1 Introduction

1.1 Motivation and problem description

"Business models must morph over time as changing markets, technologies and legal structures dictate and/or allow" (Teece, 2010, p. 177). This statement holds true for the industry 4.0 movement, representing the natural next step after the third industrial revolution being influenced by a fundamental paradigm shift toward a digitalized manufacturing and supply network (Lasi *et al.*, 2014). In this context, it is expected that rather product-oriented markets will move into service-oriented markets equipped with new players that bring other ways of business into the game compared to traditional players (Lasi *et al.*, 2014). Linked to that movement, the logistics industry as a connecting industry has also to undergo an evolution. Hofman and Osterwalder (2017) already noted in that context a rise of technologies and disruptive business models in the logistics industry. Hence, the abstracted term logistics 4.0 considers the logistics industry's evolution and its underlying companies as key drivers for stemming autonomization and digitalization as part of the more extensive industry 4.0 picture (Delfmann *et al.*, 2018). The evolution can be divided into two key areas that are technology and business models.

On the one hand side, new technologies can be seen as an efficiency driver for logistics companies, but on the other hand, services being executed by logistics companies can be insourced by customers themselves. Therefore, for logistics companies it is vital to face the given situation and intensify the digital transformation ambitions. However, in general, the status quo of key logistics companies' digital transformation activities is still in its infancy respectively it represents a significant challenge (Wörner *et al.*, 2020). The Harvard Business Review published in that context a study in 2018 claiming the death of the supply chain management (Lyall *et al.*, 2018). In that context, it is primarily about the technology as an enabler for connecting multiple parties and eliminating the activities of a logistics company as an intermediary. That situation represents a major threat for a logistics company, because it might lead to a handover or insourcing of the logistics functions to the producing companies rather than choosing a logistics company to organize their logistics activities. That implies that logistics companies need to wake up and foster digital activities to avoid that situation.

Another essential dimension can be mainly seen in the logistics industry's business model setup. The business model of third-party logistics providers, for instance, is still a cost-plus model based on physical transportation with value-added services to create some additional value and respectively increased revenues. Rarely, new digital business models can be noted in that context by the incumbents themselves. The same can be identified in academia, where digitalization of logistics companies has been barely gained attention (Hofmann *et al.*, 2017; Mathauer *et al.*, 2019).

Despite this status quo, it can be observed that more logistics companies acknowledged this threat and tried to define counteractions. The big incumbents in the area of third-party logistics services, like, for instance, DHL Supply Chain (2021) and DB Schenker (2021), established a Chief Digital Office for intensifying their digital activities. Kühne + Nagel (2021) also state on their website that they see digitalization in logistics as an important pillar. They concentrate on integrating customers via application programming interfaces (APIs), making use of big data, applying machine learning and artificial intelligence, providing the internet of things services, and working on fields in the area of blockchain technology. These movements just started about five years ago and finally gained more and more traction. Having a look at the logistics startup market as a potential indicator for the attractiveness of a need for digitalization, within the same time frame, there is a visible trend towards increasing funds spent in this industry (Gruenderszene, 2017; McKinsey & Company, 2017). From a global perspective, it resulted in substantial investment rounds and high evaluations. For instance, the Chinese logistics marketplace Manbang group received 1.9 billion US Dollar funds, and the US-based digital freight forwarder Flexport is the first logistics startup unicorn with an evaluation of about 3.2 billion US Dollar (Mathur, 2019). This exciting and growing field has also been identified by Möller *et al.* (2019), who analyzed logistics startups and their business models and derived archetypes.

Generally, it can be noted that the logistics industry already worked in the direction of collaborative models supported through technology. However, these services or digital platforms primarily served the purpose of optimizing the overarching supply or value chain. In reference to the need to digitalize the logistics industry and create footprints in the area of new digital business models, it becomes necessary to offer platforms that support business processes through a technical integration of the individual parties of a logistics ecosystem. Ecosystems within logistics are already there for a while since it is necessarily needed to collaborate successfully with multiple parties to achieve the common goal of the final product. However, these types of ecosystems are contractually created and evolved accordingly and will be vanished once the contractual agreement terminates. The concept of open ecosystems where partners can liberally join or leave is not given within the logistics industry. This implies that each newly agreed contract restarts a process of having a business process and technical alignment that are time-consuming and costly. Standards in different industries already help mitigating the time-consuming process of aligning on standard procedures, but the technical integration still represents a hurdle.

In practice, these activities can be primarily seen in the area of supply chain visibility where according to a Gartner study, in the next three years, more than 75% of the top globally interacting companies will be part or creator of supply chain business networks (De Muynck *et al.*, 2019). It can be noted that transparency is one of the key endeavors within the logistics industry. Customers heavily push toward real-time tracking information, proactive event exchange, ad hoc planning, predictive supply chain planning, etc. However, currently no one within the logistics industry is willing to share data across partners and competitors openly. This causes harm and efficiency loss on every side. In that context, "[…] [m]any firms recognize the supply chain efficiencies and competitive advantage to be gained by implementing interfirm collaborative forecasting […]" (McCarthy *et al.*, 2002, p. 449). Apart from the pure willingness, there is mistrust toward other players in the market, which hinders an open exchange (Opriel *et al.*, 2021). This can be seen in isolated activities of logistics partners. The only open exchange that can be seen is with other customers in order to shape new products, but nevertheless the logistics industry is perceived as not as open as other industries.

Having a look at academia, the term 'supply chain platform'[1] can be noted, initially defined by Gawer (2010) to describe platforms that are close to internal platforms for creating value for a final product or according to the platform leader. Since supply chains become more open, it is questionable if this is still the case or if supply

[1] "[…] A supply chain platform is a set of subsystems and interfaces that form a common structure from which a stream of derivative products can be efficiently developed and produced by partners along a supply chain […]" (Gawer, 2010, p. 10).

chain platforms are closely related to multi-sided platforms for catering to multiple needs of multiple participants. In the area of supply chain management research, Lin *et al*. (2015) propose a logistics service platform's approach. Right there, the focus lies on supply-chain-induced services being offered to customers. The platform is not meant to be opened for other participants along the supply chain or even outside of it for co-creating new services. It is more about optimizing the supply chain through new services but not on the expansion of given digital business models or even a co-creation of new digital business models. This is, therefore, a gap that can also be noted in academia.

Hence, this dissertation intends to help practitioners in the field of logistics to provide them a framework for better understanding and grasping digital business models in logistics, particularly in the context of logistics platforms as an important field for the near future. A logistics platform morphology helps cluster the different criteria and characteristics that come with complex platform business models in logistics. This morphology also helps to evaluate already existing platforms, which might lead to optimized platforms after applying this framework. The derived design principles also give general guidance while digital logistics managers create a logistics platform. Further, it might help bring other relevant stakeholders the concept of logistics platforms a little bit closer. Also, these two artifacts close gaps in academia, both in ecosystem and supply chain management research. On the one hand side, the insights close gaps identified in the ecosystem and platform research. On the other hand side, this study supports a closer linkage of the two research disciplines.

This thesis builds a model that introduces the concept of a logistics ecosystem and its design as a digital ecosystem. The difference to other studies lies in the conceptualization of a digital ecosystem in a logistics context by shaping the incentive-creating process that is typically handled in the two-sided platform research. Since technology is an enabler but not the core issue of collaboration within supply networks (Sabath *et al*., 2002), this thesis tackles a holistic approach. It is not only the intention to create a two-sided platform in order to generate money, but more an open technique to solve common issues and create new business models.

1.2 Research question, research results, and target audience

The focused logistics industry is still in its infancy of digitalization, although more endeavors and efforts can be noted to change this status quo. Not only in practice this lack or gap can be observed but also in theory. Notably, while viewing through the lens of information systems research (ISR), the combination of supply chain management (SCM) and ecosystems research reveals shortcomings in bridging gaps in both fields.

In the ecosystem research, platforms start with internal platforms until supply chain platforms are established (Gawer, 2010). In SCM research, however, inter-firm collaboration is the core focus of reviews. Right here, the focus is not only on the internal integration of departments, but it is about external integrations into entities along the supply chain (Fawcett *et al.*, 2002; Richey *et al.*, 2010; Adams *et al.*, 2014). This can be seen as the actual value driver for SCM since it takes care of all the different entities along the supply chain (Mentzer *et al.*, 2001). Albeit the close topic relation, no interconnection can be noted until that point. So here, we can already see a close link between both research disciplines and apparently a gap. Also, in practice, this gap can be perceived as actively permeated in this complex topic of logistics platforms. According to Bitran *et al.* (2006, 2007), they see the third-party logistics provider (3PL) in the leading position to orchestrate such platforms, but in real-life, no proper logistics platform can be noted until now.

Hence, this study pursues to close the identified gaps and gives practical advice on how to compose logistics platforms. Given these identified practical-induced research gaps and the need to practical advice, the following navigating research question (RQ) has been defined:

> *RQ1*: What are the characteristics of a logistics platform?

This RQ's underlying question is analyzing the practical need for the focal topic as well as its specifics or characteristics. Furthermore, it structures the theoretical foundation of logistics ecosystems and their platforms, which ultimately results in a minor artifact in the form of a systematic literature review (SLR) that also deals as a foundation for the two key IT artifacts. This SLR also considers the special characteristics of logistics platforms. Consequently, RQ2 and RQ3 represent the key RQs for this dissertation:

> *RQ2*: How has a logistics platform to be composed?
>
> > *RQ2 in detail*: What are the prerequisites for a logistics platform? How does the architectural and general composition of a logistics platform look like? What are the driving factors to its success?

RQ3: What are the design principles for a logistics platform?

RQ3 in detail: What are the design principles and the underlying assumptions for the design of a logistics platform?

The named RQs are addressed and answered as part of the design science research (DSR) (Hevner *et al.*, 2004). The DSR method intends to create so-called IT artifacts that resolve practical problems and contribute to the scientific knowledge base. In reference to RQ2 and RQ3, two IT artifacts have been created:

1. *Logistics platform morphology*, i.e., clustering the different design elements and related criteria through a morphological box.
2. *Logistics platform design principles*, i.e., verbal articulation of principles to design logistics platforms.

Notably, for the problem statement mentioned above and the derived IT artifacts, this research method fits since it contributes to both aspects. Therefore, the focal dissertation is addressed to academics and practitioners out of the following fields:

- *Academics* out of the ISR, SCM, or ecosystems research fields being interested in reviewing the creation, setup, and maintenance of ecosystems and their underlying platforms in the logistics industry. Methodologically, this dissertation applies the DSR and action design research (ADR) in a case study research, which also bears a certain level of interest.
- *Consultants* can use the morphology and design principles to consult in the creation and maintenance of logistics platforms. The artifacts help properly understand the concept of designing logistics platforms and applying them in multiple environments related to the logistics industry.
- *Logistics managers* can bridge the gap between the old and new economy and create new (digital) business models. They can digest the structure and concept of logistics platforms and use the derived design elements to sharpen their business models.
- *Project managers for digitalization* can use the morphology and design principles to transform their company by creating and implementing new (digital) business models. Also, the results help to evaluate the composition of related existing systems.
- *Software vendors* can use the morphology and design principles to benchmark their solutions compared to the recommendation in the creation and

maintenance of logistics platforms. Also, the artifacts allow to create new software modules as a contributing complementor of logistics platforms.

Generally, this dissertation provides an overview of different ecosystem types, delivers a structured morphology, and suiting design principles for logistics platforms. Accordingly, it represents a driver for the digital transformation of the logistics industry, new digital business model creation and closes a gap that lies between multiple research disciplines. Hence, its impact is evenly given in research as well as in practice.

1.3 Research discipline and field of study

This dissertation's primary focus lies on the research discipline of ISR. Originally, the information systems (IS) community focused on solely technical aspects of how a system can work effectively (Keen, 1980). However, this perception has been expanded and evolved by also including political, organizational, or social aspects in the overall research (Backhouse *et al.*, 1991). An attempt to have ISR better defined took place in 2009 in a panel discussion across multiple IS academics, which have been summarized by Nunamaker and Briggs (2011, pp. 20:1-20:2) as the following:

- "[...] While we honor our heritage in business accounting systems, we must expand our vision to embrace information needs and uses in all kinds of people and teams. Bioinformatics, medical informatics, government policy, humanitarian relief, border security, and national defense, to name but a few, are and should be recognized as central problem domains for IS inquiry. Wherever knowledge workers require information, IS researchers should be there, solving problems and creating new knowledge.
- While we continue to track the emergence and use of new technologies, we must expand our vision to inventing new systems that address information needs not covered by current systems. We must not only be observers and historians of technology, we must make technological contributions.
- While we have made great progress with a single-investigator, social-science-driven model of research, organizations now face challenges so complex that they cannot be understood from a single perspective. A solo researcher, even working with one or two others, could not resolve them in a career. We must, therefore embrace multi-investigator, multidisciplinary, even multiuniversity research teams.

- While IS students acquire a broad range of technical skills, we must develop a broader, more compelling model of the IS student and present it clearly, both to our potential students and to those who hire our students. […]”

Consequently, ISR positions itself nowadays between the world of business administration and management studies as well as computer science. The same applies to this dissertation, which tackles the field between these research fields. More in detail, it relates to the applied science field, which aims to develop academic recommendations for business practice (Ulrich, 1982).

1.4 Research methodology

Since this dissertation belongs to the ISR, the design science research (DSR) approach has been chosen as its attempts to create artifacts that “[…] solve organizational problems [and that are] represented in a structured form that may vary from software, formal logic, and rigorous mathematics to informal natural language descriptions […]” (Hevner *et al.*, 2004, p. 77). IT artifacts in that context “[…] are broadly defined as constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices), and instantiations (implemented and prototype systems) […]” (Hevner *et al.*, 2004, p. 77). Hence, one of the key goals is that “[…] [d]esign research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation […]” (Hevner *et al.*, 2004, p. 83). Accordingly, there are different levels of artifacts with regards to their contribution: (1) a situated and specific implementation, (2) a nascent design theory that derives knowledge for operational or architectural principles, and (3) a design theory about an abstract phenomenon (Gregor *et al.*, 2013). DSR further fits this dissertation’s goal since it targets relevance for practice and theoretical rigor in parallel (Gregor *et al.*, 2013). Moreover, DSR tackles the appropriate, practical usage and creation of knowledge that is not only scientific rigor but also solves a general class of problems (Walls *et al.*, 1992; Hevner *et al.*, 2004; Peffers *et al.*, 2007; Gregor *et al.*, 2013). Derived out of comparable DSR studies, Gregor and Hevner (2013) created the following DSR guidelines:

Section	Contents
(1) Introduction	Problem definition, problem significance/motivation, introduction to key concepts, research questions/objectives, scope of study, overview of methods and findings, theoretical and practical significance, structure of remainder of paper. For DSR, the contents are similar, but the problem definition and research objectives should specify the goals that are required of the artifact to be developed.
(2) Literature review	Prior work that is relevant to the study, including theories, empirical research studies, and findings/reports from practice. For DSR work, the prior literature surveyed should include any prior design theory/knowledge relating to the class of problems to be addressed, including artifacts that have already been developed to solve similar problems.
(3) Method	The research approach that was employed. For DSR work, the specific DSR approach adopted should be explained with reference to existing authorities.
(4) Artifact description	A concise description of the artifact at the appropriate level of abstraction to make a new contribution to the knowledge base. This section(s) should occupy a major part of the dissertation. The format is likely to be variable but should include at least the description of the designed artifact and, perhaps, the design search process.
(5) Evaluation	Evidence that the artifact is useful. The artifact is evaluated to demonstrate its worth with evidence addressing criteria such as validity, utility, quality, and efficacy.
(6) Discussion	Interpretation of the results: what the results mean and how they relate back to the objectives stated in the introduction section. Can include summary of what was learned, comparison with prior work, limitations, theoretical significance, practical significance, and areas requiring further work. Research contributions are highlighted and the broad implications of the dissertation's results to research and practice are discussed.
(7) Conclusions	Concluding paragraphs that restate the important findings of the work. Restates the main ideas in the contribution and why they are important.

Table 1-1: DSR guidelines
Source: Adapted from Gregor and Hevner (2013, p. 350).

More specifically, this dissertation followed the case study research (Yin, 1994) and ADR (Sein *et al.*, 2011) to support the DSR approach.

The case study research is an empirical approach considering a phenomenon in a natural context (Yin, 1994). Thereby it considers multiple data and information resources, such as semi-structured expert interviews, company information, and public data to depict the phenomenon's context and describes the focal case (Creswell, 2018). It does not only consider the as-is description of the focal issue but also tackles the proper understanding and prediction of comparable phenomena (Woodside, 2010). Eisenhardt (1989) defines the process as following:

Step	Activity	Reason
(1) Getting started	Definition of research question	Focuses efforts.
	Possibly *a priori* constructs.	Provides better grounding of construct measures.
	Neither theory nor hypotheses.	Retains theoretical flexibility.
(2) Selecting cases	Specified population.	Constrains extraneous variation and sharpens external validity.
	Theoretical, not random, sampling.	Focuses efforts on theoretically useful cases, i.e., those that replicate or extend theory by filling conceptual categories.
(3) Crafting instruments and protocols	Multiple data collection methods.	Strengthens grounding of theory by triangulation of evidence.
	Qualitative and quantitative data combined.	Synergistic view of evidence.
	Multiple investigators.	Fosters divergent perspective and strengthens grounding.
(4) Entering the field	Overlap data collection and analysis, including field notes.	Speeds analyses and reveals helpful adjustments to data collection.
	Flexible and opportunistic data collection methods.	Allows investigators to take advantage of emergent themes and unique case features.
(5) Analyzing data	Within-case analysis.	Gains familiarity with data and preliminary theory generation.
	Cross-case pattern search using divergent techniques.	Forces investigators to look beyond initial impressions and see evidence through multiple lenses.
(6) Shaping hypotheses	Iterative tabulation of evidence for each construct.	Sharpens construct definition, validity, and measurability.
	Replication, not sampling, logic across cases.	Confirms, extends and sharpens theory.
	Search evidence for “why” behind relationships.	Builds internal validity.
(7) Enfolding literature	Comparison with conflicting literature.	Builds internal validity, raises theoretical level, and sharpens construct definitions.
	Comparison with similar literature.	Sharpens generalizability, improvise construct definition, and raises theoretical level.
(8) Reaching closure	Theoretical saturation when possible.	Ends process when marginal improvement becomes small.

Table 1-2: Process of building theory from case study research
Source: Adapted from Eisenhardt (1989, p. 533).

ADR, however, is a combination of design science and action research (Cole *et al.*, 2005; Sein *et al.*, 2011). As a prerequisite, it expects the existence of a practical problem, the necessity to develop a solution, and the steering of the problem resolution through practical intervention (Sein *et al.*, 2011). DSR only talks about two phases ‘build’ and ‘evaluate’ (March *et al.*, 1995); however, ADR consists of three phases (i.e., ‘building’, ‘intervention’, and ‘evaluation’) being repeated iteratively and, therefore, resulting in the so called BIE-cycle (Sein *et al.*, 2011). This cycle ensures an iterative and critical reflection of the focal artifact for creating a practical and theoretical relevant outcome (Cole *et al.*, 2005; Petersson *et al.*, 2016).

In the focal dissertation, two IT artifacts are being created:

- Logistics platform morphology,
- Logistics platform design principles.

The logistics platform morphology reuses the multi-case study’s outcome (Eisenhardt, 1989; Yin, 1994), consisting of five cases. Two cases use the ADR paradigm (Sein *et al.*, 2011)’ and three cases support the DSR approach (Hevner *et al.*, 2004). This method suits the defined research goal to develop an artificially constructed IT artifact in the form of a morphology (March *et al.*, 1995; Simon, 1996). Generally, a morphology embodies a conceptual or mental object and allows one to grasp the complexity of logistics platforms’ creation (Ritchey, 2006). The method ensures rigor cycles through the underlying theoretical foundation and practitioners’ input (Hevner, 2007). Here, meta requirements have been used for addressing a class of problems for crafting solid IT artifacts (Walls *et al.*, 1992). These meta requirements follow the idea articulated by Möller *et al.* (2020, p. 7) that are “[...] the derivation from theory, literature, interviews, or similar suitable data sources [...]”. Then, they are mapped to the respective design elements of the morphology. This approach matches Walls *et al.*’s (1992) idea of a meta design. Also, the practice-induced case studies and ADR projects ensured design cycles through multiple feedback loops.

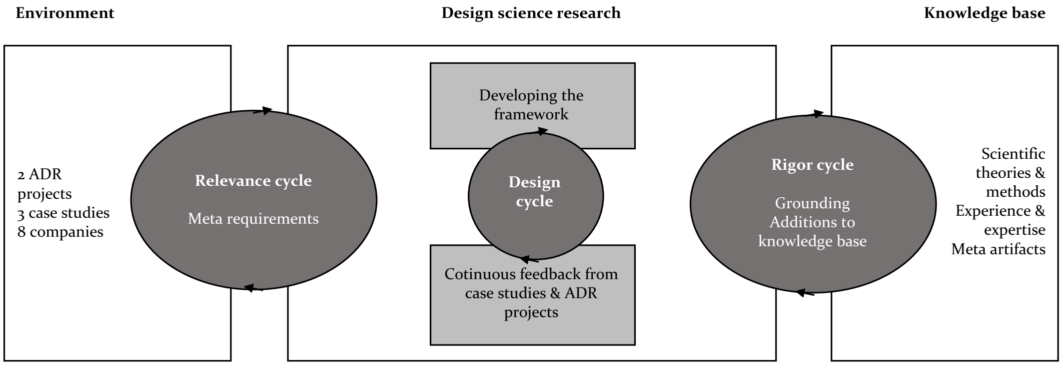

Figure 1: DSR cycles for the logistics platform morphology
Source: Own illustration following Hevner (2007, p. 88) and Lamberjohann and Otto (2022).

The second artifact represents logistics platform design principles (DPs). The focal dissertation focuses on designing an artifact in the form of DPs that find usage in an academic and practical environment. Therefore, it generates design knowledge on its journey about the artifact representing its constitution and its way of coming into existence (Cross, 2001; Gregor *et al.*, 2020). DPs, in general, are meant to codify design knowledge, to derive specific behaviors and effects of the analyzed artifact, and to make the design artifact reusable (Kruse *et al.*, 2016; Lukyanenko *et al.*, 2020). In detail, and thereby following Möller *et al.* (2020), DPs are classified dichotomously along supportive and reflective characteristics. Supportive DPs assist the designer *ex ante*, whereby the reflective DPs arise during or *ex post* the artifact design. They have been interlinked with the initial solution objectives to design logistics platforms properly. In the focal case, the solution objective represents *RQ3* (i.e., "How has a logistics platform to be composed?"). Furthermore, the identification and derivation of the DPs are embedded into the overarching DSR method and the underlying two ADR projects and three case studies. Accordingly, the meta requirements, also used for the logistics platform morphology, have been derived from multiple sources, such as literature reviews, kernel theories, interviews, or workshops, in an either inductive or deductive way. The determined DPs have then been formulated in a freely linguistic way and also been iteratively evaluated through expert interviews and an analytical evaluation. The formulation of the DPs included "[…] specific, prescriptive instruction for an artifact design (content) that addresses meta-requirements […]" (Möller *et al.*, 2020, p. 8). Also, the recommended light evaluation criteria postulated by Iivari *et al.* (2018) have been followed. Figure 2 exhibits the complete method for the DP development.

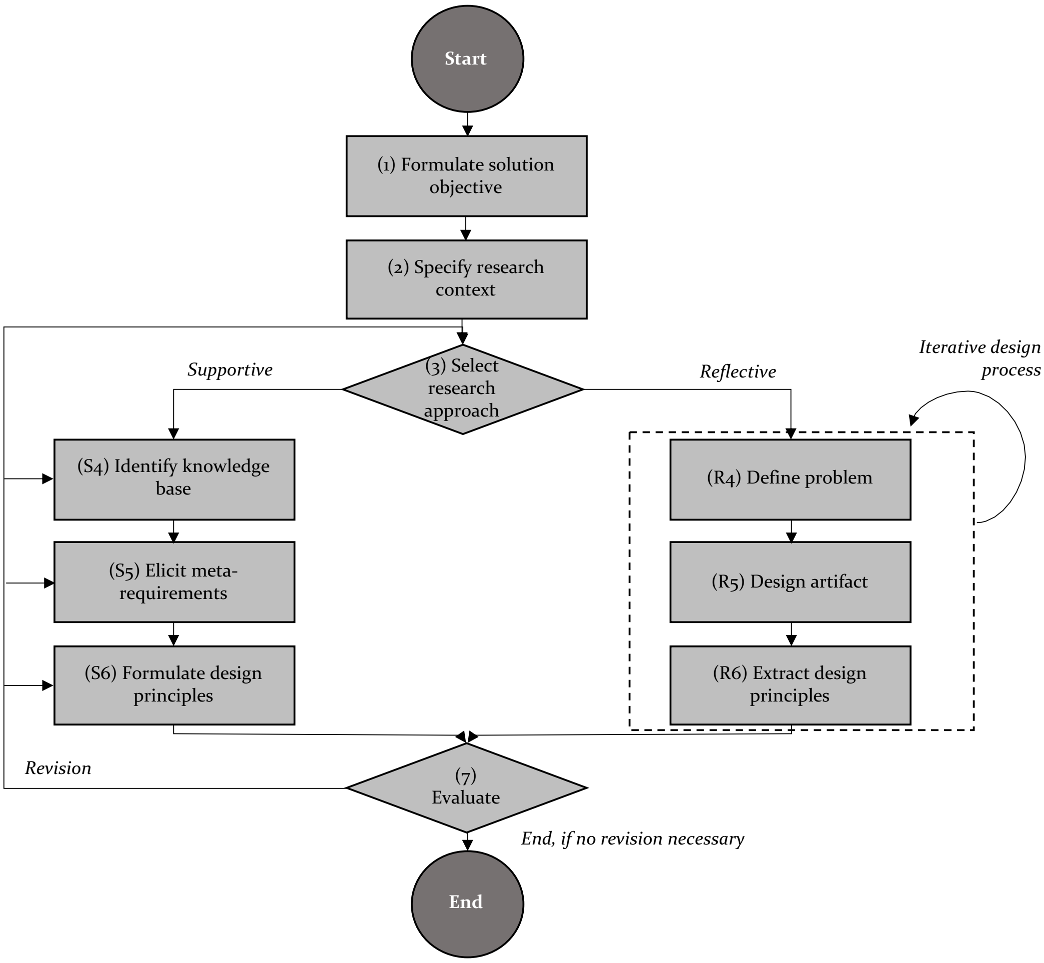

Figure 2: Method for design principle development
Source: Own illustration following Möller *et al.* (2020, p. 6).

This dissertation follows the DSR method for ensuring a comprehensive, rigorous, and relevant research process. For gathering the appropriate information, three case studies and two ADR projects have been conducted. The following visualization depicts the dissertation's overarching DSR approach inspired by Österle and Otto (2010, p. 287) and Peffers *et al.* (2006, p. 93).

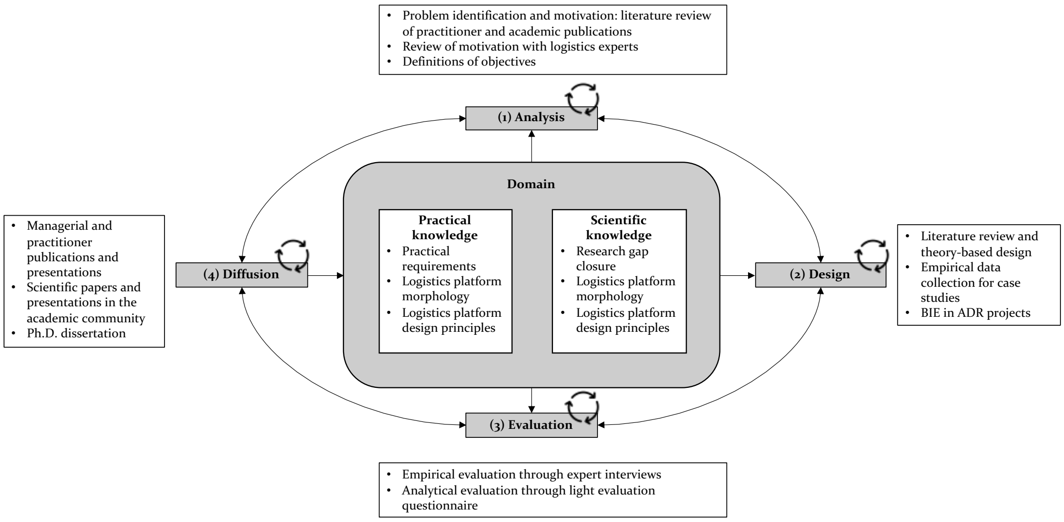

Figure 3: Overarching DSR process of this dissertation.

1.5 Structure of the dissertation

The dissertation is structured along seven chapters in total.

This chapter motivates the research topic, formulates the research questions, names the research discipline, introduces the methodology, and shows the dissertation's general relevance and impact.

In the second chapter, the overarching conceptual foundation and definitions are introduced to give the reader a general understanding of the used terms and the general embeddedness into the focal research disciplines.

The third chapter discusses the identified state of the art and related research. This research helps to create a general understanding and already designs a first structure of the to-be-built IT artifacts.

Chapter four introduces the primary empirical data in the form of two ADR projects and three case studies. This information and data represent the critical data for the whole dissertation.

In chapter five, the previous chapter's results are interpreted, which, ultimately, leads to the research results. The research findings define the two IT artifacts: a logistics platform morphology and logistics platform design principles.

Chapter six is used to evaluate the derived artifacts and show their significance. Also, they are further critically discussed.

Lastly, chapter seven summarizes the dissertation's findings, shows its limitations, and leads into an avenue of future research.

Below-shown figure structures and summarizes the overarching dissertation:

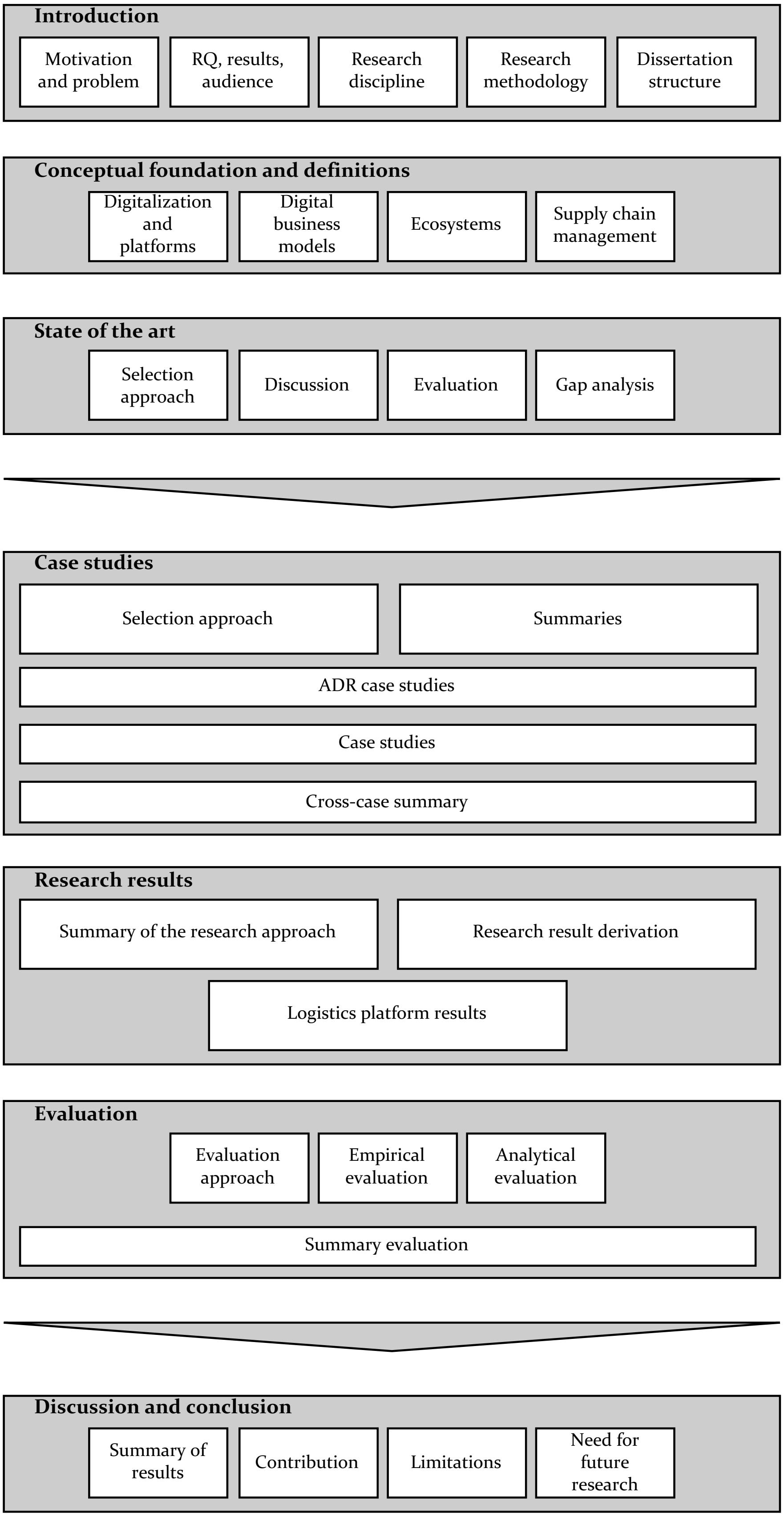

Figure 4: Structure of the dissertation.