1 Introduction

1.1 Motivation for Inter-Organizational Data Sharing

The inter-organizational data sharing between companies is one of the central pillars for creating new value in an increasingly digital society and complex supply chains (Wixom et al. 2020; Legenvre and Hameri 2023, p. 293). This is especially relevant to building resilience for supply chains to mitigate the consequences of unforeseeable global crises (e.g., the Ukraine-Russia conflict) (Alicke et al. 2022). To successfully leverage the data economy, companies need to have educated employees and appropriate data management that contributes to value creation from data sharing (Lefebvre et al. 2023; Davenport et al. 2021). Technologies such as artificial intelligence (AI) require a sound database across organizational boundaries to be used effectively in manufacturing and supply chains to improve operational processes and are estimated to save more than 100 billion US dollars (Küpper and Okur 2020). In the highly competitive transport sector, companies recognize that expanding cooperation requires participating in ecosystems to operate more profitably and sustainably (Waddell and Peterson 2021). To realize these opportunities, there are a plethora of ways to share data between data providers and data consumers. All of these options combine different roles (e.g., data providers, data consumers, data intermediaries) to create value – so-called *value constellations*. These range from bilateral data sharing between data providers and data consumers to multilateral data sharing via data marketplaces (Capgemini Research Institute 2021, p. 26; Jussen et al. 2024a, p. 6 ff.).

Finding the right data-sharing value constellation is an essential part of the European data strategy (Fürst and Kraemer 2024). The two key pillars of the European data strategy are the Data Governance Act (DGA) and the Data Act (DA) (European Commission 2024d). The DA, which entered into force on January 11th, 2024, aims to promote access to data under clear regulations to enable new value creation and business models (Federal Ministry for Digital and Transport 2023). Specifically, the DA regulates various issues, including data provision by data holders and implementing technical security measures such as encryption to prevent unauthorized access to data (European Union 2023). The DA requires mandatory sharing of data generated by IoT devices between organizations (Business-to-Business (B2B)) and governmental bodies (Business-to-Government (B2G)) (Bernal 2024, p. 12).

The DGA addresses data altruism, e.g., the voluntary release of data for no compensation and requirements for data intermediation services, which enable data sharing between data providers and data consumers (European Commission 2022b). The new legislation establishes legally binding standards and specifications regarding data providers' and consumers' rights to share data and utilize new market opportunities (European Council

2023). Nonetheless, there is also criticism regarding the DGA, as it significantly restricts the scope of action for data intermediaries, who act as neutral intermediaries between data providers and data consumers (Richter 2023, p. 461). The European Union (EU) aims to make mandatory data sharing more attractive to achieve innovation and economic growth and remain globally competitive (Bernal 2024, p. 13 f.).

Sharing data is always a trade-off between the potential gains and risks. For instance, some incentives to share are repeated in the literature corpus (Gelhaar et al. 2021b, p. 6; Jussen et al. 2024b, p. 7). These incentives include the development of new products and services (e.g., the shared mobility data ecosystem (E015 2024)) or improving supply chain coordination and resilience (Berg 2023; Röhl et al. 2021). Following the European Data Strategy and the DGA, the European Commission illustrates the strength of the benefits of data sharing, including cost savings of 120 billion € in the healthcare sector or an increase in Gross Domestic Product (GDP) within the EU of 270 billion € by 2028 (European Commission 2021b; European Commission 2022d). The Organization for Economic Co-operation and Development (OECD) also predicts the value opportunities of data sharing to be worth 2.5% of global GDP (Candelon et al. 2024).

However, a study by the German Economic Institute finds several barriers preventing data sharing. The study uncovers that 58% of over 1,000 German companies do not share nor receive data (Büchel and Engels 2022, p. 14ff.). Typical barriers are inadequate data quality, a lack of standards, or missing internal know-how (e.g., technical or organizational) to share data (Fassnacht et al. 2023a, p. 3699; Candelon et al. 2024). Even though companies more and more recognize the importance of B2B data sharing and data recipients are increasing, the number of data providers is still stagnating (Berg 2023). One example is CDQ (2024) which supports its customers in achieving high data quality through a combination of a dedicated data-sharing community and over 70 external data sources (e.g., open data, commercial registers). European initiatives like the International Data Spaces Association (IDSA) (2024a) or Gaia-X (2024) support companies by providing expertise on technical elements, including connectors (IDSA report by Giussani et al. (2024)), or by defining standards for secure and trustworthy data sharing within Europe. In practice, Catena-X (2024b) enables standardized data sharing within the automotive industry's global supply chains, using specific applications to tackle sector-wide issues. A concrete example of the data sharing in Catena-X is the Product Carbon Footprint (PCF), which records the CO2 footprint of products and was previously estimated based on empirical values and assumptions, which can lead to deviations of 25-30% (Catena-X 2024c; Ganser 2023). Key suppliers BASF (2024) and SIEMENS (2024) emphasize the importance of data sharing between them and their suppliers to calculate the PCF with the most accurate data possible.

Legislation such as the German "Lieferkettensorgfaltspflichtengesetz" (*engl. Supply Chain Act*) extends the requirements for companies with more than 1,000 employees in Germany, as they need to ensure that there is no child labor, human rights violations, or environmental contamination along their entire supply chains (Federal Ministry of Labour and Social Affairs 2023). If companies violate the requirements of the Supply Chain Act (SCA), in the worst case, they can be fined up to 2% of the average annual turnover based on the last three years (Federal Office for Economic Affairs and Export Control 2024, p. 2967). The example of the automotive supplier Continental illustrates the effort to build the necessary transparency to comply with the SCA. They have estimated around 100,000 suppliers in their entire supply chain to collect data from, which is unmanageable despite the investment of tens of millions of euros and pushes them to their limits (Zwick 2024). Driven by these current regulations, supply chains are not just sharing traditional data, including orders, stock levels, or demand forecasts, but rather data relating to supply chain risks or reverse logistics (Gartner Inc. 2021, p. 2). Supply chains become more valuable for all participants when more data is shared among all participants (Wu et al. 2024, p. 3). Figure 1 shows that more data will need to be exchanged within supply chains than previously, as data on supply chain risks, for example, requires a significantly higher degree of transparency in supply chains.

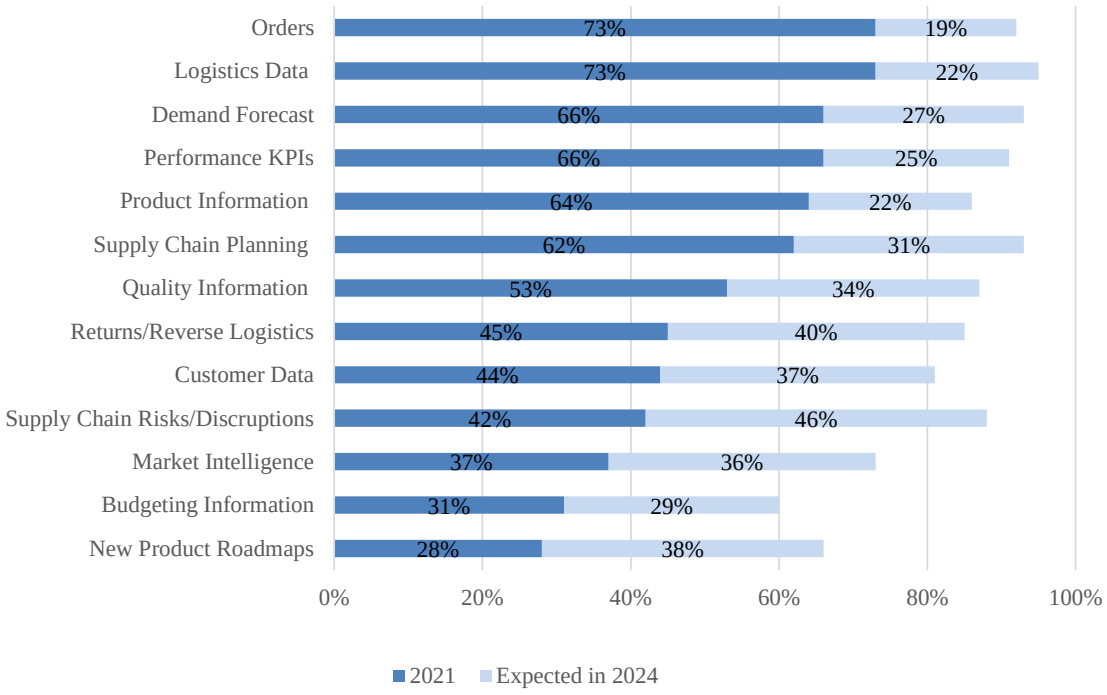

Figure 1. Shared data types in supply chain ecosystems (Gartner Inc. 2021, p. 2).

The above shows that inter-organizational data sharing is a pressing issue for companies. Consequently, companies require assistance navigating these requirements and potential benefits. Clear recommendations for systematic data sharing are currently lacking

(Schönwerth 2022). To address this gap, the dissertation provides an orientation for inter-organizational data sharing (B2B) and proposes fundamental conceptualizations and actionable decision support. The next section details the specific research questions addressed in this dissertation. In the following, data sharing and data exchange are frequently used in the same context. This dissertation explores data sharing, whereas data exchange is seen as a purely technical exchange process. Data sharing goes far beyond this and encompasses the socio-organizational interaction of actors.

1.2 Research Context and Research Questions

Based on the motivation outlined above, which refers to the importance of inter-organizational data sharing as well as the associated barriers and incentives, the central research objective of this dissertation is summarized as:

> *Development of decision support for data providers in inter-organizational data sharing.*

Even though there is initial research on inter-organizational data sharing, it lacks clear decision support for practical implementation. To achieve this research objective step by step, the dissertation is divided into three different research areas, which build on each other and contribute to achieving this goal (see Figure 2). The three research areas are: *foundations and definitions, operationalization, design and action*.

Research Area 1 – Foundations and definitions

The first research area, "foundations and definitions," conceptualizes foundational terminologies, constructs, and relationships in inter-organizational data sharing. It consists of three research questions in three papers (**P1**-**P3**).

The first paper (**P1**) addresses two research questions that delve into the conceptual distinction between data sharing and data exchange and the content-related link between the two terms. So far, the terms data sharing and data exchange have been used synonymously in the literature (Nokkala et al. 2019, p. 2). Using a systematic literature review according to Webster and Watson (2002), the existing knowledge in Information Systems (IS) research was analyzed to tackle these research questions. The key results of the paper are a comprehensive definition (**RQ1**) summarizing all relevant aspects for describing the terms and a visualization showing the relationship between them (**RQ2**).

- **RQ1:** How to define and characterize data sharing and exchange?
- **RQ2:** How to distinguish data sharing and data exchange?

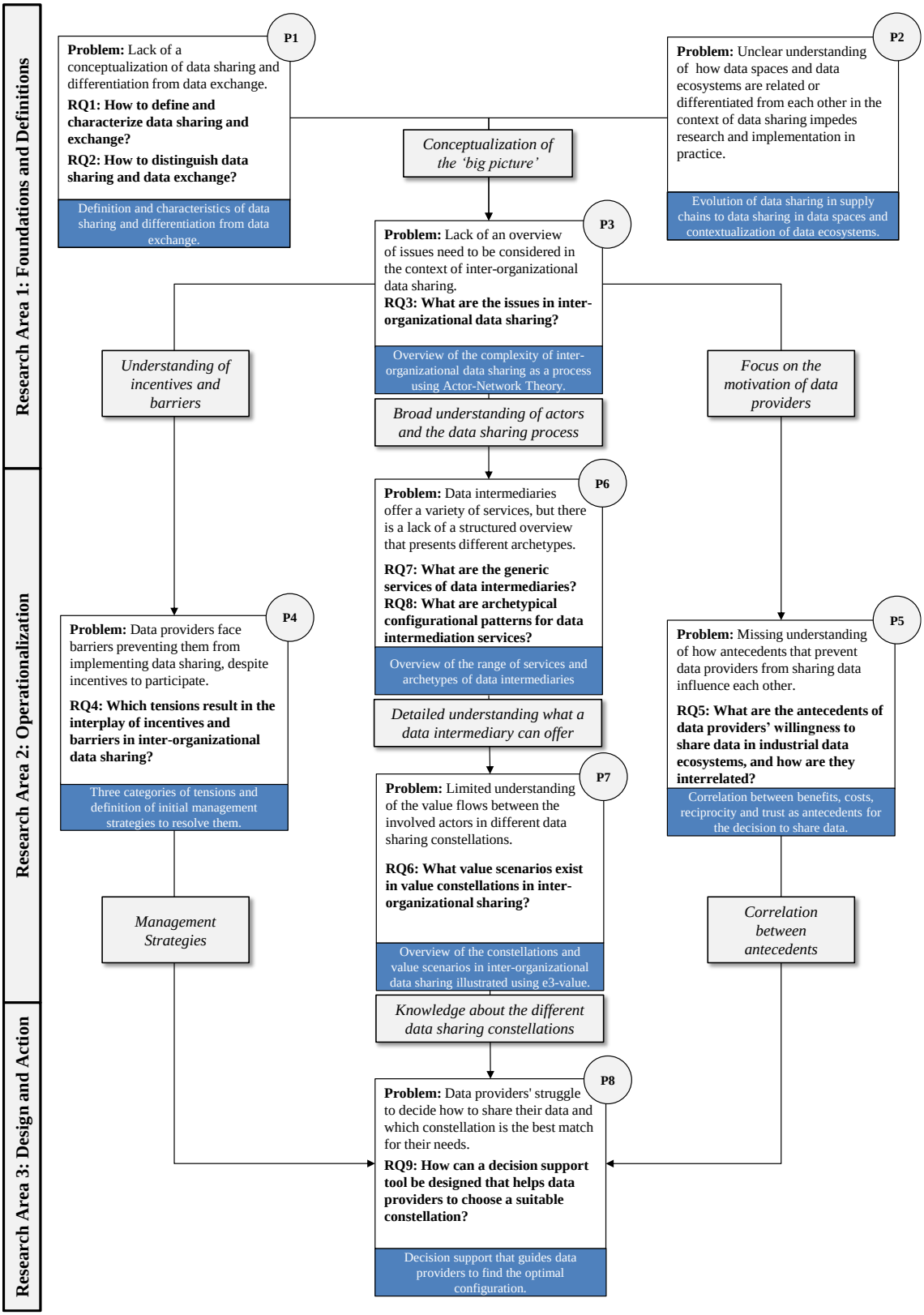

Figure 2. Context between the papers of the dissertation.

The second paper of this dissertation (**P2**) deals with the evolution of data sharing in sequential supply chains (Konsynski and McFarlan 1990) up to industrial data ecosystems (Legenvre et al. 2022). Data ecosystems and data spaces provide the playing field for inter-organizational data sharing. However, there is currently no clear definition of how data ecosystems and data spaces differ from one another, either in the literature or in practice. As a result, both terms are often used interchangeably nowadays. The paper does not answer a classically defined research question but explains the contextual relationships and foundations of industrial data ecosystems.

The third paper of this dissertation (**P3**) examines issues in inter-organizational data sharing (**RQ3**) based on the foundations of the first two papers, e.g., what data sharing means in contrast to data exchange. These issues were derived through an interview study with 13 practice partners and an analysis of practical examples. The Actor-Network Theory (ANT) gives a suitable framework for the research in this paper, ensuring a comprehensive analysis of the emergence and expansion of data ecosystems. Based on ANT, the paper summarizes the most essential issues in inter-organizational data sharing.

- **RQ3:** What are the issues in inter-organizational data sharing?

At the end of this research area, a comprehensive understanding of inter-organizational data sharing fuels the rest of the dissertation. This implies the differentiation of data sharing from data exchange, the conceptual development of data sharing, its contextualization in the data ecosystems and data spaces field, and the relevant issues that characterize inter-organizational data sharing.

Research Area 2 – Operationalization

In the second research area, "operationalization", the findings from research area 1 are examined in depth in four papers (**P4-P7**). The fourth paper (**P4**) uses a systematic literature review to investigate the incentives and barriers data providers perceive. Workshops with 21 participants expand the findings from the interview study of paper 3 (**P3**). This juxtaposition of barriers and incentives results in tensions. The underlying trade-off between barriers and incentives draws on Privacy Calculus Theory (PCT), which states that data providers weigh the perceived benefits (*Incentives*) against the risks (*Barriers*) before sharing their data. The paper answers research question 4 as a set of tensions divided into three groups: *business model tensions, organizational tensions,* and *data sovereignty tensions*. Alongside the overview of tensions, initial management strategies indicate possible solution approaches to address these tensions.

- **RQ4:** Which tensions result in the interplay of incentives and barriers in inter-organizational data sharing?

The fifth paper (**P5**) analyzes the antecedents that influence the willingness of data providers to share their data. Paper 5 performs a deep dive into the motivation (see also

paper 3) of the data provider as the party deciding to share. An interview study with 23 experts from the manufacturing sector serves as the database to capture these antecedents. The paper uses Social Exchange Theory (SET) to analyze relationships and interactions between data providers and data consumers. The key outcome is understanding the overarching antecedents' benefits, costs, reciprocity, and trust, their interplay, and how these four categories influence the decision-making process for the data provider's willingness to share data.

- **RQ5:** What are the antecedents of data providers' willingness to share data in industrial data ecosystems, and how are they interrelated?

The sixth paper (**P6**) explores data intermediation services and their archetypes. The taxonomy uses two data sources: a literature review including 48 papers and 86 publicly available data intermediaries cases. The analysis of the 86 use cases required three iterations until theoretical saturation. The paper proposes eight archetypes of data intermediation services based on a cluster analysis. These results ensure an in-depth understanding of data intermediaries for further research.

- **RQ6:** What are the generic services of data intermediaries?
- **RQ7:** What are archetypical configurational patterns for data intermediation services?

The seventh paper (**P7**) explains the range of value constellations in inter-organizational data sharing and the associated value scenarios. Paper 7 goes beyond the focus on data intermediaries (see paper 6) and takes a broader view into inter-organizational data sharing. There are already several publications on the different constellations, e.g., Stachon et al. (2023) on data trusts or Agahari et al. (2021) on data marketplaces. However, a lack of research currently compares the various constellations and transparently highlights similarities and differences. Using the e^3-value modeling language, the paper visualizes 53 use cases and analyzes the constellations and value scenarios. The individual e^3-value models show which actors are essential in the respective constellation and which value scenarios occur between them.

- **RQ8:** What value scenarios exist in value constellations in inter-organizational data sharing?

Compared to the first research area, the papers and research questions in research area 2 are much more in-depth and build on the knowledge gained in research area 1. Some issues covered in paper 3 are analyzed in greater depth in paper 7, e.g., building the data-sharing ecosystem (required roles, participation) or building the data-sharing infrastructure (sharing process, technical realization). Furthermore, paper 5 explores the motivation of data providers to share data (see paper 3) in more detail and discusses how benefits, costs, reciprocity, and trust influence the willingness to share data.

Research Area 3 – Design and Action

The third research area, "design and action", concludes this dissertation. It transfers the knowledge from the two previous research areas into practical application. The eighth paper (**P8**) analyzes the following research question:

- **RQ9:** How can organizational decision-making be supported in selecting and configuring data-sharing value constellation?

To answer this question, the paper proposes the design of an artifact – a decision support tool – based on the BAUSTEIN method (Schoormann et al. 2024). The research design employs multiple data sources: publicly available data (65 use cases), explorative literature search (18 papers), workshops with 11 practitioners, and further evaluation workshops of the decision support tool with nine practitioners. The decision support tool contains three modules. First, *problem space exploration* helps data providers self-assess their data-sharing use case. Second, *solution proposal* recommends a high-level data-sharing value constellation (e.g., data marketplace) based on a predefined decision tree. Third, *solution configuration* equips the data provider with the means to configure the value constellation in detail using e^3-value modeling language. The overall purpose of this procedure is to ensure that the data provider is conscious of options and potential value constellations in the early stages of data sharing.

This decision support tool incorporates the e^3-value models from paper 7, the understanding of data intermediaries from paper 6, and the factors influencing the actors' willingness to share data from paper 5. Together with the management strategies identified in paper 4, which recommend, for example, the exchange of the same data or the use of data intermediaries, this approach leads to the final result of this dissertation.

1.3 Research Structure

This cumulative doctoral dissertation is divided into **Part A** and **Part B** (see Figure 3). The first part of the dissertation (Part A) explains the motivation for addressing the research topic "inter-organizational data sharing" and the connection between this dissertation's publications and the dissertation's structure. Then, the research background presents the most relevant foundations. This includes the distinction between data, information, and knowledge, followed by the development of data sharing from bilateral data sharing in supply chains to multilateral data sharing in data ecosystems. The following section 0 on theoretical foundations introduces the three theories used in this dissertation (ANT, PCT, SET). It explains how these theories guided the research of inter-organizational data sharing.

The fourth section of Part A presents the research methods utilized in this dissertation. Literature reviews captured the existing scientific knowledge, and interviews and

workshops mirrored this knowledge with experts from the field. Part B presents the eight papers from the core of this dissertation and ends with the conclusion. It outlines the theoretical and practical contributions, limitations, and further research possibilities.

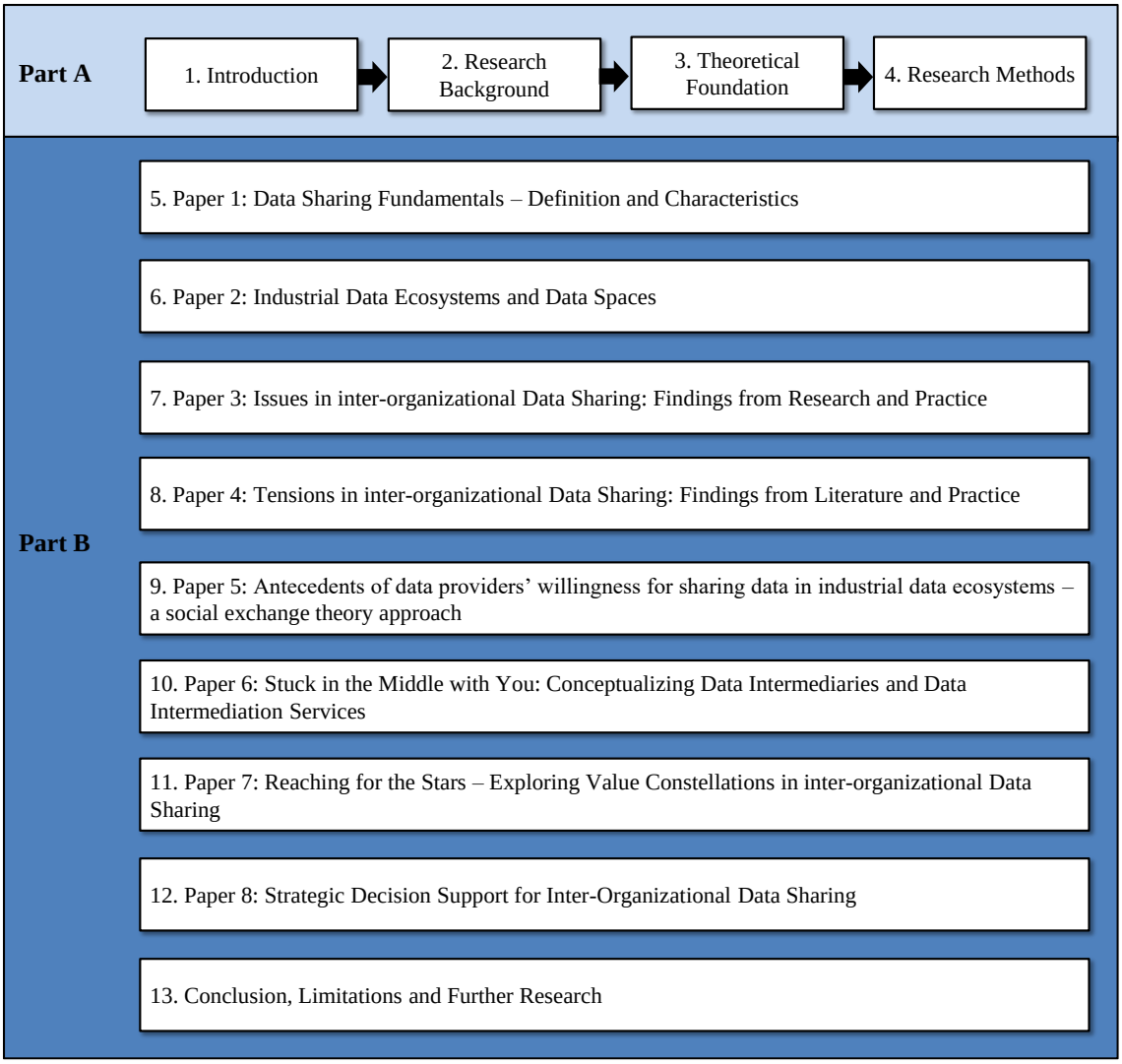

Figure 3. Structure of the dissertation.

1.3.1 Included Publications of the Dissertation

Table 1 below shows an overview of these publications (P1-P8). It distinguishes between conference papers and journal articles and indicates the outlet's corresponding VHB ranking[1]. For completeness, other papers that were not at the core of this dissertation are listed in Table 2.

[1] https://vhbonline.org/wissenschaftliche-kommissionen/wirtschaftsinformatik-wi/vhb-rating-2024-wirtschaftsinformatik last accessed: 30.09.2024

Table 1. Included publications of the dissertation.

ID	Full Citation	Type	VHB3	VHB4
P1	**Jussen, I.**, Schweihoff, J., Dahms, V., Möller, F., und Otto, B. 2023. "Data Sharing Fundamentals: Definition and Characteristics," in Proceedings of the 56th Hawaii International Conference on System Sciences, Hawaii: USA.	Conference Paper	C	B
P2	Möller, F., **Jussen, I.**, Springer, V., Gieß, A., Schweihoff, J., Gelhaar, J., Guggenberger, T., Otto, B. 2024. "Industrial Data Ecosystems and Data Spaces" Electronic Markets 34(41), S.1-17 (doi: 10.1007/s12525-024-00724-0)	Journal Article	B	B
P3	**Jussen, I.**, Möller, F., Schweihoff, J., Gieß, A., Giussani, G., und Otto, B. 2024. "Issues in inter-organizational data sharing: Findings from practice and research challenges," Data & Knowledge Engineering (150), S. 1-19 (doi: 10.1016/j.datak.2024.102280).	Journal Article	B	B
P4	**Jussen, I.**, Schweihoff, J., und Möller, F. 2023. "Tensions in Inter-Organizational Data Sharing: Findings from Literature and Practice," in 25th IEEE International Conference on Business Informatics, Prague: Czech Republic.	Conference Paper	-	C
P5	Gelhaar, J., **Jussen-Lengersdorf, I.**, Möller, F., Otto, B. XXXX. "To Share or not to Share – Exploring the Willingness of Industrial Data Providers to Share Data,"	Journal Article (submitted)	A	A
P6	Schweihoff, J., Lipovetskaja, A., **Jussen-Lengersdorf, I.**, Möller, F. 2024. "Stuck in the Middle with You: Conceptualizing Data Intermediaries and Data Intermediation Services," Electronic Markets 34 (48), S.1-26 (doi: 10.1007/s12525-024-00729-9)	Journal Article	B	B
P7	**Jussen, I.**, Fassnacht, M., Schweihoff, J., Möller, F. 2024. "Reaching for the Stars: Exploring Value Constellations in inter-organizational Data Sharing," in Proceedings of the 32nd European International Conference on Information Systems, Paphos: Cyprus.	Conference Paper	B	A
P8	**Jussen-Lengersdorf, I.**, Fassnacht, M., Möller, F., Schweihoff, J., Otto, B., Satzger, G. XXXX. "Strategic Decision Support for Inter-Organizational Data Sharing,"	Journal Article (under review)	A	A

1.3.2 Complete Bibliography

Table 2. Further publications.

Full Citation	Type	VHB3	VHB4
Möller, F., Stachon, M., **Jussen, I.**, Schweihoff, J., van der Valk, H., Schmidt, M., Handrup, S. 2022. "Towards a Taxonomy of API Services in Logistics," in Proceedings of the 55th Hawaii International Conference on System Sciences, Hawaii: USA.	Conference Paper	C	B
Duparc, E., Möller, F., **Jussen, I.**, Stachon, M. Algac, S., Otto, B. 2022. "Archetypes of open-source business models," Electronic Markets 32, S.727-745. (doi: 10.1007/s12525-022-00557-9)	Journal Article	B	B
Schweihoff, J., **Jussen, I.**, Dahms, V., Möller, F., und Otto, B. 2023. "How to Share Data Online (fast) - A Taxonomy of Data Sharing Business Models," in Proceedings of the 56th Hawaii International Conference on System Sciences, Hawaii: USA.	Conference Paper	C	B
Schoormann, T., Schweihoff, J., **Jussen, I.**, Möller, F. 2023. "Classification tools for business models: Status quo, comparison, and agenda," Electronic Markets 33(7), S.1-36 (doi: 10.1007/s12525-023-00639-2).	Journal Article	B	B
Schweihoff, J., **Jussen, I.**, und Möller, F. 2023. "Trust me, I'm an Intermediary! Exploring Data Intermediation Services," in Proceedings of the 18th International Conference on Wirtschaftsinformatik, Paderborn: Germany.	Conference Paper	C	B
Winkelmann, S., Schweihoff, J., **Jussen, I.**, Möller, F. 2023. "Turning Old into New – The Lane Change to a Circular Economy in the Automotive Industry," in 53. Jahrestagung INFORMATIK 2023, Gesellschaft für Informatik e.V., Berlin: Germany.	Conference Paper	-	C
Jahnke, N., **Jussen, I.**, Schoormann, T., Möller, F. 2024. "Designing Federated Data Marketplaces in Industrial Production: Findings from a Prototypical Implementation" in Proceedings of the 19th International Conference on Wirtschaftsinformatik, Würzburg: Germany.	Conference Paper	C	B

Duparc, E., Hesse, A., Rogalla, A., **Jussen, I.**, Schoormann, T., Möller, F. 2024. “May the Data be With You – Exploring Data-Sharing Incentives for Users,” in Proceedings of the 28th Pacific Asia Conference on Information Systems, Ho Chi Minh City: Vietnam.	Conference Paper	C	C
Gieß, A., Neumann, J., **Jussen, I.**, Schweihoff, J. 2024. “Green data, green future? How data spaces enable the product carbon footprint calculation for the automotive industry. A case study on Catena-X,“ in 54. Jahrestagung INFORMATIK 2024, Gesellschaft für Informatik e.V., Wiesbaden: Germany.	Conference Paper	-	C
Schweihoff, J., **Jussen, I.** 2024. “Keeper of the building data: Exploring the potential for data trustees in the building sector. Enabling sustainable buildings with data trustees” in 54. Jahrestagung INFORMATIK 2024, Gesellschaft für Informatik e.V., Wiesbaden: Germany.	Conference Paper	-	C
Schoormann, T., Kammler, F., Gembarski, P., Hagen, S., Brinker, J., Bollenbach, J., **Jussen, I.**, Keller, R., Kortum-Landwehr, H., Möller, F., Petrik, D., Schweihoff, J., Stachon, M., Winkelmann, S. 2024. “Sustainable ecosystems: Findings from the NaWerSys workshop series” in 54. Jahrestagung INFORMATIK 2024, Gesellschaft für Informatik e.V., Wiesbaden: Germany.	Conference Paper	-	C