multi-modal data and account for nuanced, often subjective, features (X. Liu et al., 2018).

At the same time, the demand for automated appraisal systems is rising, driven by the ongoing digitization of housing markets. Online platforms such as Zillow have already integrated CAMA systems into their service offerings to support buyers' decision-making processes and enhance their value propositions (Poursaeed et al., 2018; Zillow Group Inc., 2020). In this context, GIS has the potential to improve these systems by enabling spatial contextualization of properties.

In P5, two types of data are investigated to improve appraisal accuracy: hard and soft information. Hard information includes structured master data about a property, such as the number of rooms, which are represented as categorical and numerical attributes. This data is enriched with geospatial information extracted from GIS, covering various locational and environmental aspects known to influence real estate values (Anselin, 1998; Theriault et al., 1999; Theriault et al., 1999; Noor and Rosni, 2013; Yiorkas and Dimopoulos, 2017). In contrast, soft information as displayed by image data, specifically exterior images of houses, can contain visual characteristics related to the property's aesthetics (X. Liu et al., 2018; Poursaeed et al., 2018; Law et al., 2019; Naumzik and Feuerriegel, 2020).

To combine these heterogeneous data sources, a data-driven research approach is applied, in which a series of CAMA models are designed and evaluated. These models combine structured baseline data with hard GIS data and soft image data. The underlying dataset comprises public information on the housing market in Philadelphia,

Pennsylvania. The geospatial features are sourced from official open data platforms such as OpenDataPhilly (2011) and the City of Philadelphia (2018). Specific spatial indicators include the number of parks within a 400-meter walking distance (Noor et al., 2015), and the proximity to schools, measured as the minimum linear distance to eight distinct school types including elementary and high schools (Leby and Hashim, 2010). Furthermore, environmental quality is assessed by evaluating noise pollution caused by traffic, using a road noise map that categorizes areas into three noise levels: below 55 dB (T. Park et al., 2018), between 55 and 65 dB, and over 65 dB (Cohen and Coughlin, 2008).

The soft information in the form of image data consists of exterior house images retrieved from Bing Maps (Microsoft Inc., 2020). After preprocessing all data sources, multi-input neural networks are trained and evaluated to predict house prices. The results demonstrate that integrating geospatial data into the appraisal models leads to a significant improvement in predictive accuracy—by 12% compared to models using structured baseline data alone.

P6 enhances the investigation of P5 by integrating an information asymmetry perspective between sellers and buyers of houses. For IS research, pricing effects are of particular interest, as they are influenced by the detection and reduction of information asymmetries (Dimoka et al., 2012; Ghose, 2009). Such asymmetries occur when one party—typically the seller or agent—has more information about a product than the buyer or principal (Ross, 1973). Due to the incomplete information disclosure, the buyer cannot fully assess the quality of the product, making it difficult to determine an appropriate price prior to the transaction. As described by Akerlof (1978), this situation can lead to a market of lemons, where the risk of adverse selection forces high-quality goods out of the market. This phenomenon is particularly relevant for durable goods traded on online platforms, which are difficult to describe adequately through digital means and cannot be physically experienced before the purchase (Dimoka et al., 2012).

Houses, as durable and highly individual goods, are embedded within a complex, high-dimensional geographical context that creates numerous interdependencies. In the context of real estate, two categories of attributes can be distinguished: Search qualities and Experience qualities (Nelson, 1970). Search qualities are features that are easily quantifiable and can typically be evaluated prior to purchase, such as the number of rooms or the distance to public transportation. In contrast, Experience qualities are less tangible and often cannot be fully assessed until after the purchase

has been made. These include factors such as the ambient noise level or perceived safety of a neighborhood.

To systematically investigate the impact of these attributes on price prediction, a data-driven research design is followed. Therefore, first a survey is conducted to classify a broad range of variables as either Search or Experience qualities. Although some variables exhibit characteristics of both types, they are clustered according to their predominant nature. Afterwards, all variables are prepared for quantitative analysis through preprocessing. This includes converting qualitative attributes into numerical form, utilizing GIS and image data. For example, building density is treated as a Search quality and analyzed using GIS by calculating the ratio of building footprint area to the total neighborhood area. Noise levels are handled as Experience qualities and are analyzed according to the method used in P5.

In the third stage, a data-driven study is conducted to predict prices for a dataset of 62,641 single-family homes in Philadelphia, PA. Several ML models are evaluated using three different feature sets: one containing only Search qualities, one with only Experience qualities, and one combining both. The results show that models using a combination of Search and Experience qualities significantly outperform those relying on only one type of information. Specifically, combining both types reduces the prediction error by 15.4%. While Experience qualities alone do not exceed the predictive performance of a Search-quality-only model, their integration into a combined feature set leads to a substantial boost in accuracy.

When viewing the prediction of real estate appraisal through a service lens, a location-specific service system using GIS as a boundary object, can be designed. Such a service system is illustrated in Figure 4.5. In this system, the service provider is represented by the real estate platform operator, who integrates maps and geospatial data into the platform and makes them accessible to users. This actor leverages GIS to enhance the predictive accuracy of house prices and monitors frequently searched areas to gain insights into user behavior and regional interest. The service customer, in contrast, is the user searching for a home who relies on the platform to obtain accurate pricing information and to visualize the geographic location of properties and their surrounding context.

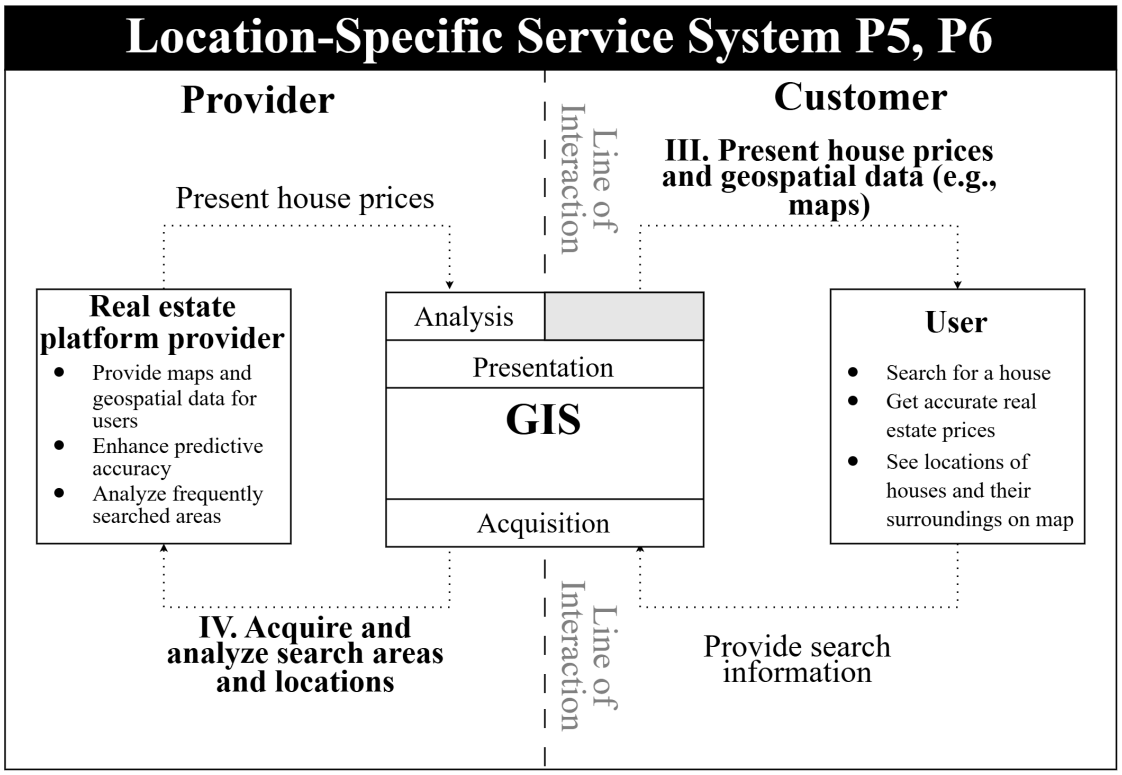

Figure 4.5: Location-specific service systems framework for real estate appraisal (B2C).

The type of service provided in this case is an LCS. While geospatial data are not a strict necessity for real estate appraisal, their integration significantly improves the accuracy of price predictions, and thus the quality of the service. On the right side of the framework, this added value is reflected in the enhancement of value proposition III through the use of GIS. From the customer's perspective, no direct local usefulness emerges, as users do not actively interact with GIS functionalities themselves. However, a shared identity between user and platform provider is established through the visual **presentation** of property prices on maps, allowing users to better understand the surroundings of a property, including its neighborhood and proximity to amenities, streets, and other relevant features. This enhances the overall user experience and supports the likelihood of a successful sale.

On the left side of the framework, GIS contributes to value proposition IV. Here, local usefulness exists for the platform provider, who utilizes geospatial data and GIS functionalities to perform a consolidated **analysis** of real estate listings. This enables the development of more accurate prediction models and strengthens the performance of the platform's CAMA systems, thus maintaining competitiveness

in the digital housing market. A shared identity arises from the provider's ability to utilize the GIS property **acquisition** of user interaction data—particularly the locations where users frequently perform searches. These search patterns reveal areas with high demand, allowing the provider to tailor and enhance the services offered in those regions. Users benefit from improved predictive accuracy, increased availability of geospatial data, a broader selection of relevant property listings, and services that are better aligned with their interests and needs.

Such a location-specific service system for real estate appraisal demonstrates that GIS data not only improve predictive accuracy, but also enable more effective service delivery and foster enhanced value co-creation. Examining the system through two conceptual lenses—data types (hard vs. soft information) and information asymmetry (search vs. experience qualities)—shows that GIS act as boundary objects. These mediate between service provider and customer, enriching both value propositions by making spatial and contextual data usable and comprehensible. This investigation is among the first to highlight and quantify the potential of analyzing data supplied by GIS for data-driven services within the IS discipline.

For RQ4 (*How is value co-created in location-specific service systems in B2B contexts using GIS as a boundary object?*), also two different cases are analyzed. The first case is a condition-based maintenance system in the context of the energy distribution grid. Although P7, P8, and P9 do not explicitly introduce a location-specific service system, GIS can be viewed as a useful boundary object within this context, enhancing the value proposition of a condition-based maintenance service.

The energy distribution grid is a critical infrastructure that has become increasingly complex due to the ongoing transition from traditional, centralized energy production to more decentralized forms of energy generation and consumption, primarily driven by renewable energy sources (G. V. B. Kumar et al., 2019). Two major developments further stress the grid. First, political initiatives aiming to promote the transition toward green energy require the grid to support bi-directional energy flows rather than just distributing electricity from centralized plants to consumers (Renn and Marshall, 2016). Second, the growing number of EV substantially increases overall electricity demand (Mureddu et al., 2018).

The European energy distribution grid is structured in different voltage levels. Power generated at large-scale plants such as nuclear facilities is transmitted via the Extra-High Voltage (EHV) network, operating between 200 and 380 kV (BMWi, 2021). This

electricity is then transformed into High Voltage (HV) within transformer stations, typically ranging from 60 to 110 kV, to supply larger regional grid areas and industrial consumers (BMWi, 2021). Decentralized production facilities like biogas plants also feed electricity into the HV network. Medium Voltage (MV), ranging between 6 and 30 kV, is used for supplying smaller grid sections, including cities, and serves industrial customers, offices, and public infrastructure (BMWi, 2021). Renewable energy sources such as wind turbines and large photovoltaic systems often generate power directly at the MV level. This voltage is further transformed into Low Voltage (LV) to supply individual households and electric vehicle charging stations, where private photovoltaic systems also contribute to energy generation.

The system for condition-based maintenance in P7, P8, and P9 focuses on the MV level, specifically on switch gears located within MV power stations. These switch gears are vital components for safe and reliable energy distribution, making their maintenance a critical task. In this context, three maintenance strategies can be distinguished. The first is reactive maintenance, in which equipment is operated until a failure occurs and then repaired. This approach avoids planned inspections and aims to maximize asset lifespans while minimizing costs for spare parts (Mobley, 2002). However, it carries the risk of unplanned downtimes. The second strategy is preventive maintenance, where maintenance actions are performed based on fixed intervals derived from operational metrics such as usage hours. This reduces the risk of failures but may result in replacing assets before they reach their useful lifespan (Mobley, 2002). The third and most advanced strategy is condition-based maintenance. This approach involves the use of sensors to monitor changes in asset conditions and applies advanced signal processing techniques based on pattern recognition to detect potential failures before they occur (Hashemian, 2011). Condition-based maintenance avoids unnecessary downtimes while also reducing the likelihood of replacing still functional equipment (Mobley, 2002).

In P7, interviews were conducted with six electric utilities in a qualitative study to gain insights into how condition-based maintenance systems must be designed to reduce errors in the operation of medium voltage switch gears. The interviews provided a detailed understanding of the current situation in practice and served as the basis for deriving eight DP, which capture central requirements for such a system.

DP 1 emphasizes the prediction of upcoming maintenance activities and was assigned a high priority. The background for this requirement lies in the high cost

pressure present throughout the energy sector, which necessitates more efficient and predictable maintenance planning. The goal is to increase planning certainty, enable extended maintenance intervals, and ensure a continuous and secure energy supply. To achieve this, algorithms should be implemented that output failure probabilities, which can be accessed by enactors through a dashboard that provides an up-to-date status overview. Visualization of these predictions should ideally take place within GIS, since GIS are already in use across multiple operational contexts by the interviewed utilities. However, DP 1 can only be implemented if the foundation for condition monitoring, described in DP 3, is also established. DP 2 addresses system integration and is also considered high priority. In the current situation, many systems used by utilities are either not integrated or only loosely connected, leading to redundancies and inefficiencies. Therefore, a key aim of DP 2 is to increase the degree of integration among existing systems. DP 3 focuses on condition monitoring and was rated as having medium priority. It reflects the present situation in which most utilities have only limited or no sensor data available regarding the status of their grid assets. Further design principles include DP 4, which involves incident and knowledge documentation, and DP 5, which focuses on workforce management for maintenance operations.

The focus of P8 lies in location analytics and GIS. It builds on the DP developed in P7 to derive four central requirements, that serve as a basis for designing a system for condition-based maintenance using the DSRM by Peffers et al. (2007). The first requirement is condition-based maintenance. Grid operators need failure probabilities and a time-to-failure calculated for each critical asset. The system provides prognostics, which include two values: availability, meaning the failure probability, and prognosis, meaning the estimated time until the asset is likely to fail (International Organization for Standardization, 2018). The second requirement is condition monitoring. This is done by collecting data from different types of sensors, such as voltage sensors, thermal sensors, camera sensors, and air quality sensors. With this data, the condition of important assets can be monitored in real time. The third requirement is the integration of different systems. These include an ERP system, a GIS, and a ML system. Based on these requirements, four services are designed. Three of these services focus on different time perspectives. The first service looks at the past by analyzing historical condition data to support cost analysis, grid planning, and strategic decisions. The second service monitors the current condition of the assets.

The third service supports the prediction of future states of the grid and the fourth is service order management, which helps to plan and carry out maintenance work.

GIS plays an important role in this system. It provides the user interface, supports geographic analysis, and visualizes both the distribution grid and the condition of the assets. GIS also helps with spatial planning of new network components and allows environmental aspects like weather data, animal populations, and other geospatial information to be considered in planning.

In P9, the DP from P7 are used to enhance the system developed in P8 by designing and evaluating an ensemble artifact consisting of a smart service system and a digital industrial platform for managing critical assets of the distribution grid using predictive maintenance. The smart service system involves service consumers, e.g., distribution grid operators, and service providers, such as manufacturers of central grid assets. The switchgear functions as a smart product within this system. Value is co-created through monitoring, where asset conditions are observed to identify risks or failures and control, where operators can remotely interrupt circuits. Further value is co-created through optimization, where performance data is used by both operators and manufacturers to improve use and design and autonomy, which allows switchgears to react to changes in nearby assets or the grid, though this function has not yet been integrated.

While in P9 the focus is on switchgears, they represent only one type of critical asset, alongside others like transformers or relays and can be from different manufacturers. Therefore, a digital industrial platform is designed, which acts as the core information system, enabling the smart service by collecting, aggregating, and analyzing data from various assets and systems. The platform integrates ERP and GIS systems of the grid operators with the assets themselves. A prototype is presented (DigiGrid), that provides a dashboard displaying asset information and performance statistics, with GIS maps embedded into views for condition monitoring and predictive maintenance.

The artifact was evaluated through a Choice-Based Conjoint Analysis (CBCA). Results show that condition monitoring (26.3%) and price structure (25.0%) most influence potential buying decisions, while the availability of geodata contributes 11.3%. Based on these insights, five DP are derived: DP 1 recommends establishing a digital platform to support value co-creation between asset manufacturers and operators. DP 2 suggests modeling a smart service system where actors interact using smart

products as boundary objects. DP 3 includes a separation into past, present, and future time intervals as used in P8. DP 4 calls for integration of different application systems and data types and DP 5 highlights the need to present data at different complexity levels, such as dashboards using GIS for high-level insights and raw data for detailed analyses.

When regarding the results from P7, P8, and P9 through a service science lense with focus on GIS, a location-specific service system can be derived (Figure 4.6). The goal is to enable reliable and cost-efficient maintenance planning for MV distribution grid operators, which is the customer of the service. The service provider in this case is the asset manufacturer. The type of service is an LCS, as geospatial data are not strictly necessary for predictive maintenance, but they enable to integrate environmental data, such as weather conditions or pollution levels, which can significantly improve the accuracy of predictions.

On the right side of the framework, GIS enhances value proposition I. Local usefulness is created for the distribution grid operator by improving the **management** of grid assets. With the help of GIS, grid operators can maintain an overview of their grid across different regions, including the spatial distribution of components and their exact locations. This allows for a better understanding of environmental interdependencies, such as proximity to forests or pollution sources like rapeseed fields. Managing assets becomes easier, especially in error situations, where navigation functionalities supported by GIS support more efficient repair services. A shared identity is established through the **presentation** of prediction results on a map using GIS, for example by marking assets with different colors depending on their predicted status, such as red for a likely malfunction within a specific time period. This visual support increases the effectiveness of maintenance activities and enables grid control centers to quickly understand the overall health status of their assets.

On the left side of the framework, GIS also enhances value proposition II. Local usefulness is generated for the asset manufacturer through the **analysis** of multiple assets and their locations, combined with environmental data, allowing for example the optimization of asset designs based on contextual conditions. For instance, asset manufacturers can develop components that are more resistant to dirt or humidity if necessary. A shared identity is formed as the asset manufacturer uses the GIS functionality **acquisition** to collect geospatial data across many locations to improve prediction models by integrating environmental influences. At the same time, the

distribution grid operator contributes operational location data, like in which areas repairs have to be performed more often, which helps the manufacturer to refine their products according to environmental conditions.

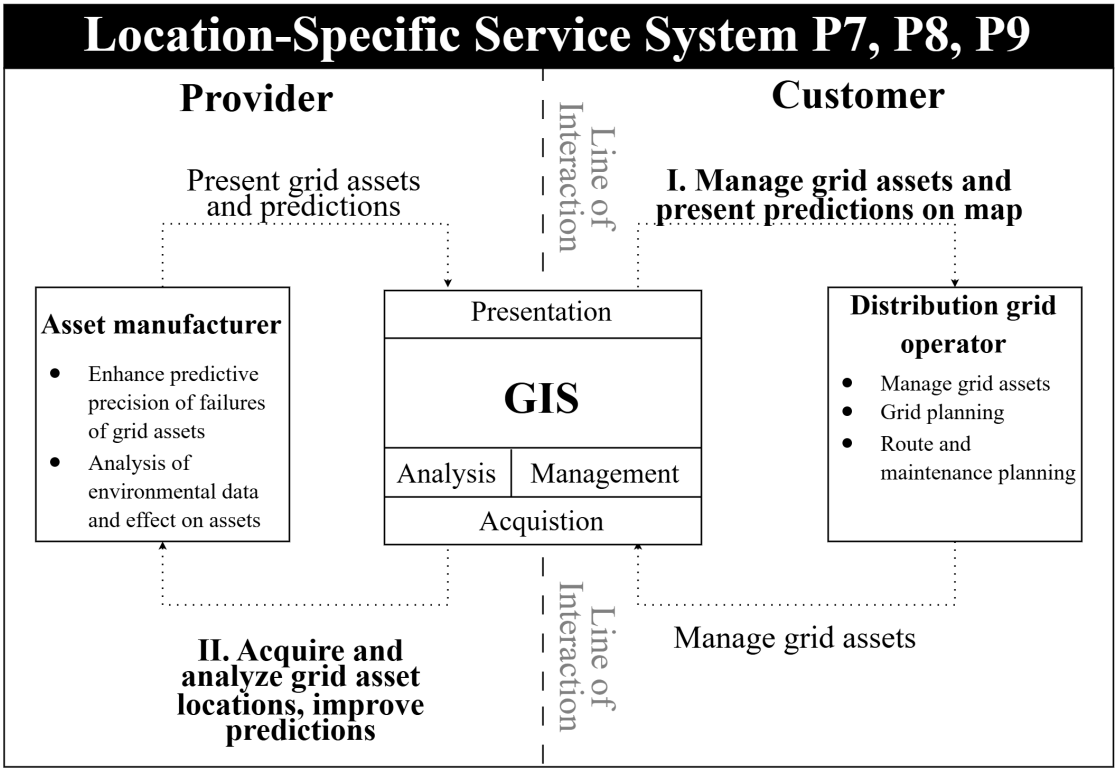

Figure 4.6: Location-specific service systems framework for the smart energy grid (B2B).

The second case within the B2B context is a DSS for EVCS placement, as described in P10. The number of EV on Germany's roads is projected to rise to 14 million within the next ten years (Podewils, 2020). Especially in urban areas, where property ownership rates are low, public charging infrastructure becomes even more important, as many people lack the possibility to charge their vehicle at home (Adam, 2020). To ensure optimal energy provision, the planning of public charging stations requires a careful and data-driven selection of locations. In the domain of location planning, GIS is increasingly used as a tool for evaluation and decision-making, given its ability to analyze complex urban structures. Since spatial decision problems often involve multiple and sometimes conflicting criteria, GIS is frequently employed alongside Multi-Criteria Decision-Making (MCDM) techniques to support comprehensive evaluations of spatial alternatives.

Although P10 does not explicitly introduce a location-specific service system, GIS play a crucial role in identifying suitable locations for EVCS and can take the function of boundary objects. The research follows the DSRM based on Peffers et al. (2007) to design and develop an AHP-based SDSS that integrates geospatial data to determine and visualize suitable locations for EVCS. In a first step, a literature review identifies relevant criteria. These include the charging behavior of EV users, spatial proximity to customers, like near gas stations or supermarkets, and population density. Further criteria are road network access, environmental impacts, and ecological considerations such as the protection of vegetation and water bodies. As not all criteria are equally important, a survey with a decision-maker from an energy grid operator responsible for EVCS placement was conducted to derive the relative weights of these criteria using pairwise comparison. As a result, proximity to users received the highest weighting (49.9%), followed by accessibility (35.43%). All weights were then combined with geospatial data to visualize both suitable and unsuitable locations on a map.

When regarding the SDSS from P10 as a location-specific service system (Figure 4.7), the service provider is the city management, aiming to manage urban infrastructure and identify optimal locations for EVCS. The service customer is the EVCS operator, who wants to find cost-efficient and profitable locations for placing charging stations.

On the right side of the framework, local usefulness is created for the EVCS operator by enabling the use of GIS functionality **management**. This supports the operator in keeping an overview of all of their installed assets and the respective locations. A shared identity emerges through the **presentation** of suitable areas on a map by the city management, using GIS. These maps can be layered with other data, such as existing EVCS infrastructure. As a result, operators can quickly identify promising areas and understand where investments might be profitable, while also aligning their expansion with the existing infrastructure.

On the left side of the framework, local usefulness is provided to the city management through the **analysis** functions of GIS, allowing them to combine the placement of EVCS with other spatial information, for example, the current state of parking availability. Based on these insights, they might adjust city infrastructure such as parking spaces or access routes. A shared identity is created as the city management uses data **acquisition** on where operators actually install their charging stations and compares these data with the proposed suitable areas. This helps identify potential

gaps or under-served zones that may require infrastructure adjustments. The data shared by EVCS operators thus helps the city management to improve their services and urban planning efforts, contributing to a more efficient and user-centered infrastructure development, while providing a more advanced service for the EVCS operator.

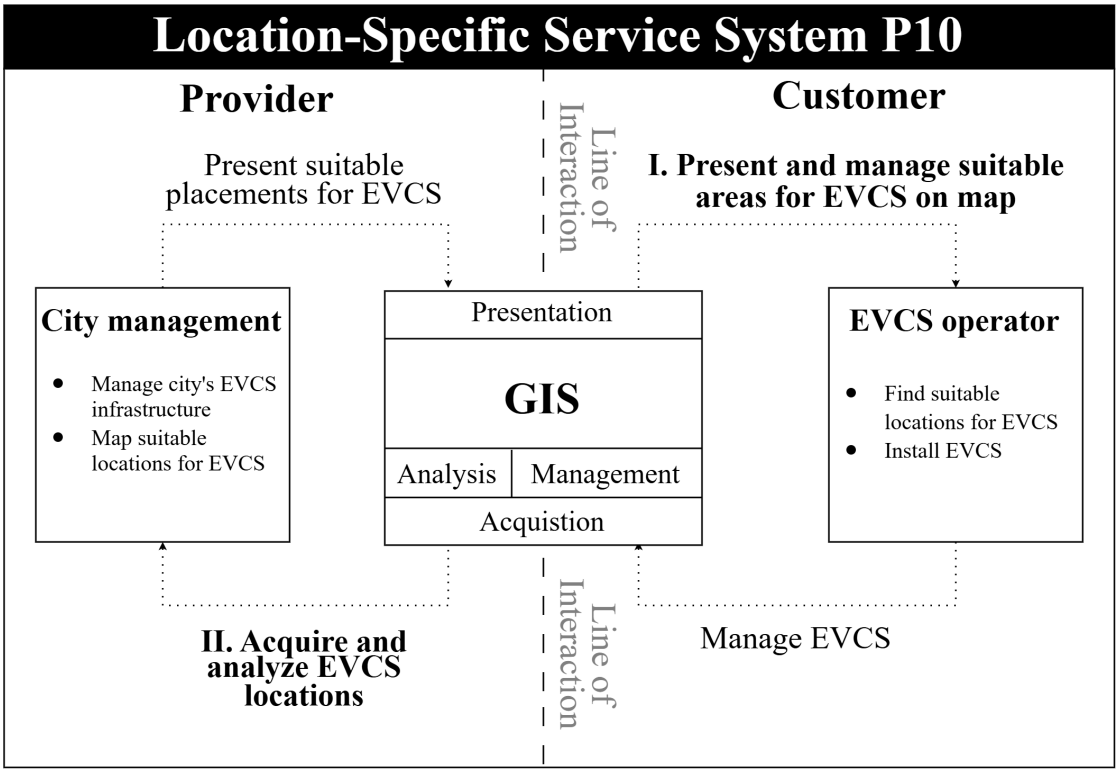

Figure 4.7: Location-specific service systems framework for EVCS placement (B2B).

4.2 Contribution to Research and Management

This dissertation contributes to research and management by integrating knowledge from two research streams, namely GIS and service systems, providing a new perspective on value co-creation. The research questions are answered by developing three types of theory. The first type is theory for analyzing (Type I), the second is theory for explaining and predicting (Type IV), and the third is theory for design and action (Type V) (Gregor, 2006). The contributions of each publication and the corresponding research questions can be found in Figure 4.8.

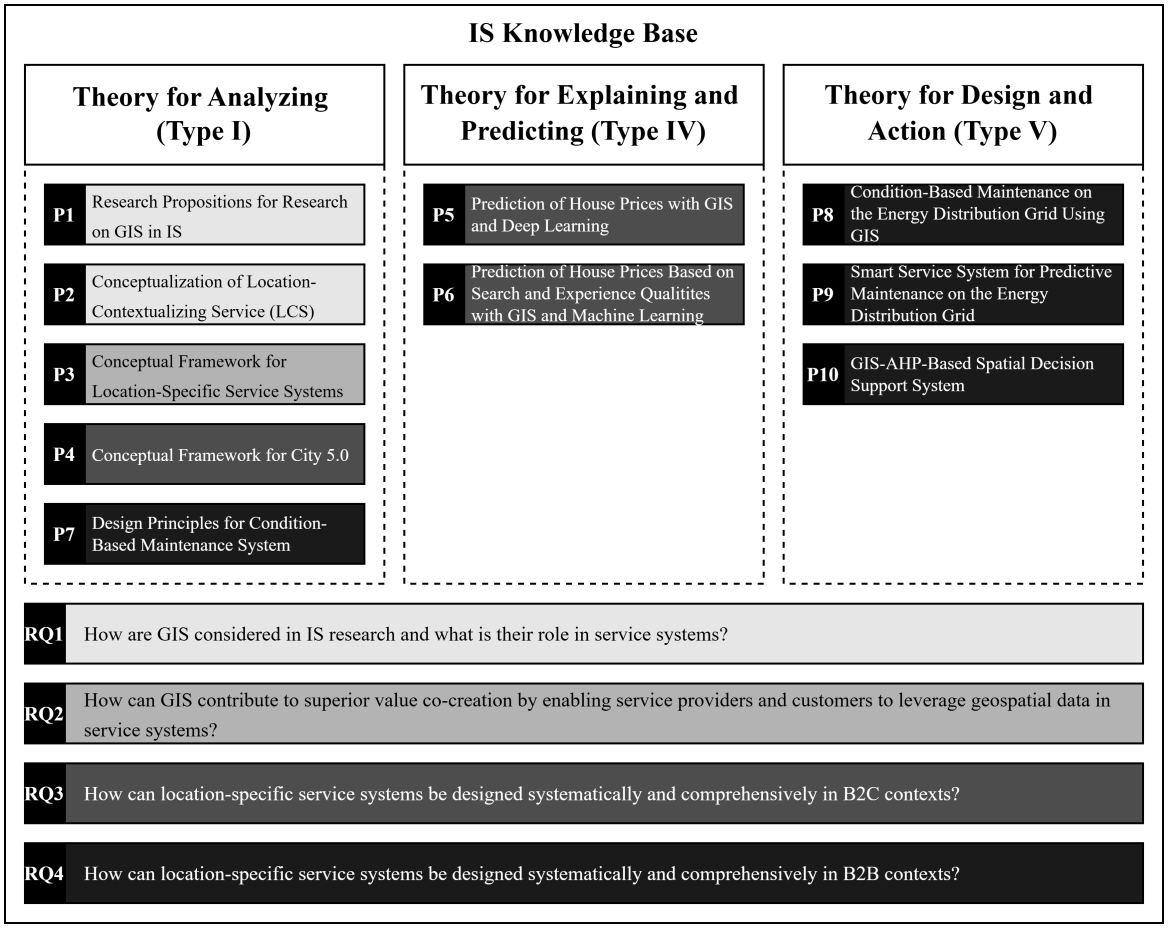

Figure 4.8: Knowledge contributions.

The first research question (RQ1) is answered by systematically deriving research propositions for IS research on GIS and by conceptualizing LCS as a theoretical complement to the well-established concept of LBS. The research propositions developed in P1 and the conceptualization of LCS in P2 each provide theory for analyzing (Type

I) (Gregor, 2006). These contributions clarify the position of GIS in IS research and address the current under-representation of geospatial data and GIS in the service system discourse. The introduction of LCS sheds light on the role of GIS as boundary objects in service systems. It highlights their function in integrating various types of data, supporting interaction between actors, and enhancing spatially informed decision-making.

The results demonstrate that location should not only be understood as an add-on, but as a constitutive element for value creation in service systems. While IS research has long focused on service design, it has rarely considered geospatial data and GIS as a highly valuable resources and boundary objects. The results show that location adds contextual depth to service systems, strengthening their relevance, sophistication, and ability to generate value for both service providers and consumers.

The second research question (RQ2) is answered by conceptualizing a framework for location-specific service systems in P3 that brings together the perspectives of LBS and LCS. This framework introduces a clear distinction between B2C and B2B contexts, thereby expanding the understanding of how location information can be integrated into service systems. The framework also highlights the similarities and differences between B2C and B2B systems with respect to the use of GIS: While both leverage geospatial data to support service delivery, the impact level differs. In B2C contexts, GIS-based services often operate at the *individual* level, enabling personalized recommendations and experiences. In contrast, B2B contexts typically involve the *organizational* level, where GIS supports aggregated insights and strategic optimization. This distinction aligns with the differentiation between individual and organizational impacts as proposed by DeLone and McLean (2002). The contribution is theory for analyzing (Type I) (Gregor, 2006), offering a comprehensive framework through which location-specific value co-creation can be studied and understood.

The framework builds on the concept of smart service systems (Beverungen et al., 2019), in which smart products collect and transmit data, including information about their location. While location is a typical property of smart products, the actual value arising from this attribute is only realized when GIS is applied. GIS enables the processing, visualization, and contextual interpretation of location data. Without it, the information collected by smart products remains unused and disconnected from actionable insights.

Thus, GIS is not only a visualization tool. Instead, it functions as a boundary object that connects service providers and service customers in service systems. GIS help to create shared meaning among actors by making services and their components locatable. In both B2C and B2B contexts, GIS supports local usefulness and shared identity, yet it does so at different levels of abstraction—individual versus organizational—depending on the stakeholder and system design (DeLone and McLean, 2002). As the results emphasize, there is a need to shift away from viewing GIS as a standalone tool and instead understand it as an essential linking mechanism within service systems. Through its integrative capabilities, GIS becomes a central enabler of value co-creation in location-specific service systems.

The third and fourth research questions (RQ3 and RQ4) are answered through evaluating how value is co-created in location-specific service systems through the use of GIS, focusing on both B2C and B2B application scenarios.

For RQ3, value co-creation using GIS is demonstrated in two B2C contexts: smart city and real estate appraisal. In P4, a conceptual framework for City 5.0 is developed, providing theory for analyzing (Type I) (Gregor, 2006). In the domain of real estate, P5 and P6 show how house price predictions can be enhanced using GIS and DL techniques. These studies emphasize the relevance of location information and the role of Search and Experience qualities, which are made measurable through the integration of GIS and ML. These contributions provide theory for explaining and predicting (Type IV) (Gregor, 2006).

RQ4 is answered through two B2B scenarios: predictive maintenance on the energy distribution grid and the placement of EVCS. P7 serves as a pre-study for P8 and P9 by deriving design principles for condition-based maintenance systems, thereby providing theory for analyzing (Type I) (Gregor, 2006). P8 and P9 build on these principles and demonstrate how predictive maintenance systems can be designed and implemented using GIS and ML, offering theory for design and action (Type V) (Gregor, 2006).

While the IS discipline has made substantial contributions in areas such as Business Process Management (BPM) (Beverungen et al., 2021) and digital platforms (Bartelheimer et al., 2022), the role of spatial information—and particularly GIS—remains underexplored. Location information is often reduced to being only an additional variable and the conceptualization of "space" in IS research lacks the maturity and sophistication seen in other disciplines (Haj-Bolouri et al., 2024).

There are several research streams in the field of IS research that address the design, implementation, and evaluation of digital technologies in organizational contexts and offer avenues for connecting and extending the insights developed in this dissertation for the IS discipline. Two major streams are AI-driven business process automation and optimization and sustainable systems engineering.

While recent IS research has begun to conceptualize autonomy in IS through multiple lenses—including human agency, technology agency, and task autonomy (Beck et al., 2022)—a critical dimension remains largely underexplored: spatial context (Haj-Bolouri et al., 2024). Most existing models of autonomous systems operate along the temporal and technological axis, focusing on when and how systems adapt. However, as autonomous systems operate in real-world environments, their where becomes just as important. Integrating GIS into the design of autonomous systems enables a shift from abstract, location-independent automation to context-sensitive, location-aware decision-making. Instead of only identifying a fault in a process, a GIS-enhanced autonomous systems can determine where the anomaly occurs and apply location-specific logic to resolve it. For example, temperature and climatic zones can be used to activate protocols based on local environmental factors. Incorporating spatial triggers in this way significantly enhances the adaptivity and robustness of autonomous systems. As Haase et al. (2024) emphasize in their interdisciplinary discussion on process automation, the effectiveness of automation depends not only on technical precision but also on the contextual fit within organizational routines and environments. GIS provides a missing context layer, bridging the gap between real-world conditions and system-driven action. As such, location data is not only a supplement to autonomous logic, but it is a critical enabler of autonomy in modern information systems.

Recent calls within the IS community have also emphasized the need for research that not only leverages digital technologies for sustainability but also critically reflects on their environmental impact (van der Aalst et al., 2023; Kotlarsky et al., 2023). While traditional approaches to sustainable systems engineering focus on metrics such as energy efficiency, they often overlook the spatial dimension as a potential lever for improving system sustainability. By integrating GIS, this work extends the research of sustainable systems beyond internal system performance and lifecycle considerations toward environmentally embedded decision-making. For example, location-based data can support dynamic optimization strategies for energy consumption, logistics planning, or infrastructure usage by aligning system behavior

with environmental conditions. This perspective aligns with recent conceptualizations of digital sustainability (Kotlarsky et al., 2023), which position digital resources and artifacts as proactive tools for shaping sustainable futures.

While both streams engage with questions of system intelligence, adaptivity, and long-term value contribution, they have so far largely overlooked the spatial dimension as a constitutive design aspect, which has also been recognized to be the case in the IS discipline in general (Haj-Bolouri et al., 2024). Thus, the findings of this dissertation challenge this view of "space", or location information. Location is shown to be relevant and context-giving. Without spatial understanding, many digital services remain ineffective or inefficient in various domains and contexts. IS research can help to address these challenges, but only if it acknowledges GIS as an integral part of its methodological and conceptual toolkit.

Still, the contributions of this dissertation go beyond theoretical insights, as the research problem and research questions also address real-world economic challenges. As such, this work provides managerial implications, particularly for municipalities, real estate appraisers, asset manufacturers, and energy grid operators, but also for other organizations that manage services with a spatial component. Although many of these actors already have access to geospatial data, IS research has yet to offer a systematic, location-sensitive approach to how services can be developed from this data and how value can be co-created within location-specific service systems in both B2C and B2B contexts.

The central management implication is the need to design and use location-specific service systems. This requires a change in perspective: practitioners need to begin to view location not only as an operational detail but as a strategic tool. Across various domains, the findings of this dissertation demonstrate the practical relevance of this perspective. In the context of smart cities, spatial constraints are just as important as temporal ones, as a citizen center may be open all day, but if it cannot be reached, e.g., by public transport, it remains inaccessible. In real estate valuation, what a property offers is often less important than where it is located. For instance, the number of rooms and the age of the house matter less than the crime rate of the neighborhood and the proximity to essential services like shopping or financial facilities. In predictive maintenance, the location of an asset is just as critical as the timing of its maintenance, as malfunctioning assets affect the surrounding grid and its components. Further, the locations of assets have influence on grid planning and operational decisions like the order of maintenance activities and personnel planning.

For charging infrastructure, the number of installed EVCS is irrelevant if they are placed in the wrong locations. Only a location-aware strategy ensures accessibility, usage, and ultimately, service success.

4.3 Conclusion and Outlook

Services play a central role in today's global economy (Organisation for Economic Co-operation and Development (OECD), 2022). As service systems become increasingly digital and data-driven, the use of location information has gained relevance, particularly in domains such as analytics, logistics, and marketing (McKenna et al., 2014; Uphaus et al., 2021). Within this evolving landscape, Service Science has established itself as a key research stream in the IS discipline, aiming to understand and shape the design, delivery, and improvement of complex service systems (Maglio et al., 2009).

The growing relevance of location information is also supported by technological and policy developments. Initiatives like the INSPIRE directive promote the accessibility of geospatial data by encouraging countries and cities to provide open and standardized data sources (European Commission, 2007). At the same time, digital technologies such as the IoT further increase the potential of geospatial integration by generating rich, real-time location data through smart and connected devices (Cao and Wachowicz, 2019).

However, the current state of research still lacks clarity on how such location-specific service systems can be systematically designed. While this dissertation lays conceptual foundations and proposes a framework, particularly through the answer to RQ3, it does not yet include a full DSR study. The existing work remains primarily conceptual or grounded in DDR. Further studies are needed to build on this foundation. The proposed framework can nonetheless serve as a valuable component in the design process. For example, to plan and extend value creation within a service system, and to reflectively evaluate it after implementation.

This dissertation demonstrates that future-oriented service systems depend on acknowledging the strategic value of location data and integrating GIS and their four properties acquisition, management, analysis, and presentation (Ehlers and Schiewe,

2012; Breunig et al., 2020) into the design and operation of service systems. Researchers can build on this perspective by further exploring how location-based insights influence value co-creation and service design. This may include investigating new value creation mechanisms, particularly when shifting from traditional one-to-many perspectives to many-to-many relationships in modular ecosystems and intersectoral data spaces.

A key insight from this work is the recognition that GIS differ fundamentally from other information systems, such as ERP systems. The ability of GIS to acquire precise location data, manage complex spatial databases, conduct detailed spatial analyses, and present geospatial information in accessible ways sets them apart from other information systems. Nonetheless, IS research has yet to fully integrate this system class into its theoretical landscape. A "map" of information systems is still missing in the literature and should explicitly include GIS as a central part of the IS research discipline.

To prevent IS research from remaining in an only abstract, model-driven world that fails to account for the physical reality in which services are embedded, location must be understood as a systematic component in theory-building. This means integrating location as a dimension into core IS concepts and treating GIS not just as an infrastructure, but as a standalone and critical class of information systems.

This dissertation thus provides a foundation for more systematic research on location-specific service systems and highlights promising starting points for exploring their specific design challenges, value mechanisms, and roles in future digital service ecosystems.

Part B
Included Publications

1 Role of GIS in IS Research and Service Systems

1.1 Geographic Information Systems in Information Systems Research - Review and Research Prospects

Title	**Geographic Information Systems in Information Systems Research – Review and Research Prospects**	
Publication Type	Conference Proceedings	
VHB-JOURQUAL4	B	
Publication Outlet	Hawaii International Conference on System Sciences (HICSS)	
Authors	**Name**	**Contribution**
	Jennifer Priefer	100%
Status	Published	
Presentation	Jennifer Priefer	100%
Awards	Best Paper Nominee	
Full Citation	J. Priefer 2023. "Geographic Information Systems in Information Systems Research-Review and Research Prospects," in *Proceedings of the 56th Hawaii International Conference on System Sciences,* T. Bui and R. Sprague (eds.), pp. 5048–5058	

Table 1.1: Fact sheet of Publication P1

1.2 Location-Based Service and Location-Contextualizing Service: Conceptualizing the Co-creation of Value with Location Information

Title	**Location-Based Service and Location-Contextualizing Service: Conceptualizing the Co-creation of Value with Location Information**	
Publication Type	Conference Proceedings	
VHB-JOURQUAL4	B	
Publication Outlet	Hawaii International Conference on System Sciences (HICSS)	
Authors	**Name**	**Contribution**
	Philipp zur Heiden	50%
	Jennifer Priefer	40%
	Daniel Beverungen	10%
Status	Published	
Presentation	Jennifer Priefer	100%
Full Citation	P. zur Heiden, J. Priefer, and D. Beverungen 2023. "Location-Based Service and Location-Contextualizing Service: Conceptualizing the Co-creation of Value with Location Information," in *Proceedings of the 56th Hawaii International Conference on System Sciences,* pp. 5062–5071	

Table 1.2: Fact sheet of Publication P2

2 Contribution of GIS to Value Co-Creation in Service Systems

2.1 Leveraging Geographic Information Systems for Value Co-Creation: A Conceptual Framework for Location-Specific Service Systems

Title	**Leveraging Geographic Information Systems for Value Co-Creation: A Conceptual Framework for Location-Specific Service Systems**	
Publication Type	Working Paper	
VHB-JOURQUAL4	N/A	
Publication Outlet	Paderborn University, Faculty of Business Administration and Economics	
Authors	**Name**	**Contribution**
	Jennifer Priefer	80%
	Daniel Beverungen	20%
Status	Published	
Full Citation	J. Priefer and D. Beverungen 2025. "Leveraging Geographic Information Systems for Value Co-Creation: A Conceptual Framework for Location-Specific Service Systems," *Working Paper Series, Paderborn University, Faculty of Business Administration and Economics (No. 137)*	

Table 2.1: Fact sheet of Publication P3

3 Co-Creation of Value in B2C Location-Based Service Systems

3.1 City 5.0: Citizen involvement in the design of future cities

Title	**City 5.0: Citizen involvement in the design of future cities**	
Publication Type	Journal	
VHB-JOURQUAL4	B	
Publication Outlet	Electronic Markets	
Authors	**Name**	**Contribution**
	Jörg Becker	
	Friedrich Chasin	
	Michael Rosemann	
	Daniel Beverungen	
	Jennifer Priefer	5%
	et al.	
Status	Published	
Full Citation	J. Becker, F. Chasin, M. Rosemann, D. Beverungen, J. Priefer, J. v. Brocke, M. Matzner, A. del Rio Ortega, M. Resinas, F. Santoro, et al. 2023. "City 5.0: Citizen involvement in the design of future cities," *Electronic Markets* (33:1), p. 10	

Table 3.1: Fact sheet of Publication P4

3.2 Quantifying the Impact of Location Data for Real Estate Appraisal – A GIS-Based Deep Learning Approach

Title	**Quantifying the Impact of Location Data for Real Estate Appraisal – A GIS-Based Deep Learning Approach**	
Publication Type	Conference Proceedings	
VHB-JOURQUAL4	A	
Publication Outlet	European Conference on Information Systems (ECIS)	
Authors	**Name**	**Contribution**
	Jan-Peter Kucklick	45%
	Jennifer Priefer	35%
	Daniel Beverungen	10%
	Oliver Müller	10%
Status	Published	
Presentation	Jan-Peter Kucklick	50%
	Jennifer Priefer	50%
Full Citation	J.-P. Kucklick, J. Müller, D. Beverungen, and O. Müller 2021. "Quantifying the Impact of Location Data for Real Estate Appraisal – A GIS-Based Deep Learning Approach," in *ECIS 2021 Proceedings*	

Table 3.2: Fact sheet of Publication P5

3.3 Elucidating the Predictive Power of Search and Experience Qualities for Pricing of Complex Goods: A Machine Learning-based Study on Real Estate Appraisal

Title	**Elucidating the Predictive Power of Search and Experience Qualities for Pricing of Complex Goods: A Machine Learning-based Study on Real Estate Appraisal**	
Publication Type	Working Paper	
VHB-JOURQUAL4	N/A	
Publication Outlet	Paderborn University, Faculty of Business Administration and Economics	
Authors	**Name**	**Contribution**
	Jennifer Priefer	40%
	Jan-Peter Kucklick	40%
	Daniel Beverungen	10%
	Oliver Müller	10%
Status	Published	
Full Citation	J. Priefer, J. -P. Kucklick, D. Beverungen, and O. Müller 2025. "Elucidating the Predictive Power of Search and Experience Qualities for Pricing of Complex Goods: A Machine Learning-based Study on Real Estate Appraisal," *Working Paper Series, Paderborn University, Faculty of Business Administration and Economics (No. 138)*	

Table 3.3: Fact sheet of Publication P6

4 Co-Creation of Value in B2B Location-Based Service Systems

4.1 Transitioning to Condition-Based Maintenance on the Distribution Grid: Deriving Design Principles from a Qualitative Study

Title	**Transitioning to Condition-Based Maintenance on the Distribution Grid: Deriving Design Principles from a Qualitative Study**	
Publication Type	Pre-Conference Proceedings	
VHB-JOURQUAL4	B	
Publication Outlet	International Conference on Wirtschaftsinformatik (WI)	
Authors	**Name**	**Contribution**
	Philipp zur Heiden	50%
	Jennifer Priefer	50%
Status	Published	
Presentation	Philipp zur Heiden	50%
	Jennifer Priefer	50%
Full Citation	P. zur Heiden and J. Priefer 2021. "Transitioning to Condition-Based Maintenance on the Distribution Grid: Deriving Design Principles from a Qualitative Study," in *Pre-Conference 16th International Congress on Wirtschaftsinformatik at Universität Duisburg-Essen,* M. H. Breitner, S. Lehnhoff, A. Nieße, P. Staudt, C. Weinhardt, and O. Werth (eds.). Oldenburg: BIS-Verlag der Carl von Ossietzky Universität Oldenburg	

Table 4.1: Fact sheet of Publication P7

4.2 Utilizing Geographic Information Systems for Condition-Based Maintenance on the Energy Distribution Grid

Title	**Utilizing Geographic Information Systems for Condition-Based Maintenance on the Energy Distribution Grid**	
Publication Type	Conference Proceedings	
VHB-JOURQUAL4	B	
Publication Outlet	Hawaii International Conference on System Sciences (HICSS)	
Authors	**Name**	**Contribution**
	Philipp zur Heiden	50%
	Jennifer Priefer	40%
	Daniel Beverungen	10%
Status	Published	
Presentation	Jennifer Priefer	100%
Full Citation	P. zur Heiden, J. Priefer, and D. Beverungen 2022. "Utilizing Geographic Information Systems for Condition-Based Maintenance on the Energy Distribution Grid," in *Proceedings of the 55th Hawaii International Conference on System Sciences*, T. Bui and R. Sprague (eds.), pp. 5672–5681	

Table 4.2: Fact sheet of Publication P8

4.3 Predictive Maintenance on the Energy Distribution Grid–Design and Evaluation of a Digital Industrial Platform in the Context of a Smart Service System

Title	**Predictive Maintenance on the Energy Distribution Grid–Design and Evaluation of a Digital Industrial Platform in the Context of a Smart Service System**	
Publication Type	Journal	
VHB-JOURQUAL4	B	
Publication Outlet	IEEE Transactions on Engineering Management	
Authors	**Name**	**Contribution**
	Philipp zur Heiden	50%
	Jennifer Priefer	40%
	Daniel Beverungen	10%
Status	Published	
Full Citation	P. zur Heiden, J. Priefer, and D. Beverungen 2024. "Predictive maintenance on the energy distribution grid–design and evaluation of a digital industrial platform in the context of a smart service system," *IEEE transactions on engineering management* (71), pp. 3641–3655	

Table 4.3: Fact sheet of Publication P9

4.4 Designing a GIS-AHP-Based Spatial Decision Support System for Discovering and Visualizing suitable Locations for Electric Vehicle Charging Stations

Title	**Designing a GIS-AHP-Based Spatial Decision Support System for Discovering and Visualizing suitable Locations for Electric Vehicle Charging Stations**	
Publication Type	Conference Proceedings	
VHB-JOURQUAL4	B	
Publication Outlet	International Conference on Wirtschaftsinformatik (WI)	
Authors	**Name**	**Contribution**
	Jennifer Priefer	70%
	Lennart Steiger	30%
Status	Published	
Presentation	Jennifer Priefer	100%
Awards	Best Prototype Award 1st Runner-Up	
Full Citation	J. Priefer and L. Steiger 2022. "Designing a GIS-AHP-Based Spatial Decision Support System for Discovering and Visualizing Suitable Locations for Electric Vehicle Charging Stations," *Wirtschaftsinformatik 2022 Proceedings* (31)	

Table 4.4: Fact sheet of Publication P10

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