Fachbereich Wirtschaftswissenschaft

Patterns of Service Innovation: An Empirical Study of Automotive Engineering Services in Germany

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ABSTRACT

Over the past few decades, scholars have discovered that service innovation transcends the confines of individual organizations and involves interactions and collaborative activities among a network of actors. However, most of the current innovation studies are based on a conceptual view of firm-centric and linear processes of research and development (R&D) that works well in production-oriented economies but may not be as appropriate when it comes to explaining innovation in service-oriented and networked economies, as they become more prevalent in the digital age. As a result, our current understanding of service innovation processes in multi-actor constellations is limited and requires further attention. This thesis contributes a qualitative study, from the automotive engineering service (AES) industry, to the growing body of scholarly work that studies how service innovation emerges from interactions and collaborative activities that take place among a network of actors. In doing so, this thesis employs a qualitative research design that is informed by four different sources of empirical data: preliminary and in-depth interviews, as well as archival data and field observations. The theoretical viewpoint taken in this thesis is informed by the service-dominant (S-D) logic, which entails a broader and systemic view of service innovation. This view emphasizes the centrality of interactions and considers innovation as a process of reconfiguring the institutionalized rules of resource integration in service ecosystems. Based on this perspective, the key finding is an empirically developed process typology that distinguishes five patterns of service innovation in the AES industry. Pre-existing patterns and concepts within the literature are extended and connected through more detailed descriptions of interactions, roles, and activities. Such an in-depth understanding of different service innovation pathways complements and substantiates recent theoretical debates on the connection between service innovation, institutions, and interactions in service ecosystems. Practitioners from the AES industry benefit from this new knowledge because it helps them to understand how their organization needs to interact and operate with other actors from their network to trigger and pursue specific innovation pathways.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

A2A	Actor-to-Actor
ADAS	Advanced Driver Assistance Systems
AES	Automotive Engineering Service
API	Application Programming Interface
B2B	Business-to-Business
B2C	Business-to-Consumer
CATIA	Computer Aided Three-Dimensional Interactive Application
CoC	Center of Competence
CRM	Customer Relationship Management
E&E	Electric and Electronic
ESP	Engineering Service Provider[1]
FP	Foundational Premise
G-D	Goods-Dominant
GDP	Gross Domestic Product
ICT	Information and Communications Technology
IS	Information Systems
IT	Information Technology
KIBS	Knowledge-Intensive Business Services
NIH	Not-Invented-Here
OEM	Original Equipment Manufacturer
PSF	Professional Service Firm
R&D	Research and Development
RO	Research Objective
RQ	Research Question
S-D	Service-Dominant
SME	Small and Medium-sized Enterprises
SOP	Start-Of-Production
SPM	Service Portfolio Management
UK	United Kingdom
US	United States

[1] German translation: Ingenieursdienstleister

VDA	The German Association of the Automotive Industry[2]
VDI	The Association of German Engineers[3]

[2] German translation: Verband der Automobilindustrie

[3] German translation: Verein Deutscher Ingenieure

1 INTRODUCTION

1.1 Motivation

The increasing prevalence of service across economic sectors has been accompanied by a growing interest in the study of service innovation (Lusch et al. 2010; Lusch and Vargo 2006a), which has recently been stressed as both *"timely and important"* (Barrett et al. 2015, p. 135). The practical and academic interest in service innovation is primarily driven by the fact that organizations are becoming ever more reliant on their capacity to continually develop new and more compelling value propositions in a business environment that is rapidly changing and increasingly interconnected (Lusch and Vargo 2006a). In this regard, a growing number of organizations recognize service as a primary driver of economic prosperity and growth. At the same time, organizations are frequently operating and competing in complex service networks (Vargo and Lusch 2011). By forming networks, organizations can focus on their core competencies and increase their agility in dealing with changes in their business environment (Agarwal and Selen 2007; Prahalad and Hamel 2006), but they also make themselves more reliant on each other's resources and knowledge (Barile et al. 2016). Contemporary thinking suggests that in such a setting, service innovation can no longer evolve from within the organization, but instead requires collaboration and engagement among multiple actors of a service network, including customers and suppliers (Lusch and Nambisan 2015). However, our current understanding of how service innovation occurs in multi-actor constellations is limited and requires further attention (Vargo et al. 2015).

The growing recognition of service innovation in networks stands in sharp contrast to the firm-centric focus of the innovation literature that considers innovations as the outcome of systematic processes of research and development (R&D) that end with market diffusion (Godin 2006, p. 639). Furthermore, the literature on service innovation is highly fragmented, and a common understanding as to what service innovation is and how it should be studied has not yet emerged (Carlborg et al. 2014; Coombs and Miles 2000). Complexity in service innovation arises especially from the fact that the innovation behavior of firms varies between industries and economies (e.g., Metcalfe and Miles, 2000; Pavitt et al., 1989). The proliferation of information and communication technology (ICT) increases the importance of networks and (intangible) service offerings across economic sectors (e.g., Barrett et al. 2015; Lusch and Nambisan 2015). Not only is ICT enabling innovation activities in networks, in that it facilitates the flow of information, eases knowledge sharing and collaboration between different actors, but ICT also becomes an essential constituent of new value propositions (Glazer 1991;

Nambisan 2013). Together, these trends fuel both the academic and practical interest in service innovation.

The existing literature adresses service innovation from three different perspectives. These are *assimilation*, *demarcation*, and *synthesis* (Coombs and Miles 2000; Witell et al. 2015). Currently, studies using the *assimilation* perspective are most common (Carlborg et al. 2014). Scholars adopting this perspective assume that innovation in services is similar to innovation in products and that, accordingly, traditional production-oriented concepts and theories can also be adopted in service innovation (Coombs and Miles 2000). However, the production-oriented nature of existing concepts has led to a narrow firm-centric focus of the literature that separates firms as innovators and customers as innovation-adopters (Lusch and Nambisan 2015; Kindström et al. 2013). By contrast, the *demarcation* perspective assumes that innovation in services is in many respects different from innovation in products (e.g., Evangelista 2000; Miozzo and Soete 2001). Such research highlights the peculiarities of service innovation, such as the intangible nature of service and the need for customer integration (Hipp and Grupp 2005). However, the ongoing trend in which firms develop innovative product-service systems that comprise a mixture of tangible and intangible components (Baines et al. 2007, 2010) makes it increasingly difficult to differentiate between innovation in service and innovation in product. This issue has motivated the third stream of research that applies a *synthesis* perspective. This stream of the literature argues that new theories and concepts are required that are equally applicable in the analysis and discussion of innovation in service and manufacturing and dissolve the traditional divide (Coombs and Miles, 2000).

More recently, the interest in a synthesis perspective on innovation has been further elevated by the growing popularity of the service-dominant logic (S-D logic) (Vargo and Lusch 2004, 2008). S-D logic describes an alternative world-view, in which service – *"the application of competencies (knowledge and skills) of one entity for the benefit of another or the entity itself"* (Vargo and Lusch 2004, p. 2) – is the fundamental basis of economic exchange and the central logic needed to explain value creation. From this view, all economic and social actors (e.g., organizations, departments, and employees) are resource integrators that are connected with other actors through value co-creation and service exchange and, thus, form wider actor-to-actor (A2A) structures (Vargo and Lusch 2011, 2016). The S-D logic emphasizes that service innovation processes specifically rely on an integration of operant resources (e.g., knowledge and skills) that, in contrast to operand resources (e.g., material), act upon other resources and transform them (Vargo and Lusch 2004, 2008). Hence, innovation processes generate new resources, such as solution knowledge or skills, which are used for the provision of new offerings (Arthur 2009).

The conceptual notion of service exchange and value co-creation in A2A networks has become the foundation of a systemic view of innovation in service ecosystems (Lusch and Nambisan 2015). Vargo and Lusch (2014, p. 161) define service ecosystems as *"relatively self-contained, self-adjusting systems of resource integrating actors connected by shared institutional logics and mutual value creation through service exchange."* An institutional view of innovation, that aims for a more realistic and applicable understanding of innovation in service ecosystems, has recently shifted into the focus of academic discussions. The connection between institutionalization and service innovation is thereby twofold: First, the service ecosystem perspective emphasizes innovation as a collaborative process that involves interactions among a network of actors whose resource integration practices are enabled, guided and constrained by *institutions* and their interdependent assemblages (institutional arrangements) (Vargo et al. 2015; Vargo and Lusch 2016). Scholars argue that, for service innovation to occur, some of the existing institutions (i.e., rules, practices, and norms) have to be disrupted and renewed (Vargo et al. 2015). Second, institutions determine how actors interact with one another and how resources are integrated, which makes them crucial to the understanding of the complex and interconnected processes through which service innovations emerge in real world-contexts. However, so far, the discussion on a synthesis view of innovation in service ecosystems remains mainly on a conceptual level, and scholars call for research that substantiates and complements existing conceptualization with empirical findings (Lusch and Nambisan 2015; Ostrom et al. 2015; Vargo et al. 2015). In particular, there is a need for industry-specific research that observes the emergence of innovations in real-world service ecosystems and shows how different actors participate in innovation processes.

Service innovation processes are by no means homogeneous, and significant differences exist in the innovation behavior among industries or firms (Evangelista 2006). One specific stream of the innovation literature focuses on knowledge-intensive business services (KIBS). KIBS involve complex problem solving, invoke a value creation process that is characterized by intense interaction between customer and provider, and rely upon professional knowledge in service provision (Muller and Doloreux 2007). The innovativeness of KIBS firms has been widely acknowledged in the literature (e.g., Larsen 2000; Muller and Doloreux 2007). For instance, den Hertog (2000) highlights the vital role of KIBS in regional innovation systems as facilitators, carriers, and sources of innovation. Larsen (2000) even asserts that KIBS firms are more innovation-oriented when compared to firms from many other service industries. Nevertheless, KIBS industries have seldom been the focus of empirical examinations from the viewpoint of service innovation, especially not those using a synthesis perspective (such as the S-D logic). Furthermore Muller and Doloreux (2007, p. 68) note that most studies were mainly concerned with *"the changes that KIBS provoke, and not with the fact that the services* *provided by KIBS, or the KIBS themselves, may evolve or change."* More research is thus required to understand the processes that lead to the innovation of KIBS themselves.

One of the most significant KIBS domains in Germany is the automotive engineering service (AES) industry. Engineering services are provided in the form of engineering projects by highly-specialized professional service firms, so-called engineering service providers (ESPs). Their primary customers are large German original equipment manufacturers (OEMs) of automobiles, such as BMW, VW or Daimler. ESPs have shown steady growth in recent decades and became a cornerstone of the global competitiveness and success of the OEMs and the German automobile industry (cf. Blöcker 2016; Kleinhans et al. 2015).

In recent years, the emergence of networks has been particularly noticeable in the AES industry. Formerly dominated by pyramid-like supplier-hierarchies, service provision and interactions between ESPs and other actors are now increasingly taking place in more complex networked constellations and are based on varying modes of collaboration (Schneider 2011, pp. 44–46). For the ESPs, this shift entails an elevation of their role towards more responsibility and autonomy during service provision (Blöcker 2016). This development is, however, accompanied by growing competition and cost-pressure among the incumbent ESPs (cf. Blöcker 2016; Kleinhans et al. 2015). There is a growing need for ESPs to engage more actively in service innovation, which requires interactions and collaborative efforts with other actors from their network. The current innovation literature provides little orientation for ESPs with respect to how innovation processes should take place in networked constellations and which interactions and activities they involve, which underscores the practical relevance of innovation research in this industry. Typologies that describe specific types of innovation processes in networks can help both researchers and practitioners to understand how the activities of different actors are interdependent. Especially for the management of ESPs, understanding these network interdependencies is essential in order to participate in, and benefit from, innovation processes (e.g., related to new technologies) that will transform their business environment and are typically not completely under their own control.

1.2 Problem Statement and Research Objectives

A service ecosystem perspective marks a significant step towards a broader and more realistic understanding of service innovation processes in networked actor constellations (Vargo et al. 2015; Lusch and Nambisan 2015). As yet, most literature on service ecosystems is purely conceptual work, and there is a paucity of empirical studies that employ S-D logic to study innovation in service ecosystems based on real-world settings. Such research is especially important since it will yield empirical insights into the usefulness and applicability of the service ecosystem perspective and thus further contribute to the evolution of S-D logic and its broadened view of service innovation (cf. Ostrom et al. 2015). The AES industry further provides a fruitful empirical research domain for several reasons. Firstly, the interactions and exchange relations between ESPs with other actors are highly complex and seem mostly incompatible with classic firm-centric linear models of innovation. Furthermore, the literature on how ESPs innovate in networked constellations is scarce. The service ecosystem perspective is considered useful in the development of a network-centric and empirically grounded understanding of service innovation that is currently lacking.

This thesis addresses the outlined research gaps by employing the S-D logic and the service ecosystem perspective in the study of service innovation processes in the empirical domain of the AES industry in Germany. Accordingly, the overarching research objective (RO) of this study can be defined as follows:

RO: To apply S-D logic thinking in the investigation of service innovation processes in the networked and collaborative business environment of the German AES industry.

Three more specific research questions were derived from this objective that will be addressed in this thesis. The first research question reflects the need to make service innovation processes in the AES industry more explicit and comprehensible. In this regard, typologies are an effective means of reducing the complexity of a research phenomenon by conceptualizing different types (Bailey 1994, pp. 5–8). Previous studies have especially encouraged the development of industry-specific typologies that use qualitative data to conceptualize different types (i.e., categories) of service innovation processes (e.g., Hipp and Grupp 2005; Carlborg et al. 2014). In the development of such a typology, this thesis addresses the following question:

RQ1: How can service innovation processes in the German AES industry be categorized?

A second question derives from the network-centric understanding of service innovation. The S-D logic emphasizes that service innovation processes require interactions among a network of actors (e.g., Vargo et al. 2015), but it provides limited insights on what types of interactions lead to service innovation. Fundamental to this view is that actors are connected through service exchange and resource integration and can thus only co-evolve in relation to one another (Barile et al. 2016; Vargo and Lusch 2011). Several studies thus emphasize the importance of gaining a better understanding of the collaborative activities and interactions among A2A networks in service ecosystems that trigger and drive service innovation (Carlborg et al. 2014; Ostrom et al. 2015). This motivates the second research question:

RQ2: How do ESPs interact with other actors from their network in the course of service innovation processes?

The service ecosystem perspective emphasizes service innovation as a process that is closely interlinked with the disruption and renewal of institutional rules, e.g., about how actors integrate resources (Vargo et al. 2015). On the one hand, contemporary thinking suggests that changes in institutions (e.g., regulatory changes) can trigger service innovation in that they enable novel ways of co-creating value (cf. den Hertog 2000). On the other hand, actors can drive service innovation processes by disrupting and renewing institutional rules (Koskela-Huotari et al., 2016; Vargo et al., 2015). So far, few studies have examined this two-sided connection in detail and, for this reason, it is not fully understood how different actors engage in institutional work and participate in the reconfiguration of service ecosystems (Wieland, Koskela-Huotari, et al. 2016). Correspondingly, the third research question seeks to investigate in what aspects ESPs influence the service ecosystems' institutional logic:

RQ3: How are service innovation processes interlinked with changes in institutions and institutional arrangements?

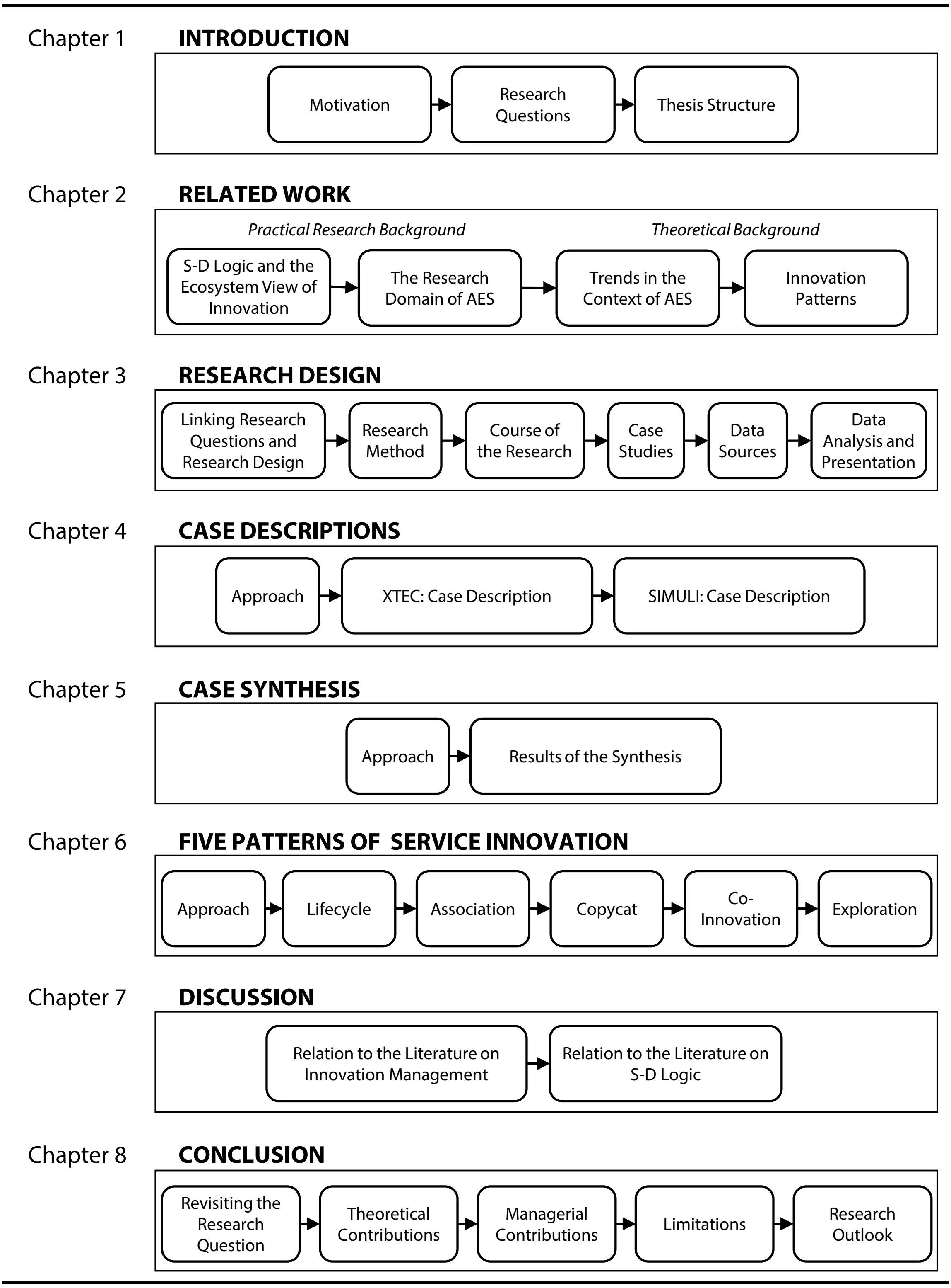
This thesis addresses the outlined research objective and research questions by employing a research design that combines qualitative-empirical techniques with an abductive case study methodology. This research design enables an in-depth investigation of service innovation processes and an exploration of service innovation patterns. The research design is informed by four different sources of empirical data. The primary source of data is in-depth interviews. As suggested in the S-D logic literature (Chandler and Vargo 2011; Wieland, Vargo, et al. 2016), the collection, and ensuing analysis, of the empirical data concentrates on ESPs as focal actors (i.e., micro level). Additionally, their interactions with other actors in service networks and service ecosystems are investigated and aggregated to a meso and macro systemic view of their business environment (Barile et al. 2016; Vargo and Lusch 2011). In order to allow for a detailed analysis of differences and commonalities in service innovation processes, two ESPs are chosen as primary cases. Additional interviews with OEMs and other ESPs were conducted to complement the empirical foundation of this study and to enrich the analysis through a comprehensive and networked-centric perspective on service innovation. Furthermore, three additional sources of empirical data support the empirical investigation: preliminary interviews, archival data and field observations. The different qualitative accounts combined with a systemic analysis enable this thesis to contribute comprehensive and detailed insights on service innovation processes in the AES industry.

The aforementioned data sources inform the development of the service innovation typology of service innovation processes, which answers RQ1. The typology is based on three different innovation dimensions (*interaction modes*, *roles in the renewal of institutions*, and *recombinant practices*), which provide a common structure for the description of five distinct service innovation patterns that form the typology. RQ2 is addressed through the analysis of the interaction modes, while the analysis of the disruption and renewal of institutions answers RQ3. The third dimension refers to recombinant practices and provides an additional dimension that is helpful in identifying distinct patterns of service innovation.

1.3 Thesis Structure

The remainder of this thesis is structured as follows. The following chapter provides an introduction to the German AES industry, along with an overview of the literature on KIBS. It furthermore conveys the underlying assumptions (premises and axioms) of the S-D logic and describes a systemic view of service ecosystems and service innovation. Subsequently, chapter 3 describes the research design, by supplying the specificities of the abductive research approach and outlining the process of implementation during this research. The description of the research design is followed by the presentation of the research findings in chapters 4 – 6. Chapter 4 presents the detailed description of the two case organizations. Chapter 5 reports on the within- and between-case comparisons. Furthermore, a synthesis of the findings into an analytical framework with three dimensions and several characteristics is supplied. The framework provides a common structure for the detection and conceptualization of service innovation patterns. Chapter 6 draws upon the basic structure of the analytical framework and presents a typology of five empirically grounded service innovation processes in the AES industry, which are conceptualized and modeled as sequences or cycles of interrelated process steps, roles, and activities taking place between ESPs and other actors in service ecosystems. Chapter 7 discusses the findings by relating them to existing patterns from prevailing literature in innovation management and the current debate on different topics related to the S-D logic. Chapter 8 concludes this thesis by summarizing the findings in the form of managerial and theoretical implications and by providing suggestions for future research. Fig. 1-1 illustrates the structure of this thesis.

Fig. 1-1 Structure of this Thesis



2 RELATED WORK

2.1 Chapter Introduction

This chapter establishes the context of this research and provides an overview of the current debate on service innovation. In line with the abductive approach, reviewing the literature has been a continuous process that has lasted throughout the study (Dubois and Gadde 2002). Accordingly, the concepts and theories were carefully evaluated and selected in close alignment with the research progress. These same concepts, theories and associated existing literature on service innovation are presented here with the aim of enabling a rich discussion of the findings of this thesis; this discussion can be found in the final section of this study, in chapter 7.

The research context is established in four consecutive sections: Section 2.2 and 2.3 present existing empirical research in the area of AES and give an overview of trends of significant relevance to the automotive industry. Given that engineering services have seldom been the focus of academic investigations, insights are drawn primarily from studies from industry-specific literature directed towards practitioners, e.g., publications from consultancies and industrial associations. Further insights are included from the academic literature on KIBS. Sections 2.4 introduces the S-D logic and provides a summary of the literature on service innovation. Finally, section 2.5 provides an overview of existing classification schemes in the innovation literature and describes established innovation taxonomies and typologies, as the two most common types.

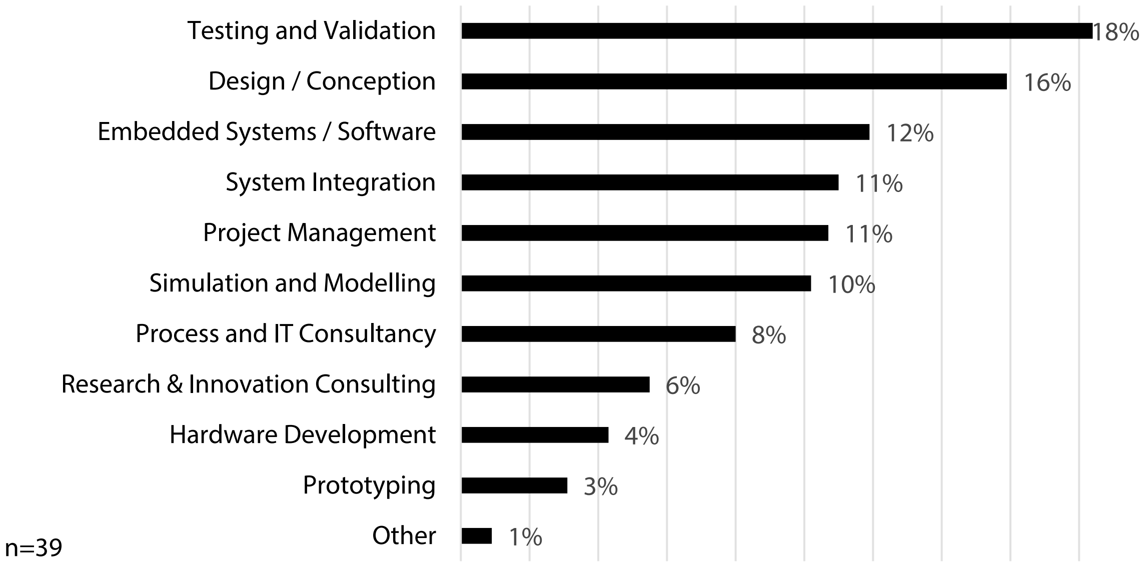
2.2 Automotive Engineering Services

2.2.1 Facts and Figures

Although the AES industry is well recognized for its economic importance, it does not have wide recognition amongst the general public (cf. Kleinhans et al. 2015). This section thus clarifies some general terms and concepts. The terminology *"engineering services"* is the official translation from the German term *"Entwicklungsdienstleistungen"* and has been coined by the Association of German Engineers (Verband Deutscher Ingenieure, VDI). According to the VDI guidelines (VDI 2006, p. 3), engineering services are defined as *"independent marketable services that are related to the provision and/or use of capabilities that are largely based on engineering knowledge and experience gained in practical engineering work."* In contrast to traditional suppliers, the production and selling of their own manufactured products is not the focus of an ESP. The role of an ESP is the provision of engineering activities according to the individual requirements of their customers (VDI

2006). In the practitioners' literature, a variety of activities are listed that are considered engineering services. As illustrated in Fig. 2-1, such activities and services range from testing and validation, design and conception, over simulation and modeling of technical parts and components, to the development of technical prototypes (cf. Lüerßen 2013).

Fig. 2-1 Service Portfolio of Engineering Service Firms in 2012

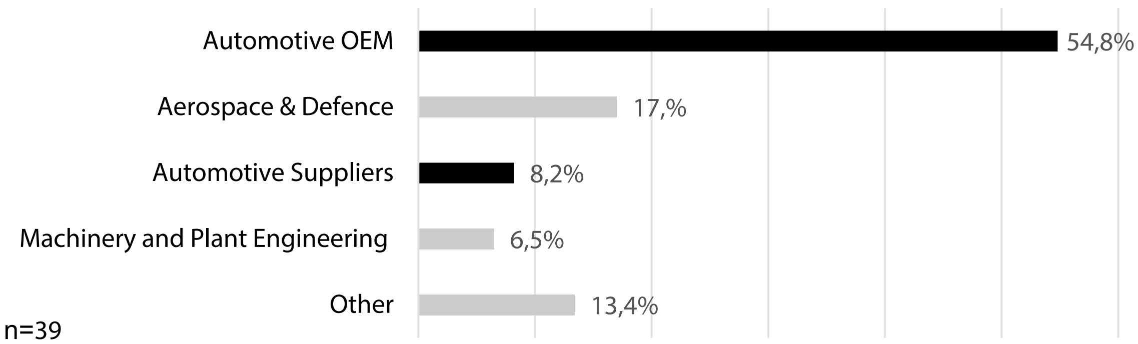


Source: Lüerßen (2013, p. 24)

The variety of activities that are associated with engineering services demonstrates clearly that the term is quite vaguely defined. A definition is also complex given that ESPs are continually evolving their service offerings and, for example, taking over new activities from their customers that were not previously within their established duties. Processes of ongoing digitalization constitute a significant trend in that they facilitate a shift in the importance of engineering activities from traditional mechanical engineering activities towards new topics related to electronics and software/IT. Analyst firms and the ESPs themselves expect significant increases in returns in related market segments within the coming years (Kleinhans 2016; Lüerßen 2013).

In Germany, the automotive industry is by far the largest market for engineering services (Lüerßen 2013, p. 25). In 2012, ESPs made 54.8% of their sales volume with automotive OEMs and another 8.2% with automotive suppliers, together accounting for more than 63% of the total sales volume (cf. Fig. 2-2). Those engineering services that are offered to automotive OEMs and their suppliers for the process of developing and manufacturing automobiles are considered to be AES (cf. Kleinhans et al. 2015).

Fig. 2-2 Significant Markets for Engineering Services in Germany in 2012



Source: Lüerßen (2013, p. 25)

A recent study, carried out by Berylls Consulting in cooperation with the German Association of the Automotive Industry (VDA) has investigated the German ESP market. The study provides a ranking of the largest ESPs in Germany by their sales volume with Automotive OEMs and suppliers (cf. Tab. 2-1). Accordingly, 25 ESPs accounted for more than 50% of the total sales volume in Germany in 2013.

To better understand the role of ESPs in the AES industry, it is helpful to examine their origins. The first predecessors of today's ESPs were small engineering offices that originated in the mid-80s in response to the requirement of large OEMs for a flexible compensation of temporary spikes in their development efforts. At that time, the professional workforce of the ESPs often worked on-site at the OEMs and mainly supported the OEMs engineering activities; for example, for the modeling of specific vehicle parts and components, such as bumpers and interior elements. It is because of this specific role that engineering services are often associated with an extended workbench that gives the ESP very little responsibility for the process and outcome of their service. However, recent studies suggest that the role of ESPs is changing as they develop fully developed engineering competencies and manage projects under their own responsibility (Kleinhans et al. 2015). By outsourcing R&D activities, OEMs can focus on their core competencies while at the same time leveraging external capacity and expertise (Chesbrough 2003; Enkel et al. 2009). This trend extends so far that OEMs are transferring the responsibility for the development of complete systems, modules and vehicle derivates[4] to their ESPs (Kleinhans et al. 2015).

[4] A certain body style for a particular car model. For example, models are offered in a four-door version and as a two-door coupé.

Tab. 2-1 Top-25 ESPs by Automotive Sales Volume in Germany in 2013

#	Firm	Total Sales Volume (in Mio. Euro)	Sales Volume Automotive (in Mio. Euro)	Share of Automotive Engineering	Total Employees
1	Bertrandt	782	704	90%	11,000
2	IAV GmbH	595	565	95%	5,000
3	AVL	1,015	457	45%	6,200
4	EDAG	383	383	100%	4,355
5	Brunel International	1,283	372	29%	13,073
6	Altran/IndustrieHansa	1,633	360	22%	21,000
7	AKKA/Mbtech Group	878	360	41%	10,785
8	FEV Group	305	265	87%	2,800
9	Alten Group	1,216	213	18%	16,000
10	Semcon Holding	290	189	65%	3,000
11	Bosch Engineering	190	171	90%	1,850
12	Rücker AG	170	170	100%	2,160
13	MAGNA STEYR	150	150	100%	900
14	APL Group	150	150	100%	950
15	MVI Group	150	135	90%	1,400
16	Applus IDIADA	134	134	100%	1,690
17	Assystem Group	871	126	14%	11,000
18	Mahle Powertrain	124	124	100%	628
19	Italdesign Giugaro	120	120	100%	743
20	Continental Engineering	120	114	95%	1,000
21	ESG Engineering	258	107	41%	1,600
22	FERCHAU Engineering	460	100	22%	6,000
23	Ricardo plc	242	91	38%	350
24	RLE International	90	81	90%	1,974
25	GIGATRONIK-Group	82	78	95%	1,350

Source: modified from Kleinhans et al. (2015, p. 16)

Economic figures underline the increasing importance of ESPs in the automotive industry. Since 2014, ESPs have shown yearly growth rates in turnover of between 5 % and 8 % p. a. These growth rates are expected to continue on a similar trajectory between 2018 and 2021 (Lüerßen 2014). In 2015, ESPs in Germany employed more than 50,000 technicians and highly qualified engineers that make a significant contribution to the innovativeness of the German OEMs (Kleinhans et al. 2015). Recent studies consider the local and quick availability of a wide range of engineering services at the development sites of OEMs as a major factor for the success and competitiveness of the German automotive industry in comparison to its global competition (Kleinhans et al. 2015).

2.2.2 Engineering Services as Knowledge-Intensive Business Services

This section gives an overview of how engineering services are reflected in the academic literature. Despite their economic importance, engineering services have rarely been the subject of research, which may also be due to a lack of public attention. Kleinhans et al. (2015, p. 3) describe ESPs as *"hidden champions in the automotive value creation chain"* who are highly innovative but hardly present in public perception. One of the reasons for this is that non-disclosure agreements often bind ESPs to transfer all of their rights to ideas and developments to their customers, thus making it especially challenging for them to advertise their innovative activities and technological achievements.

The term *engineering services* is mostly used in the practitioners' literature, but is less common among the academic community. In the official service classification of the EU (Eurostat 2008), the closest category is that of R&D services. These are however often understood in a more broader sense and may also include scientific or marketing-related services (cf. Koschatzky and Stahlecker 2010; Rodriguez et al. 2017). Engineering services should therefore be more appropriately considered as a specific sub-group of R&D services. In the literature on service and innovation, engineering services are mentioned and discussed in several publications under the broader concept of KIBS (Miles 2005; Miles et al. 1995). In today's knowledge-based economies, KIBS receive increasing attention from the academic community and scholars emphasize their central role in regional innovation systems as an essential driver of economic growth (cf. Miles 2005; Wood 2002).

As engineering services are considered to be a specific sub-domain of KIBS, the KIBS literature can provide some general insights on the nature and characteristics of engineering services. First, scholars emphasize KIBS as in many ways distinct from other types of services and argue that KIBS should thus be considered a completely separate research domain.

Some of the most prominent advocates of this view are Miles et al. (1995). Miles et al. (1995, p. 18) define KIBS as services that *"involve economic activities which are intended to result in the creation, accumulation or dissemination of knowledge."* They identify three distinguishing characteristics of KIBS (Miles et al. 1995):

1. Service provision is heavily reliant upon professional knowledge,
2. They either are themselves primary sources of information and knowledge or integrate themselves into the production process of their customers by providing intermediary services, and
3. They are of competitive importance to their customers and are supplied mainly from business to business.

KIBS are knowledge-intensive in that they are concerned with solving complex problems that are often in some way unique. Problem understanding and solution development combine elements of collective learning, creativity, and information sharing, which rely heavily on the tacit knowledge and experience of the actors involved (Muller and Doloreux 2009). Furthermore, KIBS are labor-intensive, which means that major activities carried out during problem analysis and solution finding cannot be fully automated and therefore involve some manual work – typically carried out by a highly qualified professional workforce (Nordenflycht 2010). Another definition of KIBS is given by den Hertog (2000, p. 505). He defines KIBS industries as *"private companies or organizations; relying heavily on professional knowledge, i.e., knowledge or expertise related to a specific (technical) discipline or (technical) functional-domain; and supplying intermediate products and services that are knowledge-based."* This definition emphasizes that KIBS are professional services that are co-produced by the workforce in collaboration with the customer. This means that the customer is often directly involved in essential service activities, such as problem definition or solution development. The quality of the service is thus mainly dependent on the relationship and trust between the customer and the provider and, hence, the quality of their communication (den Hertog 2000).

Service taxonomies are a common means of highlighting specific characteristics of services and differentiating between types of services. Miles et al. (1995) describe the nature of KIBS in more detail by establishing a separation between *"professional services"* and *"new-technology-based services"* as two separate subcategories of KIBS (cf. Tab. 2-2).

Tab. 2-2 The Main Categories of KIBS

The two Main Categories of KIBS	
KIBS I: traditional professional services, liable to be intensive users of new technology	• Marketing/advertising • Training (other than in new technologies) • Design (other than that involving new technologies) • Some financial services (e.g., securities and stock-market-related activities) • Office services (other than those involving new office equipment, and excluding 'physical' services like cleaning) • Building services (e.g., architecture, surveying, construction engineering) • Management consultancy (other than that involving new technology) • Accounting and book-keeping • Legal services • Environmental services (not involving new technology, e.g., environmental law, and not based on old technology, e.g., elementary waste disposal services)
KIBS II: new technology-based KIBS	• Computer networks/telematics • Some telecommunications (especially new business services) • Software • Other computer-related services, e.g., facilities management • Training in new technologies • Design involving new technologies • Office services involving new office equipment • Building services (centrally involving new IT equipment, such as building energy management systems) • Management consultancy involving new technology • Technical engineering • Environmental services involving new technology • R&D consultancy and high-tech boutiques

Source: Muller and Zenker (2001, p. 1503) based on Miles et al. (1995, pp. 19–20ff.)

Miles et al. (1995) justify their differentiation by the fact that the role of technology varies between different types of KIBS. In general, most KIBS rely on technology during service provision. In fact, in the digital age, the economical production of most KIBS seems hardly possible without the use of information technology (IT) and ICT. Whether in consulting, marketing or software development, KIBS providers use IT and ICT to work effectively with their customers and provide services efficiently. Although the role of technology in these cases is particularly apparent during service provision, Miles et al. (1995) highlight the second category of services in which the role of technology is not only a means of providing the service, but also a central orientation point for knowledge and skills. Engineering services are considered a typical example of this kind of new technology-based service (cf. Tab. 2-2). ESPs not only make use of various forms of IT and ICT during service provision, and in the communication with the customer, they also align knowledge and skills to various areas of automotive technology such as different manufacturing techniques, structural domains or systems in the vehicle.

The knowledge-intensity of KIBS puts them in a central role in regional innovation systems[5]. Technology-based KIBS such as R&D services (and engineering services), are often directly involved in the innovation activities of their customers (Miles et al., 1995; Muller and Zenker, 2001). Additionally, their contributions often involve joint activities with different partner firms in a network. In this regard, den Hertog (2000) differentiates between three roles in which KIBS firms participate in processes of service innovation:

- *Facilitators of innovation*: KIBS firms make innovation possible if they support their customers in their innovation processes; for example, when an engineering firm works out an innovative solution together with the customer.
- *Carriers of innovation*: KIBS firms transfer an innovation from another party in their network to their customers. For example, a KIBS firm identifies a compelling software solution and suggests its implementation to its customer.
- *Sources of innovation*: KIBS are involved in initiating and launching innovation activities. For example, when a KIBS provider talks to its customers, it brings in its own ideas that become the starting point for innovation activities.

The variety of roles that KIBS firms assume in innovation systems underscores the interconnectedness of their business environment and the complexity of innovation processes. At the same time, the distinct network orientation of KIBS firms and their innovativeness make them an ideal empirical domain for examining networked processes of service innovation.

2.2.3 Competencies and Market Dimensions of Engineering Services

Engineering services are provided in projects and are geared towards meeting customer requirements that typically result from the individual challenges and problems in the R&D value creation process of the automobile. German OEMs carry out the majority of their R&D activities at a small number of development sites across Germany (Kleinhans 2015). ESPs typically operate in geographical close proximity to their customers – sometimes even directly on-site in the R&D facilities of the OEMs. Physical presence is especially required when OEMs want to supervise the engineering activities themselves and are not willing to transfer full responsibility to their ESPs. The fact that many service activities involve a direct communication and interaction between service provider and customer results in close

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[5] The term *innovation system* stresses the importance of information flow and knowledge diffusion among people, organizations, and institutions to the emergence of innovations (Freeman 1995).

relationships that are built on a high level of mutual trust (Blöcker 2016; Miles 2008). For most projects the ESP is confronted with a unique situation, e.g., regarding requirements and project partners. Given that engineering services are highly customized, ESPs tend not to have a defined service catalog but instead they offer a generic set of engineering competencies that enable them to handle diverse activities and challenges in a specific market segment. *Product technology* and *value chain* are two essential dimensions based upon which competencies and their corresponding markets can be organized and segmented.

Markets According to Product Technology

The expertise and competencies that underlie AES are geared towards automotive technology. Knowledge, resources (e.g., project teams), and processes in the AES industry are thus organized to support the fulfillment of requirements in technological areas of the product architecture and the associated development processes and production technologies (cf. Colfer and Baldwin 2016; Sanchez and Mahoney 1996). Examples of such product areas are the engine, powertrain, chassis, exterior, and interior. Each of these areas poses individual challenges to the engineering expertise and skills of the ESPs and therefore represents both a competence area and specific market segment for AES. Tab. 2-3 provides an exemplary overview of typical competence areas.

Tab. 2-3 Examples of ESP Competencies

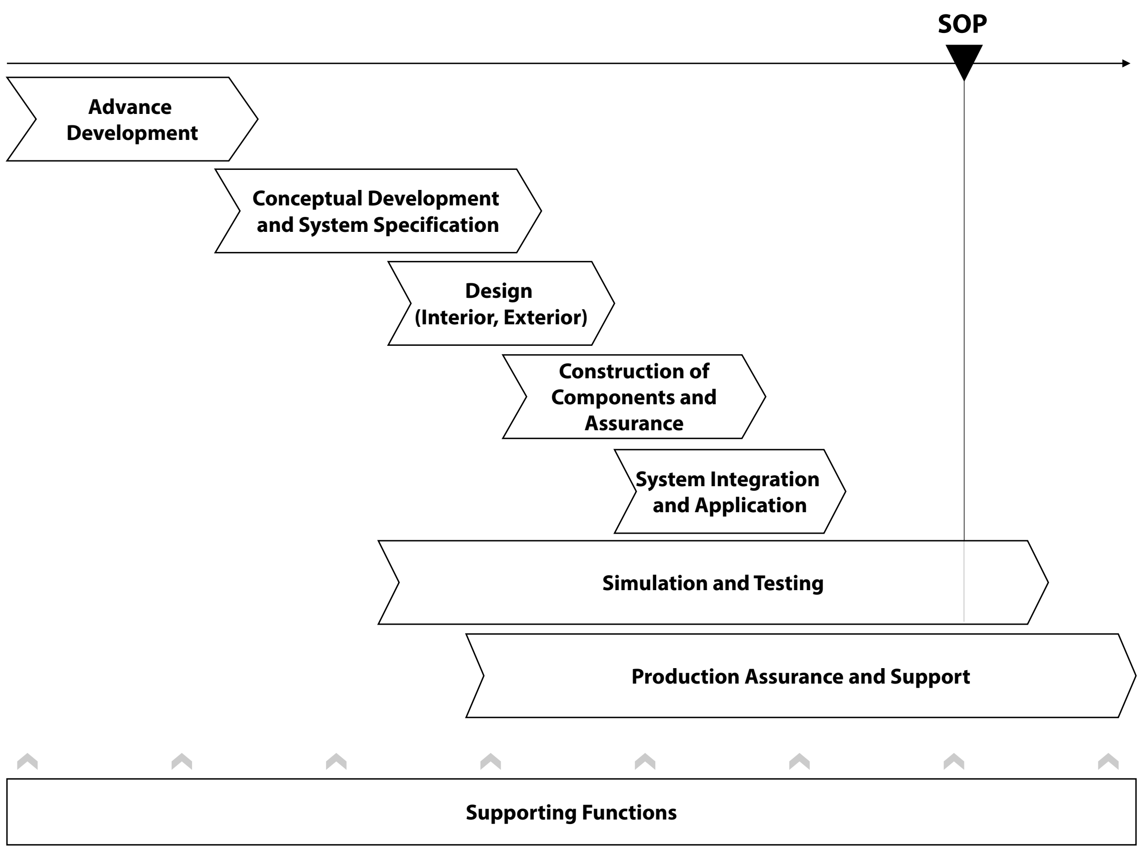
Competence Type	Examples of Engineering Activities
Chassis Development	Conception and development of the bodywork under consideration of various conflicting requirements, such as producibility, cost of manufacturing, and weight.
Exterior Development	Conception and development of parts, such as exterior trims and moldings or components, such as bumpers.
Interior Development	Development of door trims, panels for displays and switches, roof liners or integral components, such as the middle console.
Temperature Management	Analysis and optimization of heat flow in systems and subsystems (e.g., in the engine).
Development of Kinetic Systems	Conception and prototyping for display systems (e.g., combined instruments, central displays).
Acoustic Design	Analysis and optimization of vehicle acoustics, e.g., motor sound and noise canceling in the passenger cell.

With the progress in automotive technology, the markets for AES continue to change. In the past, the focus of ESPs was primarily on individual activities, such as creating technical models according to predefined requirements. However, in recent years, the function of embedded systems and sub-systems has also become a focus of ESPs, making it more crucial for them to develop a holistic and comprehensive understanding of development processes. ESPs are now increasingly concentrating on the holistic requirements of systems and subsystems; for example, by carrying out all necessary activities in the development of a chassis and considering various functional requirements (e.g., producibility, production costs, rigidity, weight). Nowadays ESPs offer competencies in acoustic design, temperature management, but also generic competencies in the field of lightweight construction, where the functional aspects regarding weight and costs are within the focus of engineering activities.

Engineering Activities According to the Value Creation Chain

The competencies and services offered by ESPs can also be organized into a second market dimension, which is the value creation chain of the automobile (sometimes referred to as product lifecycle). ESPs integrate themselves at various points along the value creation chain of the automobile and take over development activities that were previously carried out by the manufacturers themselves. A recent study of the VDA gives an overview of the different phases of the value creation chain in which engineering services play a role (Fig. 2-3).

Fig. 2-3 The Automotive Value Creation Chain



Source: Kleinhans et al. (2015, p. 13)

While engineering services are typically involved in the phase before the start of production (SOP), some ESPs offer support in the coordination of logistics and production activities in later phases. In practice, a distinction is often made between upstream phases of development (advance development, as well as conceptual development and system specification) and series development, which starts with the design phase (cf. Fig. 2-3).

2.2.4 Contract Forms and Business Models

The business model of ESPs is adjusted to the requirements of pre-defined contract types, which, in Germany, are strictly regulated by labor law. The regulation of engineering services is intended to prevent abusive forms of the use of external personnel through employment in supposedly independent service or employment contracts[6]. Contract types are intended for specific purposes and impose several legal requirements on the offering and provision of engineering services, e.g., concerning the responsibility and decision freedom of the service provider in a project, as well as the organization of the cooperation between the provider and the customer. The study by Kleinhans et al. (2015) distinguishes between three established (and legally defined) contractual forms:

- The purpose of a *personnel leasing contract* is to create the boundary conditions for the temporary leasing of employees to another organization, i.e., an OEM or supplier (BGA 1985). Since employees work under supervision and authority of the customer, body-leasing contracts give the provider little responsibility for the service outcome. Some ESPs have also focused on personnel leasing services.
- A *contract for labor and work* exists when a service provider implements a service independently with the help of its employees, under his responsibility and according to his plan (BGA 2014). This contract form is often used for consulting services or concept developments, where the service outcome is not precisely specifiable and thus difficult to measure regarding quality and success.
- With a *service contract*, ESPs take over larger engineering packages in the form of projects and thus provide engineering results independently and with full responsibility for the service project and its outcome. Here, the provider needs to deliver a predefined and specified project outcome at a specific point in time with predefined criteria for the measurement of success.

Tab. 2-4 compares the essential features of the various types of contract. Different types of contracts are used depending on the market segment and the specific preferences of the customer. As will be explained later in this chapter, there is a trend towards the growing importance of service contracts.

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[6] See also *BAG, 3 AZR 395/11*, 2014, *BAG, 5 AZR 225/84*, 1985

Tab. 2-4 Summary of Different Contract Forms

Differentiating Criteria	Personnel Leasing	Contract for Labor and Work	Service Contract[7]
Interactions and Collaboration	Employees become part of the customer organization and work under external supervision and authority.	The provider independently produces a service under own responsibility and with an own plan.	The contractor independently performs a previously defined work.
Responsibility and Risk	With the supervision and control, the customer also takes over a significant share of the responsibility and risk.	The service provider only owes the activity, not the success.	The service provider owes the success. The customer has no right to instruct the provider regarding when, where and how to provide the service.
Specification	The service outcome does not need to be precisely defined. Body-leasing contracts are limited to 24 months.	The service outcome is often roughly specified and leaves considerable freedom regarding possible outcomes.	The service outcome is precisely defined by predefined criteria for the measurement of success.

Source: based on Kleinhans et al. (2015, p. 23)

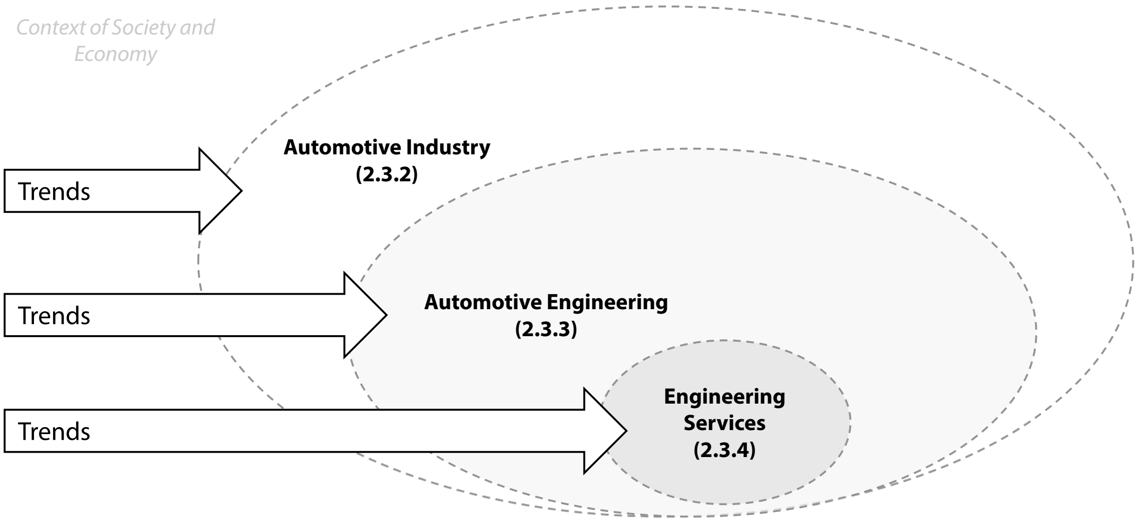
[7] German translation: Werkvertrag

2.3 Trends in Automotive Engineering

2.3.1 Different Levels of Contexts

Socio-technical and economic changes in the market environment of the OEMs play an essential role in developing an understanding of how the requirements for engineering services change. For this reason, this section not only provides a discussion of the changes in automotive development but also zooms out into the broader context of the automotive industry. Trends are outlined in three different sections, each of which refers to a specific contextual frame (cf. Fig. 2-4). The first section describes socio-technical and economic trends in the context of the automotive industry. The second section takes the perspective of the OEMs and describes their changes and challenges in automotive engineering. The third section describes related trends in the market for engineering services.

Fig. 2-4 Trends on Different Interrelated Contextual Levels



2.3.2 Automotive Industry

The German automotive industry is in a phase of significant change, driven by various economic and socio-technical trends, in particular by digitalization (Piccinini et al. 2015; Viereckl et al. 2016; Kaas et al. 2016). How AES develop in the market is tightly linked to the development of automotive technology and the objectives and strategies of large OEMs. The literature outlines a wealth of trends and developments in the German automotive industry; however recent industry reports (e.g., Kaas et al. 2016; Viereckl et al. 2016) have identified three categories of change which are particularly striking (cf. Tab. 2-5): *changes in the mobility behavior* that lead to new customer preferences, *technological disruption* with respect to alternative engines and the rise of self-driving cars, and finally, *changes in automotive markets* that put pressure on the OEMs to reinvent their business models and break with previous management paradigms.

Tab. 2-5 Trends in the Automotive Industry

Changes in mobility Behavior	**Technological Disruption**	**Changes in Automotive Markets**
• Changes in how traditional car-buyers perceive and use mobility • A shift in consumer preferences from traditional car-features and owning cars towards service and using cars	• Electromobility • Assistance systems that enable cars with autonomous driving capacity	• The diversity of markets and business models increase while revenue streams shift to services • OEMs compete against new competitors on several front lines • New business models and technologies depend upon collaborations

Changes in Mobility Behavior

The preferences and life styles of end-consumers (including traditional car-buyers) are rapidly changing under the influence of digitalization (Balser 2016). While a decade ago, the automobile was often the preferred choice of transportation, nowadays the smartphone has become a universal point of access to a variety of mobility services (cf. Kaas et al. 2016, p. 8), e.g., car-sharing, bike-sharing, public transport, etc. With the increasing availability of alternative mobility options, customers tend to disengage their travel choices from the automobile as the sole mode of transportation and instead combine various modes of transport in order to complete their journey (Bellos et al. 2017; Busse et al. 2017). In particular, younger generations and people who live in urban areas have changed their travel behavior and have become less interested in car ownership (Dudenhöffer 2015). New regulations that discourage vehicle ownership to counteract worsening traffic conditions and air pollution further reinforce this trend (Baynes 2017; Gropp and Jung 2018). All of this urges car-makers to reconsider their traditional business models and instead to develop new value propositions that meet the changing preferences and needs of their customers.

Second, the values and attitudes of customers towards the automobile has changed, which in turn is driving a shift in their preferences from traditional features towards digital functionalities and services (Kruse 2009; Proff et al. 2012, pp. 371–372). For younger generations in particular, the automobile is losing some of its former importance as a status symbol (Kruse 2009). Scholars also see this as a sign of a decline in the emotional relationship between customers and the automobile (Proff et al. 2012, p. 371). Traditional features, such as the vehicles' driving performance, that in high-volume segments were previously decisive for OEMs to differentiate against competition, have lost some of their former importance. Instead, customers tend to pay more attention to digitally-enabled features and service offerings, both inside and outside the vehicle, and they expect a seamless integration with their digital lifestyle. For many of the incumbent OEMs, this trend poses significant threats, because new market participants are often more experienced and capable of providing a seamless user experience across platforms and systems.

Technological Disruption

The pace of technological change in the automotive industry has accelerated significantly in recent years. *Electric mobility* (i.e., the electrification of the drivetrain of vehicles) and *autonomously driving cars* are two major disruptions in automotive engineering, which challenge many of the fundamental principles of the automobile industry (VDA 2017).

First, numerous trends and events have created a strong momentum for an increase in the diffusion of electromobility in the market (Kaas et al. 2016). Stricter emission regulations have put the European OEMs under pressure to push the development of more efficient drive systems. In this context, the scandal surrounding the manipulation of exhaust gas measurements has caused a loss of public confidence in diesel cars, as a result, driving bans are looming in several European cities. Additionally, several European countries, including France, Finland, and the UK, have recently announced a full ban on all cars with combustion engines (Bauchmüller et al. 2017). This puts additional pressure on car makers to adjust their product strategies accordingly (Peters et al. 2016). At the same time, new market participants, such as US OEM-newcomer Tesla, have shown that obstacles to electric mobility, such as the limited range of the battery and the need to improve the existing charging infrastructure, can be overcome. All of this contributes to the fact that OEMs are preparing for an electrically powered future. These ambitions are further emphasized by the announcement of a wealth of new electric vehicle models (hybrid or full electric) that will be launched in the coming years (Fromm 2017). However, the speed of market acceptance is difficult to predict and depends on several factors, such as the extent to which regulations accelerate change and the period that OEMs will need in order to ensure that a comprehensive charging infrastructure is in place (Kaas et al. 2016).

In the last decade, advanced driver assistance systems (ADAS) have become available at a relatively low cost and cars with partially autonomous driving functionality are already available on the market. However, the connected car – that has a variety of sensors on board and is connected to the internet to enable ADAS – is only an intermediate step on the road to fully autonomous vehicles. Recent market forecasts expect the availability of vehicles that drive independently from A to B and handle the full range of scenarios without the driver having to intervene as early as 2019 (Campbell 2017). Market researchers expect that by 2035 21 million autonomous vehicles will be sold each year (Korosec 2016). The development of autonomous vehicles poses huge technical challenges to OEMs and currently consumes a vast amount of resources. However, developing autonomous technology is crucial for European

OEMs, since the advent of autonomous cars will offer considerable potential for follow-up innovations and the development of new service offerings, e.g., autonomous taxi services and value propositions that allow passengers to spend their time on other things rather than on the control of the vehicle during the journey (Wachenfeld et al. 2016).

Changes in Automotive Markets

The traditional rules in the automotive industry are changing, leading to new modes of cooperation and competition in the market (Kaas et al. 2016). In recent decades, the automotive industry has seen an enormous growth in the variety of vehicle models and variants (Pil and Holweg 2004). New variants appear in ever shorter intervals and are increasingly designed for niche segments of the market. One reason is that emerging markets are beginning to make individual requirements and regulatory demands to OEMs that force them to further diversify their vehicle portfolio (ElMaraghy et al. 2013; Peters et al. 2016). However, product variety is not necessarily heading into a clear direction. Market observers expect that the OEMs' revenues will shift from traditional car sales towards business models that revolve around digital service offerings such as car-sharing or digitally enabled upgrades (Kaas et al. 2016; Viereckl et al. 2016). These new business models may not require today's levels of model diversity and instead enable customization via platforms and built-in configuration options. For example, digitally enabled upgrades and functions can be made software-restricted and permanently or temporarily unlocked directly from within the vehicle (cf. Peters et al. 2016).

Second, the markets are becoming increasingly complex and present OEMs with the challenge of competing on different front lines with other incumbent OEMs, as well as with new competitors (Kaas et al., 2016). In addition to Tesla from the US, many Asian OEMs are about to make the move to the vehicle volume business and are expected to become serious competitors of the incumbent OEMs in the coming years. New OEMs benefit from the rise of electromobility. First, because the drivetrain of electrically powered vehicles is considerably less complicated than those of a vehicle with a combustion engine (OliverWyman/VDA 2012; Winterhagen 2016); this reduces the obstacle for new players who want to enter the automobile market, many of whom concentrate solely on electromobility. Second, these new parties further benefit from the fact that Asia has become the hotspot for battery development and production. In turn, the incumbent OEMs may need to relocate more of their development and innovation activities abroad. Given these challenges and considering the related need for significant investments and organizational changes, German OEMs are so far hesitating to make the final leap from combustion engines to successor technologies (e.g., Kröger 2018).

At the same time, the development of new business models requires OEMs to cooperate with actors who do not traditionally belong to the automotive industry, but who are pushing from the outside into their markets. Cooperation is particularly necessary to develop new digitally enabled services that are related to autonomous driving and new mobility concepts (Viereckl et al. 2016). These fields rely on critical resources and technologies that OEMs are often unable to develop or acquire on their own. Examples are map data, secure computing power, self-learning algorithms and a telecommunication infrastructure that is fast enough to enable high-speed communication with and between connected cars. Service platforms and data analytics make the automobile an essential piece of technology in a sophisticated mobility service ecosystem, in which OEMs can offer a variety of value propositions to their customers. Integration is a decisive factor and the role of the OEMs in the market of tomorrow depends very much on their capacity to remain in control of the data of their customers. If new competitors provide the integration between automobiles and digital platforms, such as Android and iOS they may gain an advantage over traditional OEMs (Viereckl et al. 2016; Kaas et al. 2016).

2.3.3 Automotive Engineering

The trends shown in the previous section have a substantial impact on automotive engineering, particularly regarding the requirements and roles of ESPs. Based on an analysis of the existing literature on current developments in the AES industry, four key topics can be identified (cf. Tab. 2-6).

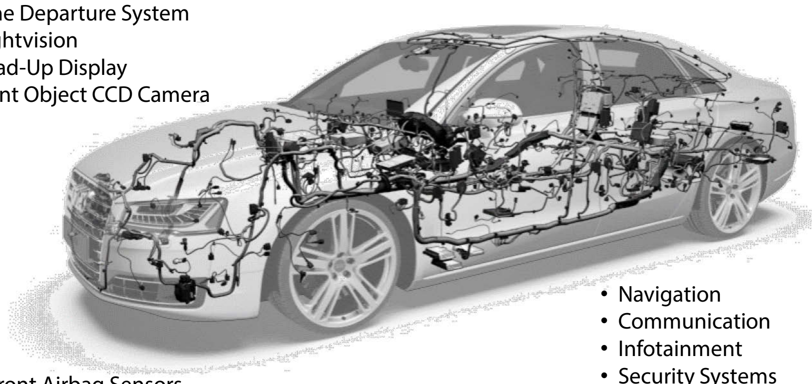
Tab. 2-6 Trends and Requirements in Automotive Development

Engineering Complexity	**Increasing Develop-ment Efforts**	**A Shift in Competence Demand**	**Partnerships for Innovation**
• The interdependen-cies between vehicle functions and syst-ems are increasing • The number of syste-ms and sensors that are embedded in car parts and comp-onents is growing	• A spike in the number of car variants and derivatives increases the need for engineering capacity	• The role of traditional engineering compe-tencies for OEMs is declining • OEMs to need to develop new competencies and skills, in particular, those related to digital tech-nologies and services	• Growing importance of cross-industry cooperation • OEMs become more dependent on external know-ledge and skills

Engineering Complexity

Automotive technology and the underlying development activities are becoming increasingly complex (e.g., Maxton and Wormald 2004; Weber 2009). Modern vehicles feature a wealth of sensors and control units that are embedded in different product areas, where they carry out a variety of functions, such as detecting obstacles on the road, ensuring that the car is holding the track or scanning traffic signs. Fig. 2-5 gives an overview of important sensors and systems that today already feature in many premium vehicles. All these components, systems, and subsystems have to be developed, integrated, and closely aligned with different vehicle functionalities, such as driving comfort, crash safety, driving dynamics, and fuel efficiency (Kleinhans et al. 2015). In particular, the growing importance of ADAS increases the number of electrical, electronic and software assets in the vehicle (Giusto et al. 2016). Considering the ultimate goal for the OEMs of developing self-driving cars, the trend towards more complexity will surely continue (cf. Maxton and Wormald 2004, p. 154f). Future generations of self-driving cars will require a multitude of additional sensors and systems, which were not required before, e.g., to monitor the driver's condition and readiness to take over manual control of the vehicle.

Fig. 2-5 Sample View of Vehicle Sensors and Systems



Source of the vector graphic: Audi Technology Portal (2017)

Increasing Development Efforts and Outsourcing

The complexity and diversity of vehicle variants and drive systems has lead to an increasing demand for engineering resources in automotive development. The growing variety of vehicle models and individualization options means that development expenditure has risen considerably in recent years (Grunewald 2015; Kleinhans et al. 2015). Although the OEMs have recruited some new employees and engineers, their permanent staff is not growing fast enough to compensate for the rising demand for development resources (Kleinhans et al. 2015). As a result, the share of contracts awarded externally in automotive development has lately seen a constant growth (Peters et al. 2016; Schneider 2011). OEMs assign more and more development tasks to their suppliers and ESPs, which they used to carry out themselves. The economic development of the ESPs mirrors this trend. Over the past few years, many ESPs have grown at an above-average rate and have expanded their range of services to include new competencies and new customers (Kleinhans et al. 2015).

A Shift in the Competence Demand

The increasing importance of service-driven business models and digital functions in vehicles is shifting the expertise and development focus of OEMs and suppliers towards electronics and software (Viereckl et al. 2016). In the development of ADAS, digital features, new service offerings or software and electronics competence, competitiveness and business success are absolutely vital: *"Engineering is the core competency of today's car manufacturers and suppliers, but this might not be the skill that ensures success in the mobility service business in the future"* (Bernhart et al. 2016, p. 14). This is why OEMs and suppliers are investing heavily in digital competencies, i.e., resources and knowledge related to IT, software, and electronics. However, changes are also a concern in relation to managerial competencies in the coordination of development activities at the intersection between traditional hardware development and software development: *"The ability to oversee a software team will become a critical part of the managerial competence of an automotive leader"* (Kaas et al. 2016, p. 34). Also, several studies have pointed to the challenge that arises from the fact that hardware and software development follow cycles that are not compatible. While the typical development cycle of the vehicle is currently about seven years, the software for vehicles needs to be developed and updated in cycles that are considerably shorter. At the same time, nascent technological trends on electric engines and autonomous driving urge OEMs to develop competencies and organizational capabilities that the incumbent OEMs, in particular, often do not yet have (Kleinhans 2016; Viereckl et al. 2016).

Partnerships for Innovation

The development of smarter, electric and ultimately autonomous vehicles requires a wide range of new technologies, resources, and skills (e.g., electronics, IT and software), which OEMs can often not achieve alone, but only through partnerships with other actors (Kaas et al. 2016). However, it is not just a matter of developing a technology, instead many other aspects and requirements have to be coordinated. Such topics range from security issues, the provision of infrastructures (e.g. communication infrastructure for transmitting massive amounts of data between cars and server clusters), the integration of payment services, to the intuitive handling of applications on the smartphone or the dashboard of the vehicle. Technology companies that have their roots in markets and industries outside the automotive industry, like Apple, Google, Microsoft and Intel, are prime examples of companies that use their knowledge and experience in the field of data and software to develop innovative services and technologies that may disrupt some of the established business models in the automotive industry. Recently, OEMs have announced several new cooperations, or have expanded existing ones. For example, Audi has stepped up its cooperation with graphics cards manufacturer, Nvidia, and is using its Artificial Intelligence and Machine Learning platforms to teach its vehicles how to assess the environment (Korosec 2017). In another alliance, OEMs, suppliers, and telecommunication providers are cooperating in the development of data standards and infrastructure for autonomous driving (Fromm and Bernau 2014). Additionally, start-up companies are frequently involved and these provide essential innovations and technologies to OEMs, to which they would otherwise not have access (Kaas et al. 2016). The role of networks and cross-industry cooperation in the automotive industry is thus increasing.

2.3.4 Engineering Services

The changes to the higher context levels of the automotive industry and the automotive development coincide with changes in the market for engineering services. Kleinhans et al., (2015, pp. 21–23) provide a good overview of current changes in the requirements for ESPs, which can be summarized into four core topics (cf. Tab. 2-7).

Tab. 2-7 Changes in AES Requirements

A Shift in Responsibility	**New Legal Regulations**	**New Competence and Knowledge Demands**	**Cost-pressure and Internationalization**
• ESPs assume full responsibility for engineering activities and manage projects under own authority.	• Changes in legal regulations require a separation of the ESP work from that of the customer	• ESPs build up new knowledge and competencies in the field of electronics and IT • ESPs strengthen their project management competence	• There is increasing cost-pressure in the market • ESPs expand existing or establish international branches

Source: based on Kleinhans et al. (2015, pp. 21–23)

A Shift in Responsibility

ESPs have begun to assume more responsibility for the complete development process and (sub-)projects (Kleinhans et al. 2015). In the past, ESPs used to carry out engineering activities under the direct control of the OEMs. In this role ESPs were merely offering resources to their customers with limited influence on the outcome of their services. This collaboration mode is therefore known as *extended-workbench.* However new modes of collaboration are gaining importance. ESPs are frequently assuming roles in which they are completely responsible for the development of whole systems or lese they manage process phases on their own authority (Kleinhans et al. 2015). The OEMs often develop the basic model themselves and then outsource the development of variants for country-specific or different types of engines to their ESPs. Such projects are typically realized in service contracts.

New Legal Regulations on the Design of Service Contracts

Legally compliant service contracts require a precise description of the tasks that the customer assigns to the ESP and a strict separation of responsibilities (cf. section 2.2.4). However, in the past, service contracts were often misused, in that projects were formally organized in a service contract but employees of the ESP worked at the customer site and under the supervision and authority of the customer. In response, new legal regulations recently came into effect that were formulated to counteract the misuse of service contracts (BGBI 2017). These new regulations define several criteria for legal compliant service contracts and require a precise specification of service elements; these include ensuring a measurability of success; independent service provision by the ESP, who must be spatially separated from the customer and must assume the full entrepreneurial risk. The exact effects of these amendments are not yet foreseeable. However, experts expect a considerable influence on the operational cooperation between ESPs and OEMs, as well as further development of the role of ESPs in the value chain of the automobile and speak of a turnaround in the sense that ESPs will be expanding their offices and IT infrastructure in order to carry out projects in compliance with the law (cf. Kleinhans et al. 2015, pp. 28–35).

New Competence and Knowledge Demands

As the project responsibility grows, so too, do the demands for competencies and knowledge of ESPs. On the one hand, these requirements relate to formal and informal processes, as well as structures in the OEMs' development environment. According to Kleinhans et al. (2015), ESPs coordinate their work more autonomously with other actors in the customer's organization than previously. Knowledge of the decision-making processes and the political culture of OEMs, as well as on their formal development systems, becomes vital for the ability of ESPs to assume new roles in collaboration with their customers. On the other hand, ESPs are frequently in need of specialist knowledge. For small and medium-sized ESPs in particular, it is becoming more important to focus on specific topics, such as lightweight construction or specific materials. At the same time, the trend towards more electronics and IT in the vehicle means that ESPs need more expertise in order to address the requirements for networking different components and systems in the vehicle. Complementing competencies in the classical mechanical field of development with digital competencies is, therefore, an essential challenge for ESPs (Kleinhans et al. 2015). In this context, Kleinhans et al. (2015) also see opportunities for ESPs to extend their knowledge beyond the vehicle to include infrastructure and back-end IT.

Cost-Pressure and Internationalization

ESPs and other actors in the automotive industry face a steady increase in cost pressure (e.g., Blöcker 2016; Kleinhans et al. 2015). One of the vital factors for the success of ESPs in the market is, therefore, to continuously optimize their cost structures and improve efficiency in the implementation of engineering activities. As a consequence, the AES industry is currently undergoing a phase of accelerated concentration and consolidation (Blöcker 2016, p. 5). There has been a series of mergers and acquisitions among the incumbent ESPs. Blöcker (2016) has identified a restructuration process that leads to a reduction of the ESPs that can offer their services directly to OEMs, so that more ESPs become sub-contractors or even drop out of the market completely. Cost pressure forces many ESPs to set up or expand international locations in order to achieve further cost advantages by relocating activities and resources abroad (Blöcker 2016). Another reason for internationalization is the expansion of engineering services to the international development sites of the OEMs in order to support them locally in meeting country-specific development requirements (Kleinhans et al. 2015).

2.4 S-D Logic and the Ecosystem View of Service Innovation

2.4.1 Transition from G-D Logic to S-D Logic Mental Models

How academics and practitioners view the nature and process of innovation is shaped by dominant mental models (Lusch and Nambisan 2015, p. 156; Lounsbury and Crumley 2007; Friedland and Alford 1991). Mental models are based on small sets of fundamental assumptions or axioms that together offer a consistent logic for human reasoning and conscious or unconscious processes of thought and decision-making (Johnson-Laird 2006). The mental models that have shaped academic and managerial thought on economic exchange and value creation are the two contrasting perspectives of *Good-Dominant (G-D) logic* and *Service-Dominant (S-D) logic* (Vargo and Lusch 2004, 2008). In the literature on innovation, these two fundamental logics are reflected in different conceptions as to what innovation means, how innovations emerge, how innovation should be studied, and on a normative level, which principles and paradigms should guide firms and managers in their efforts to innovate.

Foundations of G-D Logic

The roots of G-D logic can be traced back to the seminal work of Smith (1776) on *"The Wealth of Nations"* (Vargo and Lusch 2004; Vargo et al. 2008). The book is considered a fundamental work in classical economics and reflects upon the foundations of economics at the beginning of the industrial revolution. In the context of an economy that, in the 18th century, began to refocus on the production of goods and products, Smith came to the assumption that the basis of economic theory was the production of (tangible) units of outputs, i.e., commodities, that have embedded value measured in terms of market price (Vargo and Lusch 2004). Based on this worldview, G-D logic postulates that the primary purpose of a firm is embedding value into products or goods during manufacture and distribution to customers in the marketplace (Vargo and Lusch 2008, 2004a; Constantin and Lusch 1994). Accordingly, this implies a distinction between the role of the firm as a producer of value and the role of the customer, who destroys value during consumption (Normann 2001). It also implies a unidirectional flow of material and information from the manufacturer to the customer. Through a G-D logic lens, services (plural) are considered contradictory to tangible products. Thus they were often thought of as a *"series of activities"* carried out by the firm (Vargo et al. 2008, p. 146) and defined by virtue of not being tangible products (Vargo and Morgan 2005). The negative definition implies that they are an add-on or a sub-form of the product. Scholars were thus mainly concerned with the explication of such differences (Vargo and Morgan 2005) and the reconciliation of good-dominant interpretations of economic exchange with service-specific characteristics, such as intangibility, preservability, or intense customer-involvement during production (e.g., Wieland et al. 2012).

Practitioners and academics have long based their understanding of innovation on good-dominant thinking. Wieland et al. (2012) point out that this is reflected in the fact that scholars have established sub-disciplines, such as service marketing or service operations to address service-specific characteristics. As briefly mentioned in the introduction, the classic *non-S-D logic* literature of innovation management is divided into two perspectives: the demarcation perspective and the assimilation perspective (Coombs and Miles 2000; Lusch and Nambisan 2015). The demarcation perspective assumes that service innovation is fundamentally different from product innovation and thus should be covered with unique conceptual models and theories, whereas the assimilation perspective de-emphasizes these differences and focusses on the adaptation of product-oriented innovation theories in order to meet the service-specific innovation context (Coombs and Miles 2000). However, both perspectives reflect the production-centric worldview of G-D logic of measuring the value that is embedded in products or service offerings and is later destroyed during consumption. Scholars criticize the fact that neither the assimilation perspective nor the demarcation perspective appears to be adequate in order to explain and understand service innovation in the digital age; they note further that there is a need for an integrated and unifying understanding of innovation that considers both innovation in products and services (Coombs and Miles 2000; Gallouj and Savona 2009; Lusch and Nambisan 2015).

The third perspective is termed the synthesis perspective (Coombs and Miles 2000). Because the nature of economic exchange and value creation in the digital age is moving away from

G-D logic, the demarcation and assimilation perspectives are becoming even more problematic. More specifically, Lusch and Nambisan (2015) point out three significant trends. First, innovation processes must rely on collaborative activities and complex interactions among many actors in networks, including customers and suppliers (Nambisan and Sawhney 2007). Second, most innovations comprise intangible standalone offerings or associated elements with high information content (Glazer 1991; Lusch and Nambisan 2015), making the differentiation between product and service innovation problematic. Third, digital age innovation focusses primarily on experiences and the value that users co-create with services, products and technologies, whereas traditional G-D logic emphasizes the optimization of value creation processes through standardization and the division of labor (Prahalad and Ramaswamy 2004; Vargo and Lusch 2004, 2008). In summary, these trends reveal weaknesses in the demarcation and assimilation perspectives and lead to growing interest in a synthesis approach to innovation.

Foundations of S-D Logic

The S-D logic was introduced by Vargo and Lusch in 2004. In their landmark article, published in the Journal of Marketing under the title *"Evolving to a New Dominant Logic for Marketing"*, they postulate a worldview in which service is the fundamental logic to explain economic exchange and value creation and, hence, stands in sharp contrast to the G-D logic (Vargo and Lusch 2004). The underlying assumptions of this service-centric perspective are formulated into several foundational premises (FPs). The S-D logic has drawn considerable interest from the academic community and the initial FPs have been continually refined. Although originally developed as a marketing concept, the S-D logic has become an interdisciplinary framework that finds broad recognition in other research domains, such as supply-chain management (e.g., Lusch 2011), strategic management (e.g., Day 2004; Frow et al. 2015), operations management (e.g., Smith et al. 2014; Pohlmann and Kaartemo 2017), information systems (IS) (e.g., Akaka and Vargo 2013; Maglio et al. 2009) and also, more recently, innovation (cf. Wilden et al. 2017). In 2008, Vargo and Lusch integrated the feedback from a number of scholars into an updated and extended version of the FPs. The continuous development has furthermore led to a consolidation of the FPs into five axioms from which the other FPs can be derived (Lusch and Vargo 2014, p. 15). In its current version (Vargo and Lusch, 2016), S-D logic rests on 11 FPs – five of them are considered axioms (cf. Tab. 2-8).

Tab. 2-8 Premises and Axioms of S-D logic

FPs/Axioms	Foundational Premises and Axioms of S-D logic
FP1 (Axiom)	Service is the fundamental basis of exchange.
FP2	Indirect exchange masks the fundamental basis of exchange.
FP3	Goods are a distribution mechanism for service provision.
FP4	Operant resources are the fundamental source of strategic benefit.
FP5	All economies are service economies.
FP6 (Axiom)	Value is co-created by multiple actors, always including the beneficiary.
FP7	Actors cannot deliver value but can participate in the creation and offering of value propositions.
FP8	A service-centered view is inherently customer oriented and relational.
FP9 (Axiom)	All social and economic actors are resource integrators.
FP10 (Axiom)	Value is always uniquely and phenomenologically determined by the beneficiary.
FP11 (Axiom)	Value co-creation is coordinated through actor-generated institutions and institutional arrangements.

Source: Vargo and Lusch (2016, p. 8)

The first FP (and axiom) is essential to S-D logic in that it states that service is not a contradistinction from tangible goods or products but in fact, a broadened concept, i.e., a fundamental basis of all economic exchange: *"all exchange is based on service"* (Vargo et al. 2008, p. 147). This axiom is based on the definition of service as the "*application of competencies (knowledge and skills) by one entity for the benefit of another*" (Vargo and Lusch 2004, p. 2). The use of service (singular) emphasizes that service is the fundamental basis of all economic exchange, while in contrast, the use of the term services (plural) implies an interpretation as a certain output or a specific offering (Vargo and Akaka 2009). In line with this, this study uses the singular *"service"* to underpin the S-D logic perspective and the plural *"services"* to characterize a particular type of exchange relationship or offering, such as engineering services. The first premise (FP1 – "*service is the fundamental basis of exchange*") takes a central role in the S-D logic, as the other FPs are derived from it (Vargo and Lusch 2016). As postulated in FP3, where products or goods are involved in the exchange of service, they are regarded as distribution mechanisms (Lusch and Vargo 2006b, p. 40) or service delivery vehicles that enable the integration and application of resources (Vargo and Lusch 2008). From this notion, it is further derived that all economies are service economies (FP5) and that the exchange of money or goods is not representative of the value that actors experience from economic exchange. In fact, it only masks the indirect and according to the S-D logic, more significant exchange of competencies between actors in service networks (FP2).

FP6 is another axiom that re-conceptualizes value as not being embedded in the object of exchange but as always being co-created by multiple actors who engage in the exchange of service, including the customer, who experiences value in use (Vargo and Morgan 2005; Vargo and Lusch 2004). This notion implies that firms cannot deliver value directly to other actors but instead firms make value propositions that allow them, directly or indirectly, to support and facilitate the value co-creation process of other actors, e.g., customers (FP7). The interactivity of exchange may vary between different forms of service exchange. As mentioned previously, KIBS often involve an intense interaction and collaboration between customer and provider (Sampson and Froehle 2006). The customer integrates resources such as their own knowledge and skills into the service process and articulates specific needs or requirements. FP8 emphasizes this customer-centric and relational orientation of S-D logic (Vargo and Lusch 2004, p. 11) and FP9 points to the need to recognize all social and economic actors as resource integrators that are both value co-creators and value beneficiaries. Accordingly, actors form networks in which service is exchanged for service (Lusch and Vargo, 2006b, p. 285). FP10 "*value is always uniquely and phenomenologically determined by the beneficiary*" refers to the fact that the amount of value that actors co-create in use depends on contextual and actor-specific factors. In this regard, FP11 adds an institutional layer for the analysis of the context in which interactions and value co-creation activities take place, by emphasizing that the nature of the experiences and actions are determined by institutions and institutional arrangements.

The transition from G-D logic towards S-D logic was illustrated by Vargo et al. (2008, p. 146) using the manufacturing and usage of automobiles as an example. From a G-D logic perspective, value becomes embedded into the automobile in the process of assembling and integrating technologies and resources into the automobile. By contrast, from an S-D logic perspective, the automobile itself has no such inherent value. Vargo et al. (2008, p. 146) argue *"it is only when the customer makes use of the automobile in the context of his or her own life – that it [the automobile] has value."* In S-D logic, value creation is relational and context-specific, so that the amount of value that customers co-create is not determined by the production process but during usage (e.g., while driving a car or due to its effects on self-identity, etc.) and depends on a variety of contextual (e.g., available infrastructure and weather conditions) and customer-specific factors such as the customer's driving skills, and relations with other actors.

2.4.2 A Systemic View of Service and Value Co-Creation

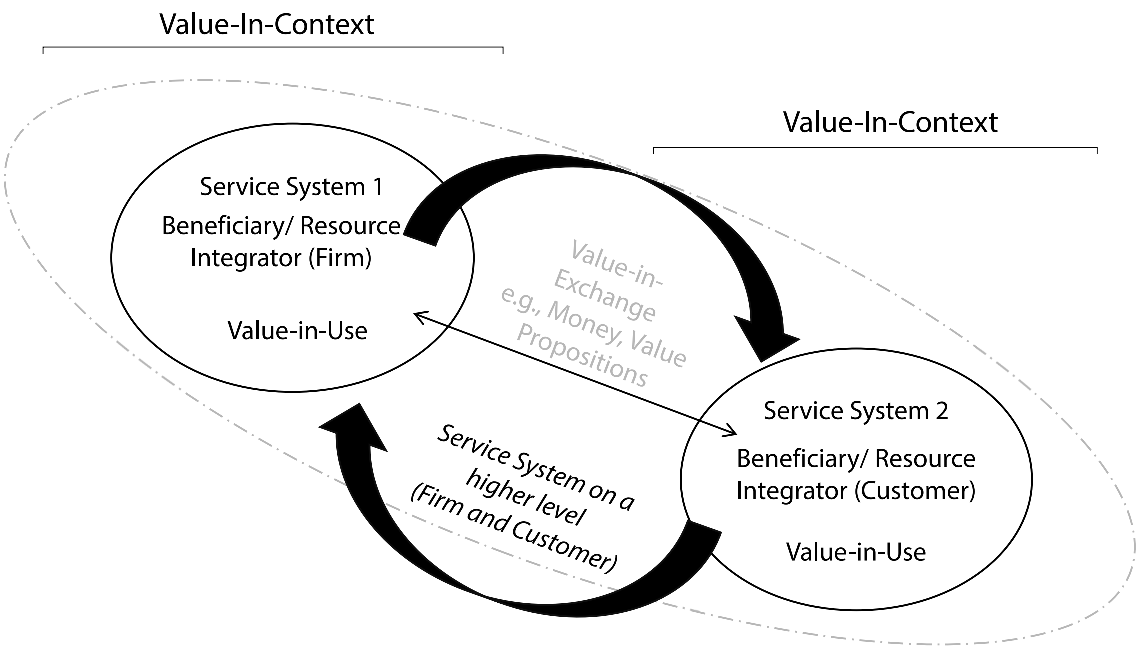
Recently, scholars have begun to steer the development of S-D logic towards a systemic understanding of service exchange and value co-creation in *service systems* and *service ecosystems* of service-for-service exchange (Vargo and Lusch 2011, 2014, 2016).

Service Systems

As stated, S-D logic is based on the thought that value is co-created in use through the application and integration of resources in networked constellations of mutual service-for-service exchange (Vargo and Lusch 2004, 2008). In this way, S-D logic broadens the narrow view of individuals or dyads towards value creation and resource integration in networked constellations. This idea draws attention to the fact that value creation does not happen in isolation, but instead on contextual interrelations with resources and actors in networks (Chandler and Vargo 2011; Vargo et al. 2008). However, a systemic view of service goes beyond a network perspective and emphasizes the dynamic self-adjusting nature of systems that reconfigure themselves as they function (Vargo and Lusch 2011, p. 5). The networked and dynamic interpretation of service exchange has led to the conceptualization of a *service system* as a *"configuration of people, technologies, and other resources that interact with other service systems to create mutual value"* (Maglio et al. 2009). Any economic actor can be considered an instance of a service system, including families, firms, nations, and economies (Spohrer et al. 2007, p. 72). The smallest service system is a human and the current largest is the world economy. Regardless of the size and complexity of the service system, its function is to integrate and transform resources for the better, and to co-create value for itself and others (Lusch and Vargo 2006b). Service systems are connected to other service systems by value propositions (Maglio et al. 2009; Spohrer et al. 2007). This gives rise to networks of service systems, i.e., service networks, in which actors interact and work together for their own benefit and the benefit of one another.

Fig. 2-6 illustrates the essential components of a service system by showing the dyadic relation between firm and customer (e.g., an individual or another firm) and highlights the difference between value-in-exchange and value-in-use. The small arrow between the two service systems illustrates the direct exchange relation (e.g., through goods or money) that is de-emphasized by S-D logic. The two large arrows illustrate the indirect exchange of knowledge and skills, which is emphasized by S-D logic. The illustration furthermore highlights that actors experience value that is determined by their own individual context, i.e., value-in-context. How actors assess and experience value is primarily determined by their interrelations and dependencies to other actors (Chandler and Vargo 2011).

Fig. 2-6 Value Co-Creation among Service Systems



Source: modified from Vargo et al. (2008, p. 149)

A systemic view of service points to the complex and dynamic nature of value creation among constellations of actors and resources that collectively provide the context through which value gains its individual and collective meaning (Vargo and Lusch 2011). Akaka et al. (2015, p. 217) underline the role of such interrelations by stating that *"Value creation cannot occur in isolation. It requires the interaction (direct or indirect) of at least two, if not more, actors"*. The notion of value-in-use emphasizes that value is phenomenologically experienced by the beneficiary, e.g., customer, and furthermore that the usefulness of resources is dependent on the context in which resource integration takes place (Chandler and Vargo 2011). In fact, in most cases, resources are of little use in isolation and thus need to be combined and bundled with other resources (Lusch and Nambisan 2015). Additionally, actors perceive and assess value on different systemic levels, e.g., on firm-level and employee-level (Chandler and Vargo 2011). In this regard, organizations are socially-constructed (service) systems that transfer the competencies and skills of lower level entities (employees and partners) into market-ready service offerings to co-create value for themselves and others (Lusch and Vargo 2006b). Employees, software, computers, and infrastructure that are involved in this process are resource bundles and nested configurations at a lower systemic level. The interrelations between these resources and actors offer actors (e.g., employees) a context for the integration of their competencies and skills. Employees co-create value for themselves and other actors, e.g., the firm and the customer. Accordingly, value co-creation is not limited to an individual system (e.g., firm) but becomes apparent in networks where collective assemblages of multiple systems are beneficiaries, e.g., firms, employees or even the society as a whole (cf. Fig. 2-6) (Maglio et al. 2009; Vargo et al. 2008).

Service Ecosystems

To better reflect the dynamics and complexity of value creation and innovation in the digital age, S-D logic scholars are continuously expanding the systemic view of service and emphasizing the evolutionary and dynamic nature of service-for-service exchange in *service ecosystems* (Vargo and Lusch 2011, 2016). The concepts of service ecosystems and service systems are closely related in that they are both grounded in S-D logic and draw on a systemic understanding of service exchange among configurations of actors and resources (Vargo and Lusch 2016). However, while the notion of a service system emphasizes the role of technology (Maglio et al. 2009), a service ecosystem emphasizes the role of institutions (Vargo and Lusch 2016, p. 11). Institutions should not be confused with organizations (Vargo and Lusch 2016): in a game of economic survival, organizations are the players, while institutions are (human devised) rules in the form of social structures that coordinate political, economic and social interactions (North 1990, pp. 4–5), i.e., *"the rules of the game"*. According to Vargo and Lusch (2016, p. 11), institutions can be *"formal codified laws, informal social norms, conventions, such as conceptual and symbolic meanings, or any other routinized rubric that provides a shortcut to cognition, communication, and judgment."* Tab. 2-9 gives a (non-exhaustive) overview of components of institutions that are mentioned in the literature (e.g., North 1990; Scott 2001; Vargo and Lusch 2016). Through multiple instances of service exchange and ongoing interactions, institutions become a coordinating framework, shared by a network of actors. In this way, institutions not only coordinate actors in their interactions and activities but also evolve from these interactions themselves (Vargo et al. 2015; Vargo and Lusch 2016).

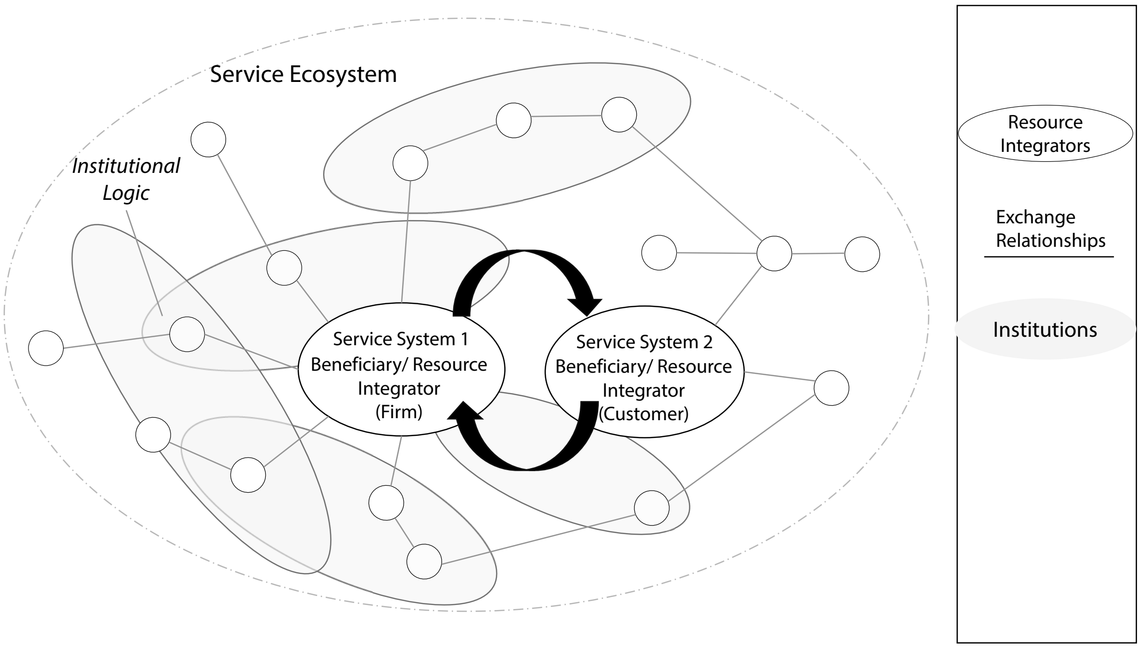
Tab. 2-9 Examples of Components in Institutions (non-exhaustive)

Type	**Examples**
Legal Practices	It is a legal requirement of German law that projects (above a particular volume) are competitively tendered in the market.
Norms	Switching off mobile phones in meetings to avoid disturbances.
Values	A firm commits itself not to do business with suppliers that employ child labor.
Beliefs	OEMs believe that their competitiveness depends on strong cost pressure on suppliers.
Standards	Exchanging, technical drawings via CATIA[8] stl-format.
Symbols	Nokia has become a symbol for the failure to adapt to the digital revolution.

[8] CATIA (Computer Aided Three-Dimensional Interactive Application) is a software application for computer-aided engineering and other related development activities

Adopting a service ecosystem perspective, institutions and their arrangements determine how actors interact and collaborate with other actors in service systems and networks, conceptualize markets, assess and experience value, and how they perceive their environment (Lusch and Vargo 2014; Wieland, Vargo, et al. 2016). Fig. 2-7 provides a sample illustration of a service ecosystem with several service systems.

Fig. 2-7 The Service Ecosystem Concept

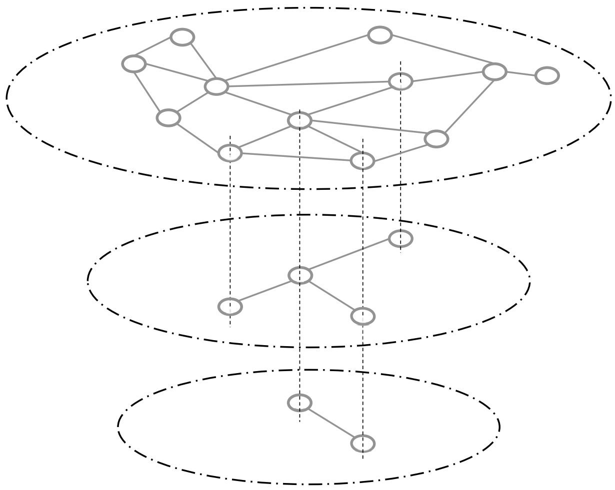


Source: based on Vargo and Lusch (2011)

To develop a more realistic understanding of value creation and innovation processes, Chandler and Vargo (2011) suggest that scholars should oscillate the scope of their analysis between different systemic levels, e.g., micro-, meso-, macro-levels (Lusch and Vargo 2014). The different systemic levels should be delimited from each other and defined appropriately for the research in question (Wieland, Vargo, et al. 2016). The service perspective used in this study differentiates between direct service-for-service exchange on the micro-level (individual ESPs and their dyadic relationships), direct networked service-for-service exchange at the meso-level (relationships between one ESP and several other actors in a network), and complex service exchanges (indirect and direct) at the macro-level of the service ecosystem (ESP market and automotive industry). Fig. 2-8 illustrates this distinction, which is consistent with the different levels proposed in the S-D logic literature (e.g., Chandler and Vargo 2011; Vargo and Lusch 2016).

Fig. 2-8 The Distinction between Micro-, Meso-, and Macro-Level

Level	Relations	Example
Marco	Multiple indirect relations in various constellations	The automotive engineering industry, the ESP market
Meso	Direct relations between a focal actor and other actors from his or her network	The relations between an ESP to OEMs, universities, and other ESPs
Micro	Dyads or individual actors	The relation between an ESP and an OEM



2.4.3 Innovation in Service Ecosystems

The study of service ecosystems requires the analysis of interrelated processes of change among multiple interdependent and co-evolving systems, such as organizations (Barile et al. 2016; Vargo and Lusch 2016). Concerning the conceptual understanding of innovation, the service ecosystem perspective extends the view of innovation beyond firm activities and linear[9] process models (Wieland et al. 2012). It furthermore draws attention to the interactions within and between service systems, the value that is co-created and assessed on an individual or collective level framed by social context, and the integration and recombination of resources in the process of innovation (Aal et al. 2016).

The S-D logic perspective on innovation in service ecosystems is in many ways different from the traditional understanding of innovation of neoclassical economics. Firstly, the notion of a service ecosystem broadens the traditionally narrow analytical scope beyond single entities (e.g., firms) or dyadic relations (e.g., firm-customer) and emphasizes service innovation as a collaborative process among networked constellations of co-evolving actors (Lusch and Nambisan 2015). The traditional separation between firms as innovators, and customers as innovation adopters (i.e., passive consumers) is thus replaced with the conceptual notion that service innovation processes unfold under the influence and diverse contributions of a variety of actors, including the customer (Lusch and Nambisan 2015; Vargo and Lusch 2011). Furthermore, the systemic and service-centered view of innovation of the S-D logic drives a shift in innovation research from the traditional focus on technological innovations and

[9] The term linear refers to innovation as a structured process that starts with (market) research, adds a phase of product or service development, and ends with production and diffusion (Godin, 2006, p. 639)

outputs to an emphasis on processes and interactions in networked actor constellations. This is highlighted by the following citation: *"innovation is not defined by what firms produce as output but how firms can better serve"* (Vargo and Lusch 2008, p. 5). From an S-D logic perspective, service innovation becomes a transcending concept that applies to all forms of innovations, regardless of whether tangible artifacts are involved or not. It further considers both the design phase and the use phase (cf. Orlikowski 1992) as components of the service innovation process (Vargo et al. 2015). Accordingly, innovation means that actors develop more compelling ways of co-creating value, which is a process that typically requires multiple actors of a network to change the established way of integrating and combining resources. Essential for this perspective on innovation is the assumption that innovations emerge, first, *through institutionalization* and, second, *through recombination*.

Innovation through Institutionalization

The notion of a service ecosystem expands the conceptual view on economic exchange, beyond the interactions within a network of resource integrating actors, towards the role of a shared institutional logic by which these practices and interactions are coordinated, constrained, and enabled (Vargo and Lusch 2011, 2016). This notion of a service ecosystem has inspired an institutional view of service innovation as a process of reconfiguring institutions on different systemic levels (micro, meso, and macro). Vargo et al. (2015) refer to this process as *institutionalization*, i.e., the making, breaking, and maintaining of institutions. Prior research on institutions has shown that the connection between innovation and institutional change is subject to a dualist role (cf. Vargo et al. 2015). On the one hand, service innovation drives changes in rules, norms, and practices, so that actors alter their behavior and interact, integrate resources, and co-create value in novel ways. Notably, institutional changes can influence how value propositions are perceived in the market. This means that even if the offering itself remains unchanged, its value to customers in the market may decline or increase. On the other hand, previous studies have shown that firms can innovate by enacting activities that purposefully disrupt and renew institutions (Battilana et al. 2009; Lawrence and Suddaby 2006).

The service ecosystem approach to innovation takes a dynamic view of *markets* and *technology*. Institutionalization is thereby considered a unifying concept that reconciles the traditional divide between market innovation and technological innovation by focusing on practices and knowledge (cf. Vargo et al. 2015). Recent S-D logic publications draw on the work of Kjellberg and Helgesson (2006, 2007), who emphasize that *markets* are not static but instead are continually performed through market practices (cf. Vargo et al. 2015). Vargo et al. (2015) argue that markets exist only by being continually recreated through the application of institutional practices and interactions among actors in service networks and service ecosystems (cf. Vargo et al. 2015). In this regard, Kjellberg and Helgesson (2006, 2007) differentiate between exchange practices (e.g., how customers and providers interact), normative practices (practices that create rules and standards), and representative practices (practices that create images of the market). A market can, therefore, be seen as a complex and consistent set of such practices that are changed or newly created through service innovation (cf. Vargo et al. 2015).

Technology in service ecosystems may be considered as *"potentially useful knowledge that may provide solutions to new or existing problems"* (Vargo et al. 2015, p. 65; cf. Mokyr 2011, pp. 1–3). Technology has a dualist role as both a potential outcome and an enabler of service innovation (Vargo et al., 2015). Innovation does not always lead to the creation of new artifacts but innovation may become apparent through new ways of using existing technology (which corresponds to the institutionalization of new practices). From an institutional perspective, innovation processes are always linked to the generation of new knowledge, e.g., on how to apply technology to solve a particular problem. This is also consistent with the observation that actors may innovate by developing new practices around technologies that go beyond the envisaged ways of use (Vargo and Lusch 2016). On the other hand, this also emphasizes that changes in the institutions and therefore, service innovation, are not necessarily the result of well-managed processes but happen through resource integration and the continuous efforts of actors to create more value. Actors may thus participate in and contribute to service innovation processes in various ways, both knowingly or unknowingly (e.g., Gallouj and Savona 2009).

Innovation in service ecosystems is a relatively new topic, which has so far been characterized by a prevalence of theoretical discussions and a paucity of empirical contributions (Vargo et al. 2015; Vargo and Lusch 2016). Previous research on institutional change has shown that actors can influence their institutional environment (Lawrence and Suddaby 2006). However, further research is needed on the extent to which actors in service ecosystems can innovate by making targeted and purposeful changes to institutions in service ecosystems. The actual processes and activities through which institutions are disrupted and renewed have so far rarely been the focus of attention, and the issue of how they are linked to innovation in service ecosystems remains open. The question of focused institutional change indicates a need to devote more reflection to the role of institutional power, which can be understood as the power to control people and to direct their behavior, typically by repetitively activating *"some set of socially constructed controls – that is by some set of rewards and sanctions"* (Pepperson 1991, p. 149).

In service ecosystems, institutional influence and power can be disproportionately distributed (e.g., Lawrence 2008). However, the different hierarchical positions of actors in service ecosystems has not yet been sufficiently targeted by in the literature. The few empirical studies on service ecosystems have focused on actors with a distinct influence on other parties. For example, Koskela-Huotari (2016) focused on four large enterprises which, simply because of their size, appear to occupy a dominant position in their ecosystem; this enables them to orchestrate the behavior of other actors (e.g., customers or suppliers) by deliberately breaking and replacing existing sets of institutionalized rules. Aal et al. (2016) examine how a large restaurant chain reconfigures its service ecosystem by putting new institutional rules in place. Wieland et al., (2016) described the institutional influence of the US car manufacturer Tesla, which also occupies a dominant position. In contrast, little attention has so far been given to the innovation behavior of actors that are in less dominant positions and whose institutional influence is rather limited, compared to those cases provided in the existing literature. Given the aim of S-D logic to provide a framework that applies to all empirical domains, more diversity in the study of service ecosystems would be desirable. In the current study, therefore, it will be interesting to observe the extent and method that ESPs can influence the institutional logic of their service ecosystem. According to Czarnitzki and Spielcamp (2003), KIBS firms often suffer from low demand density. This means that there are often only a few potential customers in a specific region who can choose from a limited number of different service providers with similar competencies and service offerings. The result is a considerable imbalance of institutional power in favor of the buyer-side. Such an imbalance of institutional power corresponds well to the service ecosystems of ESPs in the AES industry in which OEMs are a group of actors that are much more dominant than the ESPs themselves (cf. Kleinhans et al. 2015).

In summary, the S-D logic highlights that service innovation is a process of reconfiguring institutional rules and resource integration practices in service ecosystems. However, the link between institutional change and service innovation does not seem to be well understood. To date, the few empirical studies on innovation in service ecosystems merely focus on influential actors and thus do not adequately reflect that institutional influence of actors in their service ecosystems may vary considerably.

Innovation through Recombination

A fundamental paradigm of innovation in service ecosystems is the recombination of resources and competencies in service networks (Beverungen et al. 2017; Lusch and Nambisan 2015). The role of recombinant innovation can be traced back as far as Schumpeter, who considered innovations built upon a combination of existing things as one of the most common forms of innovation (Schumpeter 1934). It is a common paradigm of the innovation management literature that innovations emerge from novel combinations of existing resources and knowledge (Schumpeter, 1943).

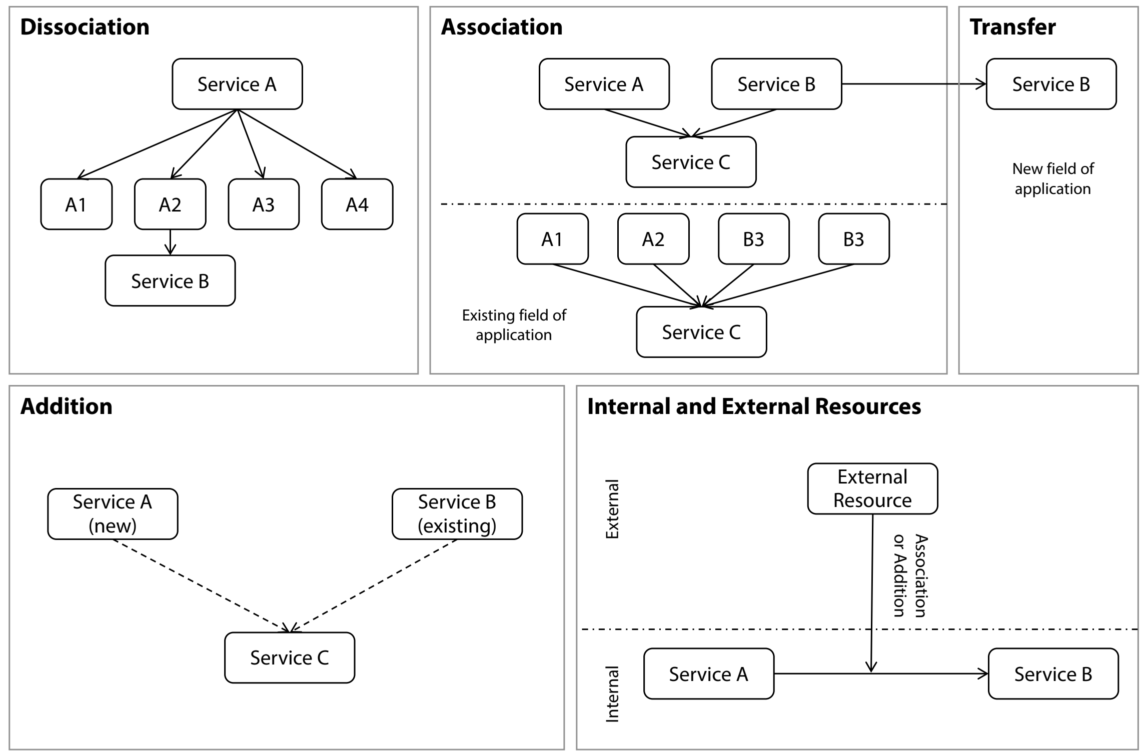
While recombination is often considered a specific form of innovation in line with many other types, such as incremental, radical, or formalized innovations (Gallouj 2002), recent S-D logic publications consider it to be the underlying innovation paradigm that fuels all other types of innovations in service ecosystems (Lusch and Nambisan 2015). In fact, innovation is rarely entirely constructed from the ground up and usually can be dissected into preexistent building blocks, (such as software, infrastructure or other technology, as well as service offerings,) that are combined in novel ways (Wirth et al. 2015).

The literature mentions a variety of recombinant principles and operations. In a recent literature review, Beverungen et al. (2017) present a conceptual scheme that details four specific recombinant operations (Fig. 2-9):

- *Dissociation* refers to the design of a new value proposition by splitting up an existing one or by isolating components and turning them into commercial offerings. An example of such an approach can be taken from consulting, where providers have developed a software solution to tackle recurring customer problems and occasionally begin to market these solutions as stand-alone offerings.
- *Association* describes the emergence of a new value proposition through a combination of existing offerings or service components, or by creating new relationships between previously unconnected elements. Examples are all types of service bundles and digital services, such as those that, integrate existing services via an Application Programming Interface (API).
- *Transfer* refers to the association of a service or service component (e.g., specific knowledge) with a new application context, in which new ways of value co-creation are enabled. For example, a consulting firm may use their knowledge in the management of complex projects to offer training on project management to other customers.
- *Addition* is another recombinant principle and refers to the enhancement of an existing value proposition with components or features. For example, a logistics provider may create a software application that allows its customers to track goods.

The resources that are added to, or associated with, can be drawn from sources that are either internal or external to an organization. This is illustrated in Fig. 2-9, in the lower righthand square.

Fig. 2-9 Recombinant Operations



Source: Beverungen et al. (2017, p. 139)

2.5 Innovation Patterns

Recognizing and describing patterns is an essential academic approach to identify and understand new and potentially complex phenomena (Thorngate 1986, p. 71). The innovation literature proposes classification schemes that characterizes types of Innovation processes or conceptualizes actor behavior within such processes (Hipp, 2000). Bailey (1994, p. v) suggests these classification schemes can be distinguished into two research approaches: typologies and taxonomies. While typologies are primarily based on conceptual or qualitative research, taxonomies are based on quantitative research and typically use cluster analysis to classify cases according to their differences and similarities. Tab. 2-10 provides an overview of relevant innovation taxonomies and typologies.

Tab. 2-10 An Overview of Innovation Taxonomies and Innovation Typologies

Type	Approach	Conceptual Logic	Sources
Innovation Taxonomies	Quantitative empirical research that characterizes group- or industry-specific innovation behaviors	Innovation in services as distinct from innovation in products. Service innovation as an innovation pattern on its own.	Pavitt et al. (1989), Evangelista (2000), Miozzo and Soete (2001), De Jong and Marsili (2006), Camacho and Rodriguez (2008)
Innovation Typologies	Qualitative empirical or conceptual research that distinguishes and describes types of innovation processes	Innovation processes in KIBS industries are distinct from other industries.	den Hertog (2000), Toivonen and Tuominen (2009)
		Service innovation as all-encompassing and as a process of institutional change (S-D logic)	Koskela-Huotari et al. (2016)

Innovation patterns proposed in the literature vary as to their approach and conceptual logic. Innovation taxonomies typically highlight characteristics of service firms that identify reasons for different industry-specific innovation activities, whereas innovation typologies are more concerned with the processes through which innovations in services emerge and the conceptualization of types of service innovation processes. A further distinction can be made between typologies examining KIBS-specific innovation processes and those employing S-D logic to classify service innovation processes based on categories not limited to certain types of innovations, such as technical innovations, but are more broadly applicable in different innovation contexts. A selection of the taxonomies and typologies is presented in more detail below.

2.5.1 Innovation Taxonomies

Many studies attempting to identify innovation patterns assume the existence of significant differences in the innovation behavior between firms or industry sectors; however, they also assume a similarity in the patterns taken to innovate by some groups of firms. Studies that follow this assumption, typically draw on quantitative sector-level or firm-level data and use factor analysis to classify firms into different clusters or groups, distinguished by a specific characteristic innovation pattern (Hipp 2000). The taxonomies resulting from this deductive approach divide companies into different classes, whose characteristics correspond to specific types of innovation outcome or innovation behaviors (cf. Hipp 2000, pp. 123–126).

One of the pioneer studies, conducted by Pavitt et al. (1989), identified different sector-specific trajectories of technological change. The authors distinguished between three types of firms: *supplier-dominated firms* (e.g., service industry), *science-based firms* (e.g., electronics industries), and *production-intense firms*. The category of *production-intense firms* was divided into two further categories: *specialized equipment producers*, e.g., mechanical industries; and *scale-intensive firms*, e.g., vehicle industry. The work of Pavitt et al. (1989) inspired several follow-up studies that proposed similar taxonomies or suggested refinements of the original taxonomy. One of these studies, Miozzo and Soete (2001), suggested a refinement to the original taxonomy that differentiates between four types of firms:

- *Supplier-dominated sectors:* Firms in this category are the least innovative in that their innovation activities center primarily on process innovations. Their innovation activities are thus primarily driven by suppliers. One reason for this is that firms in the supplier-dominated sector tend to lack R&D and engineering capabilities and often have limited software expertise. Repair and hospitality services are typical examples.
- *Scale-intensive physical network sectors:* Firms that rely on physical networks and enact large-scale processes within which activities and tasks are divided among several parties. R&D activities often aim to reduce costs and to simplify processes. Travel and transport are typical examples.
- *Information network sectors:* Firms that rely on information networks. Examples for firms in this sub-category are finance, insurance, and communications. Firms in this category innovate by developing new, or improving existing, technologies.
- *Service-based and specialized supplier sectors:* Firms in this category naturally orient their business activities towards innovation. They make extensive use of research institutes and universities as sources of innovation. Innovation activities are thus often collaborative and rely on an in-depth understanding of customer needs and problems.

The taxonomy proposed by Miozzo and Soete (2001) has provided the conceptual foundation for several further studies that have attempted to identify firm-specific innovation patterns in various industries, sectors, and countries. For example, de Jong and Marsili (2006) investigated innovation patterns among small and mid-sized service firms. Camacho and Rodriguez (2008) investigated innovation patterns in the Spanish service sector and reassigned the existing categories of Miozzo and Soete to a new taxonomy. Evangelista (2000) identified innovation patterns that are characteristic of different Italian service industries. These studies have in common that they reflect a distinct G-D logic and draw on a narrow interpretation of service innovation (cf. also Tidd et al. 2005; Tidd and Hull 2003). Typically, the authors differentiate between service-firms and non-service firms, and also between innovation in services and innovation in products. In fact, several taxonomies assume that service innovation has a distinct innovation pattern of its own (Miozzo and Soete, 2001; Pavitt, 1984).

Taxonomies have significantly contributed to innovation research; however, they have also been criticized for various reasons. For example, Hipp (cf. 2000, p. 136) argued that many taxonomies limit the scope of their analysis to organizational factors and neglect other equally important contextual variables, such as those related to technology or a firm's social and economic environment. Another problematic point is that quantitative studies assume that service innovations are necessarily the outcome of well-managed innovation activities, starting with the identification and analysis of a problem or need and ending with the development and marketing of a service. However, more recent studies have shown that service innovations also tend to arise in an unplanned and sometimes chaotic fashion (e.g., Gallouj and Weinstein, 1997; Toivonen and Tuominen, 2009). Finally, a growing number of scholars argue that there is no standard or unique pattern of innovation for specific firms or industries and that taxonomies do not adequately reflect that the individual ways that firms innovate (Camacho and Rodriguez 2008; de Jong and Marsili 2006).

2.5.2 Innovation Typologies

Innovation typologies has produced another stream of the literature that conceptualizes specific types of innovation processes, based on the commonalities and differences in the innovation behavior of firms or industries. Innovation typologies are distinct from innovation taxonomies, in that they are the result of qualitative empirical studies or conceptual research (Bailey 1994; cf. Hipp 2000, pp. 115–117). In comparison to taxonomies, innovation typologies are underrepresented in the innovation literature.

Scholars widely agree that the innovation behavior of KIBS firms does not adhere to many traditional innovation models that were developed in manufacturing industries (Camacho and Rodriguez 2008; Muller and Doloreux 2007; Sundbo and Gallouj 2000). One reason is that the innovation activities of KIBS firms (more than in other industries) rely on intense collaboration with local customers (Miles 2008). Scholars have thus attempted to address these peculiarities by proposing KIBS-specific innovation typologies. A frequently cited KIBS-specific innovation typology has been proposed by den Hertog (2000). He conducted conceptual research and developed a multi-dimensional model that frames service innovation along four dimensions of novelty: service concept, client-interface, service delivery system, technological options. Den Hertog asserted that innovation often requires changes in multiple dimensions simultaneously and relies heavily on knowledge and creativity. Drawing on insights from the model, den Hertog presented five basic patterns of service innovation:

- *Supplier-dominated innovations:* This pattern refers to innovations that emerge from the availability of new technology that results in a technology push. For example, microwaves have enabled new forms of catering services, which allow food to be warmed up quickly and directly at the premises of the customer.

- *Innovation within services* refers to the changes in the internal organization of a service provider. An example is a new service delivery system that drives changes in the internal service production processes.
- *Client-led innovation*s characterize innovations that occur when service firms innovate in reaction to a particular need or problem that comes to their attention in the market. For example, green banking services emerged from the desire of customers to invest in ways that are socially responsible.
- *Innovation through services* refers to the role of service providers within the innovation processes at the customer organization. An example is that service providers help their customers in the development of innovative products or solutions.
- *Paradigmatic innovations* describe innovations that affect multiple actors of a value chain. Such innovations are primarily driven by technological revolutions, for example, when the availability of new means of transport or communication alters the behavior and capabilities of all actors in a value chain.

The work of den Hertog (2000) has significantly extended the understanding of innovation in KIBS. The five patterns show that changes in service offerings are not necessarily driven by service providers themselves but may also be triggered by other parties from their network, e.g., by suppliers or customers. However, the work of den Hertog is still shaped by the dominant mental model of G-D logic, which is shown by the fact that service innovation has been considered distinct from innovation in products. Furthermore, den Hertog's patterns are more concerned with the changes that KIBS firms provoke and less with the fact that the services offered by KIBS firms, may evolve or change (Muller and Doloreux 2009).

Another typology that explicitly deals with the changes in KIBS has been proposed by Toivonen and Tuominen (2009). To examine innovation behavior, the authors draw on qualitative empirical data from three different KIBS industries (marketing communications, architectural design, and engineering consultancy. Five patterns of innovation in KIBS industries emerged as a result of their study:

- *Internal processes without a specific project* describe those processes that lead to unintentional innovations – which are sometimes *"borderline cases between innovations and continuous adaptation"* (Toivonen and Tuominen 2009, p. 894).
- *Internal innovation projects* refer to project-based efforts that are carried out in the internal organization and often run parallel to daily business.
- *Innovation projects with a pilot customer*: These projects target the development of innovations in collaboration with the customer, so that the customer participates in the innovation activities and becomes an evaluator and informant during the process.

- *Innovation projects tailored for a customer*: These projects are directed at a customer-specific need or problem, and involve joint innovation activities of the service provider and the customer. According to Toivonen and Tuominen (2009), the resulting innovations are ad-hoc by nature and are often difficult to transfer to other customers or to other application fields.
- *Externally funded innovation projects:* These projects are often research-oriented, so that the service provider engages in collaboration with research institutions or universities. Such innovation activities are often systematic and follow formal plans and process descriptions.

These proposed innovation patterns are among the most explicit descriptions of innovation processes in KIBS. According to Toivonen and Tuominen (2009), the five process types *"illustrate the multiplicity of innovation practices in service firms."* Furthermore, the authors point out that the innovation activities of KIBS firms are often a response to new customer needs. However, the conceptual description of the five process types offers little detail on the steps and activities involved and reflect the traditional divide between the firm as innovator and the customer as innovation adopter.

Despite the increasing interest in a service ecosystem perspective, there has been little empirical analysis of innovation processes in service ecosystems. As one of the few exceptions, Koskela-Huotari et al. (2016), studied the innovation behavior of four different enterprises (two manufacturing companies, a food marketplace, and a retailer) and describe patterns in the way these firms reconfigure the logic in their service ecosystems by making, breaking and maintaining institutional rules:

- *Changing the business logic*: the authors describe how firms innovate by changing the rules that guide and determine business decisions. As an example, Volvo Buses replaced old practices in their administrative system with new rules that enable a more distinct focus of service development activities on customer usage.
- *Changing the innovation procedures:* for innovations to emerge, firms must first change the rules that guide, and often to a certain extent constrain, their innovation activities. For example, Siemens replaced the rule of how to establish customer contact, which inspired a new way of involving customers in innovation processes.
- *Changing the core competencies:* changes in the structures and rules within organizations can lead to new core competencies and enable new value propositions. For example, when ICA (a retail and banking organization) institutionalized a new cooperation between two internal departments, the firm was able to develop an innovative value proposition that integrated internal competencies in a novel way.

- *Changing the market structure:* changes in the traditional concept of how actors and resources are integrated into value propositions and service systems can lead to innovations. For example, the restaurant/supermarket chain Eataly broke free from the established concepts of supermarkets and restaurants and mixed both concepts in an innovative approach that led to the emergence of a new market.

An essential finding of Koskela-Huotari et al. (2016) is that the emergence of innovation in service ecosystems requires some rules to be broken, while others must be maintained. The authors explain this by virtue of the fact that actors (in most institutionalized practices) need a certain degree of orientation based on established routines and practices, so that changing too many rules simultaneously may be counterproductive.

2.6 Chapter Conclusion

The concepts and theories reviewed in this chapter provide the context of the current study. They do not represent the full range of literature that has been taken into account during the research process. Instead, the selection was chosen parsimoniously, with the aim of providing the foundation for the analysis and discussion of findings in later chapters. Relevant topics and concepts were proposed in four sections: Section 2.2 introduced the empirical research domain of AES in Germany, as a subdomain of KIBS. Section 2.3 provided an overview of relevant trends in the German AES industry. Section 2.4 introduced the S-D logic and its service ecosystem perspective on innovation. Finally, section 2.5 gave an overview of previous studies that have followed different approaches in the detection and conceptualization of innovation patterns.

In summary, the service ecosystem perspective of S-D logic represents a new and promising approach to study innovation in KIBS domains. Given that the German AES industry is currently experiencing significant changes, the service ecosystem perspective may aid practitioners in better understanding resource integration practices in service ecosystems and how innovation activities and interactions in networks reconfigure institutional rules. On the other hand, the service ecosystem perspective is, itself, still in its infancy. Recent discussions have so far taken place on a mainly theoretical level, thus providing the opportunity for the current research to underpin and complement theoretical ideas empirically. In particular, classification schemes are considered useful to develop a more realistic understanding of how different actors in service ecosystems participate in, and contribute to, service innovation processes.

3 RESEARCH DESIGN

3.1 Chapter Introduction

This chapter introduces the research design of the current study. According to Yin (2014, p. 28) *"a research design is a logical plan for getting from here to there, where here may be defined as the initial set of questions to be answered, and there is some set of conclusions (answers) about these questions."* Ensuring the research design is explicit is considered crucial to the better understanding of its merits and potential limitations (Maxwell 2012). This chapter describes the qualitative research design of this study, which is characterized by an abductive[10] process of collecting, analyzing and interpreting qualitative data from different sources.

3.2 Linking Research Questions and Research Design

The research design links the research questions to the techniques used in the collection, analysis, and interpretation of empirical data (Yin 2014, pp. 28–29). The qualitative research design of this thesis was chosen in alignment with definitions and conceptual views from existing S-D logic literature. S-D logic and the service ecosystem perspective consider the importance of institutions, interactions, and resource integration practices in the analysis of service innovation processes. More specifically, this study adopts the S-D logic interpretation of service innovation as an interactive process that leads to the institutionalization of new resource integration practices (Vargo et al. 2015). Furthermore, S-D logic invokes a systemic view of service innovation that suggests analyzing changes and interactions in service innovation processes on different systemic levels, i.e., micro-, meso-, and macro-level.

Regarding the empirical data, an approach was selected that concentrates on two ESPs as focal actors. Data were collected from the ecosystem in which these companies operate and interact with other actors, in particular, with large OEMs, who are primary customers of AES (cf. section 2.2.1). For this reason, interviews with OEMs and other ESPs were conducted in addition to the interviews with representatives from the two main case organizations. Furthermore, as encouraged by the S-D logic (e.g., Wieland, Vargo, et al. 2016), the analysis focused more on the process of service innovation and less on the outcome. To extend the analytical scope beyond individual actors and to gain a macro-understanding of service

[10] Abduction is a form of logical reasoning (Peirce 1974) that aims at theory development by continuously interfering with theory and practice. Abductive research alternates between induction (theory generation) and deduction (theory testing and refinement) (Dubois and Gadde 2002; Peirce 1974; Reichertz 2014).

ecosystems, insights were aggregated across interviewees and firms (Vargo and Lusch 2011). Given these remarks, the following three research questions are posed:

- *How can service innovation processes in the AES industry be categorized?* (RQ1) This research question provides the foundation for the development of a classification scheme that conceptualizes different types of service innovation processes according to observed variables. As mentioned previously, recent literature has called for new innovation typologies that make the processes of service innovation more explicit and comprehensible by conceptualizing different types (e.g., Carlborg et al. 2014; Hipp and Grupp 2005). According to Bailey (1994, p. 12), a classification scheme is a *"premier descriptive tool"* that groups different cases based on their similarities. The classification of service innovation processes is thus mostly a challenge of detecting patterns in the empirical data; these will allow a description to be made as to the typical course of how service innovations emerge. Two essential tasks derive from this challenge: First, to identify suitable variables that will allow service innovation processes to be distinguished and grouped accordingly; second, to define and describe the specific process types.
- *How do ESPs interact with other actors from their network in the course of service innovation processes?* (RQ2) Considering service innovation processes involve interactions in networked constellations, this question aims to investigate the roles of ESPs and their interactions with other actors that lead and drive service innovation in engineering services. Prior research has shown that KIBS firms do not generally organize their innovation activities in dedicated innovation departments, instead they link them closely with service provision (Toivonen et al. 2007). This translates into the need to analyze, from a broader perspective (e.g. capturing interactions in different contexts, including those during service provision), the flow of knowledge and information between ESPs, OEMs and other actors.
- *How are service innovation processes interlinked with changes in institutions and institutional arrangements?* (RQ3) As discussed previously, the notion of a service ecosystem invokes an institutional view, according to which resource integration and value co-creation are enabled, guided, and constrained by institutional rules (Vargo and Lusch 2011, 2016). Examining innovation through an institutional lens draws on the notion that service innovation processes are coupled with the disruption and renewal of norms and rules (Vargo et al. 2015). This view allows the researcher to consider various types of interactions and activities in the analysis, including those that are only implicitly connected with innovation. Given that innovations in KIBS rarely follow detailed plans, and typically proceed in processes with a low degree of formality (e.g., Toivonen and Tuominen, 2009; Muller et al., 2012), an institutional view seems a particularly useful method to gain a more comprehensive understanding of service innovation in AES.

3.3 Research Method and Abductive Case Study Approach

To investigate service innovation in the AES industry – a phenomenon that is highly complex and insufficiently understood – an abductive case study methodology was chosen. The research design and methodological approach follow the established guidelines of case study research and the use of qualitative methods (especially those provided by Yin 2014; and Cassell and Symon 2004) and incorporate the logic of abduction (Dubois and Gadde 2002, 2014).

3.3.1 Research Method

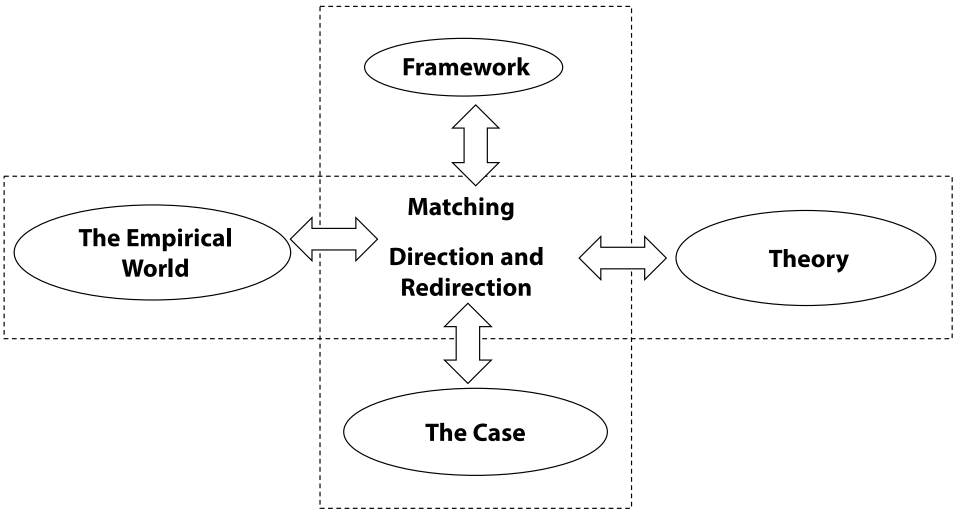
This research utilizes a case-study methodology. According to Yin (2014, p. 16), a case-study is "*an empirical inquiry that investigates a contemporary phenomenon (the 'case') in-depth and within its real-life context, especially when the boundaries between phenomenon and context may not be clearly evident.*" Contrary to experimental methodology and most quantitative studies, the subject of a case study is not separated from the context, therefore the analysis is not limited to predetermined variables (Yin 2014). In particular, if it is difficult to separate the phenomenon under investigation from the context, (as with service innovation) (cf. Vargo et al. 2015), case study research has the advantage of enabling the researcher to examine the relevance of causalities in an exploratory fashion, without having to consider relavance at the outset. By following this path, the researcher collects detailed information in order to understand the subject and the contextual conditions (Yin and Davis 2007). In this study, the primary method of gaining empirical insights into the research phenomenon (i.e., service innovation) is by conducting and analyzing interviews with relevant groups of respondents. Characteristic for this approach is that the researcher analyzes interview transcripts from the participants, then, based on his understanding and following rigorous empirical consideration (Yin 2014, pp. 133–135), he develops an interpretation of the phenomena. More so than in quantitative studies, the conclusions drawn from the analysis of the data are thus dependent on the individual interpretation and ideas of the researcher (May and Perry 2014).

3.3.2 Abductive Approach

This study applies an abductive approach to case study research based on the guidelines provided by Dubois and Gadde (2002, 2014). The abductive case study methodology is different from many case study approaches found in the literature and for this reason a brief introduction is provided here. The abductive approach is a response to the high degree of uncertainty with which researchers are often confronted, at the beginning of their research activities, and which makes it difficult to foresee and plan the course and outcome of the research (Creswell 2003, pp. 73–74). The abductive approach embraces the uncertainty related to exploratory research, by assuming that the essential research activities, such as data collection, data analysis, literature review and theory development, do not take place in successive pre-planned phases, but are instead carried out intertwined – preferably closely (Dubois and Gadde 2002, 2014). The researcher's initial understanding of the research problem is thereby refined in several iterations; therefore ensuring he does not become fixed in the pursuit of predetermined research aims, but instead remains flexible and able to adapt to topics and questions that arise during his research. The initial research questions and objectives may thus change several times in the course of the research process (Dubois and Gadde 2002, 2014). The high degree of agility in the research process makes abduction particularly useful for exploratory studies that aim to discover new things and investigate phenomena that are poorly structured (Dubois and Gadde 2002, 2014); this corresponds well with the aim of this research to examine processes of service innovation.

Dubois and Gadde (2002, p. 555) describe four elements of the abductive approach: the *empirical world* (e.g., interview data), the evolving *research framework* (typically in the form of a coding scheme), *theory* (the literature, e.g, on innovation), and *the case* (research aims, findings, and their presentation). The authors encourage scholars to continuously go *"back and forth"* (Dubois and Gadde 2002, p. 555) between the four different elements in a procedure that leads to a continuous matching and comparing between existing theoretical concepts, the empirical data, and analytical interpretations (i.e., the findings). Scope and method of data collection are thereby not static but are continuously directed and redirected throughout the study. The evolving framework is thereby successively refined and enables the researcher to develop a better understanding of the emerging case (Dubois and Gadde 2002; Dubois and Gibbert 2010). Fig. 3-1 illustrates this procedure, which Dubois and Gadde (2002, p. 555) describe as *"systemic combining."*

Fig. 3-1 Systemic Combining in Abductive Case-Study Research



Source: Dubois and Gadde (2002, p. 555)

3.4 Course of the Research

The research process lasted from May 2014 to December 2017. During this time, primary research activities, such as data collection, literature research, and theory development were carried out mainly in parallel and were closely interlinked (Dubois and Gadde 2002; Dubois and Gibbert 2010). In the course of the research process, the research aims, the scope of the data, the focus of the analysis, and the considered theoretical knowledge were subject to three significant reorientations resulted in the division of the research process into four consecutive phases. Tab. 3-1 gives an overview of the phases and describes their specific characteristics.

Tab. 3-1 The Four Consecutive Phases of this Research

Phase	**Phase I**	**Phase II**	**Phase III**	**Phase IV**
Timeframe	*May – Oct 2014*	*Nov 2014 – Feb 15*	*Mar – Oct 2016*	*Nov 2016 – Dec 2017*
Purpose of the phase/ research aims	Familiarization of the researcher with the research domain, assessing relevant themes in the field.	Understanding recombinant processes and the role of ESPs in networks.	Examining service innovation processes and capabilities, and changes in service innovation practices.	Detecting and modeling service innovation patterns.
Empirical data collection	9 preliminary interviews (1 ESP), field observations.	14 in-depth interviews (5 ESPs, 3 OEMs), archival data (e.g., company documents).	17 in-depth interviews (4 ESPs, 3 OEMs), field observations.	6 in-depth interviews (3 ESPs), archival data.
Literature considered	The literature on KIBS (e.g., Miles et al. 1995; Muller and Zenker 2001).	The literature on KIBS, recombination, and service modularity (e.g., Cabigiosu et al. 2013; Bask et al. 2011; Arthur 2009).	The literature on KIBS, S-D logic, and service innovation (e.g., Toivonen et al., 2007; Toivonen and Tuominen, 2009; Sundbo and Gallouj, 2000).	The literature on service innovation and S-D logic (e.g., Lusch and Nambisan 2015; Vargo et al. 2015).
Theoretical framework and code template	Coding of various themes and clustering to larger code categories.	Focus on recombination and modularity in services, reassignment, and modification of codes.	Focus on service innovation, four key topics: business environment, resource integration, value propositions, service innovation procedures.	Dimensions and characteristics of the analytical framework, service innovation patterns.
Redirections and outcomes	Selection of a first case. Direction of the study towards recombination and changes in the role of the ESP.	Redirection towards innovation.	Selection of a second case. Redirection of the study towards an S-D logic perspective on innovation.	Analytical framework, service innovation process typology.

Although this study draws on different data sources, the primary method of data collection was in-depth interviews with ESPs and OEMs. Tab. 3-2 gives an overview of the interviews in the different phases of this study. In total, 46 interviews were conducted – 35 interviews with ESPs and 11 with OEMs. Due to the repeated reorientation of the study, the focus of the interviews was gradually refined and adapted to the evolving research questions. The following four sections describe the different phases of the research process and the respective changes. Subsequently, section 3.6 provides further details on the different data sources and describes the approach taken to conduct the interviews.

Tab. 3-2 Interviews Conducted during the Research Process

Firm Type	**Organization** [11]	**Phase I**	**Phase II**	**Phase III**	**Phase IV**	**Total**
ESPs	XTEC	9		8	2	19
	SIMULI		2	4	2	8
	IDESIGN		1			1
	MCRAFT		1	1		2
	YEDGE		1			1
	ZMETAL		1			1
	XTR				2	2
	TAGOW			1		1
OEMs	AUTO AG		2	1		3
	BRUM AG		1	1		2
	XRAD AG			1		1
	DRIVE AG		5			5
Total		**9**	**14**	**17**	**6**	**46**

3.4.1 Phase I

In high-tech sectors, such as the AES industry, companies tend to be particularly reluctant to give researchers access to internal resources and information. However, in case study research it is vital to ensure sufficient access to empirical data (Yin 2014, p. 28). The first phase of the research (cf. Tab. 3-1, Phase I) thus began with negotiations on access to XTEC, a medium-sized ESP, with more than 500 employees. Securing access to an organization was considered essential to reduce uncertainty at the beginning of the research process regarding the collection of sufficient empirical data (King 2004a). Following the success of the negotiations,

[11] For reasons of anonymity, the real company names were replaced with fictitious names.

the first round of data collection took place between May and September 2014. Instead of directly narrowing the scope of the questions to a specific research topic, the objective was to become familiar with the research area and to identify relevant research topics. A similar approach has been successfully used in previous exploratory studies (e.g., Singh, 2014).

In Phase I, nine preliminary face-to-face interviews were conducted with managers and employees working at XTEC. The interviews took place during an on-site visit at XTEC, which enabled the researcher to make additional field observations (cf. 3.6.4). Informants were selected with a priority on diversity to consider multiple perspectives and roles (King 2004a, p. 16). Accordingly discussions revolved around diverse topics, ranging from value creation activities, modes of collaboration, innovation activities, strategic goals, to current market-related trends. Further information on the preliminary interviews is provided in section 3.6.1. To obtain approval for the second phase of more detailed interviews and to narrow the scope to a specific theme, the results of the preliminary interviews were compared to the literature and discussed with XTEC's management board. In subsequent discussions, the management board expressed a distinct interest in the topic of recombination and indicated the need to understand better how ESPs can develop new service offerings by combining and recombining resources and competencies within, and across, the organization. Furthermore, the interviewees highlighted the influence of a massive transformation of the AES industry on the role of ESPs in collaboration with OEMs and other stakeholders. During the discussions with the management board, further topics of interest surfaced, such as agility in the organization, innovation, and service modularity. In response to these insights, the study was explicitly refocused towards the aim of examining recombinant processes in the light of current market dynamics.

3.4.2 Phase II

The second phase of the research (cf. Tab. 3-1, Phase II) started with the second round of data collection, which was carried out between November 2014 and May 2015. This phase involved conducting 14 in-depth interviews, with a more specific thematic focus on recombination, service development, and the business environment. As encouraged by XTEC, interviewees were selected from a more diverse range of market participants that included multiple ESPs and OEMs (cf. Tab. 3-2). The interviews were semi-structured and broadly followed the theme of predefined interview guidelines; however without being limited to them. The interviews covered the role of ESPs in the collaboration and interaction with OEMs and other stakeholders, modularity in services, and innovation opportunities for the ESPs. Additionally, the influence of the transformation of the automobile industry on the role of the ESPs in the automotive development environment was discussed. Respondents mentioned several additional topics, which shifted the thematic focus of the interviews more in the direction of innovation. A first insight, which was identified, was that the role of ESPs was changing and that ESPs, unlike in the past, were assuming more control over the course and outcome of their services; this opened up new opportunities for ESPs and created a more distinct need for them to actively engage in service innovation. However, the large number of interviews with several different firms was not sufficient to draw more profound conclusions. This suggested the need to narrow the scope of data collection to individual ESPs and, more specifically, to the topic of innovation. A second insight was that the initially envisaged topic of recombination proved to be inseparably interlinked with various other topics and, as a result, was less decisive than expected, when compared, for example, to the interactions and roles of ESPs in collaboration with other actors, who were more dominant in the interviews. In response to these insights, the study was reoriented a second time, with two particular aims, firstly, to identify a second case, for a comparison with XTEC, and secondly, to more precisely focus on innovation in engineering services.

3.4.3 Phase III

After the reorientation of the study towards the key topic of innovation (cf. Tab. 3-1, Phase III), statements from the interviews were compared with concepts from existing literature that describe service innovation in KIBS domains. As mentioned previously (cf. chapter 2), the existing body of knowledge on innovation revealed a research gap in this area. While the interviews supported what has been described by the S-D logic interpretation of service innovation, (e.g., the significant role of networks and interactions) (Lusch and Nambisan 2015), the collection of more empirical data was considered necessary to explore service innovation from the S-D logic perspective. Hence, it was decided to specifically investigate innovation in engineering services from the S-D logic perspective. The third phase of data collection was completed between May and October 2016 in a similar way to the previous phase, but with a more distinct focus on service innovation. Interviewees from the previous phase were invited to participate in the follow-up study. In total, 17 interviews were conducted during this time. One of the firms that had already participated with two interviewees in the previous interview phase and had expressed a particular interest in the research was SIMULI, a mid-sized ESP. Managers of the firm outlined the need to understand better how the firm could develop new service offerings and agreed to provide informants for six further interviews. This possibility to collect data from a second ESP provided an opportunity for a more detailed investigation of the organization and a comparison of their innovation behavior with XTEC. In this phase, the research process became increasingly abductive, in that interviews with XTEC and SIMULI were continually compared and matched with the existing body of knowledge on service innovation from the S-D logic literature. Detailed textual descriptions of both cases supported the analysis. The analysis made apparent that the service innovation processes exhibit patterns in that they show regularities in the occurrence of activities, roles, interactions, and their respective constellations. In response to this insight, the study was reoriented again – this time with the aim of detecting and conceptualizing specific process patterns, as part of a comprehensive service innovation process typology for the AES industry.

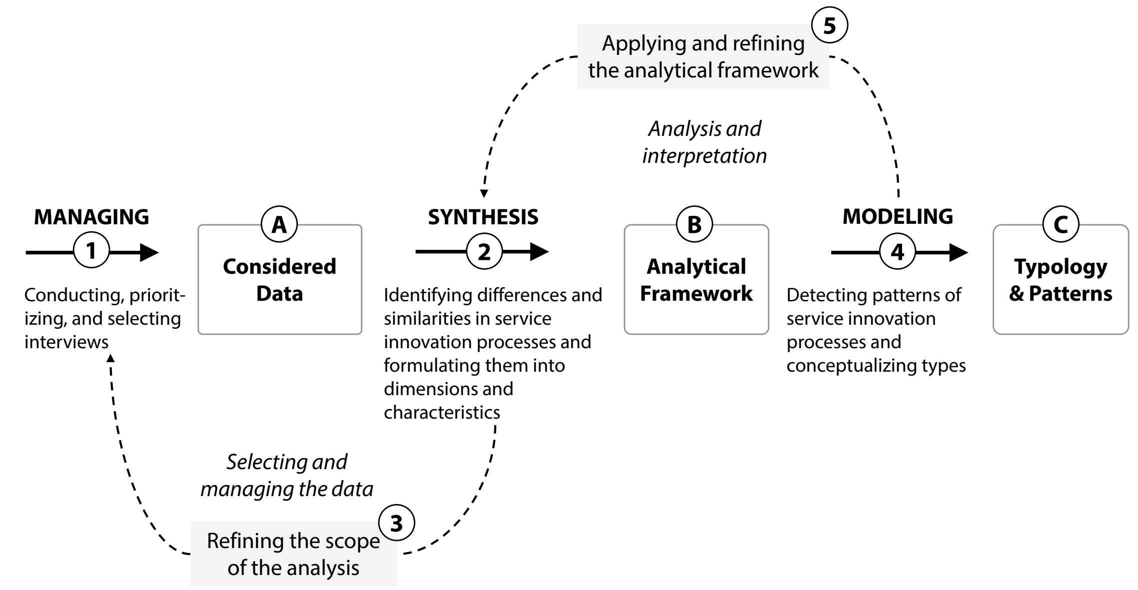
3.4.4 Phase IV

The fourth phase of the research, which was completed between November 2016 and December 2017 (cf. Tab. 3-1, Phase IV), concentrated on the analysis of the interview data and the conceptualization of research results. The detection and conceptualization of service innovation patterns was an iterative process that happened in two interrelated cycles of *selecting and managing the data* and their *analysis and interpretation*. Fig. 3-2 illustrates the interplay between the two cycles.

The complexity and extensive amount of interview data required active management (step 1, Fig. 3-2). Related activities included assessing interviews according to relevance and prioritizing them for analysis. Furthermore, six additional interviews were conducted (cf. Tab. 3-2) to complement the data and reflect statements and insights on the two main cases in a broader context. The scope of the analysis was first narrowed down to interviews with the two primary cases of XTEC and SIMULI (A, Fig. 3-2), which offered particularly rich accounts for service innovation processes. The selection of interviews was followed by a phase of analyzing interviews and synthesizing findings into an analytical framework with several dimensions and characteristics (step 2, Fig. 3-2). During the analysis, the scope of the considered interviews was gradually refined, such that the analysis was extended to additional interviews and other firms (step 3, Fig. 3-2).

The focus of the analysis was the innovation behavior of the ESPs, for example, their roles, activities, and interactions with other actors from their network. The interviews were screened for information, which enabled the differentiation of service innovation processes, both with a focus on individual organizations, as well as across organizations (i.e., cases). The aim was to identify variables in service innovation processes that would allow the classification and distinguishing of specific types, based on their similarities and differences. This synthesis approach (step 2, Fig. 3-2) led to the development of an analytical framework with three dimensions and several characteristics (B, Fig. 3-2). Section 5.2 provides more information on the synthesis approach. The choice of concepts for the dimensions and characteristics of the analytical framework was made in close alignment with the S-D logic, so that existing concepts, which helped to distinguish service innovation processes, were incorporated. Furthermore, the analytical process was supported through the use of a code template (cf. section 3.7), which established an active link between concepts and the empirical data.

Fig. 3-2 Conceptualization of Service Innovation Patterns in Phase IV



The application of the framework to the interview data supported the detection and differentiation of service innovation patterns and informed the construction of the service innovation typology (step 4, Fig. 3-2). Dimensions and characteristics of the analytical framework were mapped to text passages, which described similar behaviors and activities in service innovation processes. Over time, this resulted in the conceptualization of several tentative types of service innovation processes. In the course of further analysis, relevant contextual information was then assigned to these types, with the goal of gaining a more comprehensive understanding. Section 6.2 provides more information on the conceptualization of the patterns. Initially, more than ten different patterns were detected in the empirical data. However, the large number of patterns reduced the usefulness and manageability of the typology and led to a considerable overlap between process types. As suggested by Bailey (1994), the number of types was reduced by continuously comparing and matching the patterns with each other and the empirical data; this process eventually led to five patterns remaining.

The application of dimensions and characteristics to the data led to the analytical framework itself being modified and adapted in several iterations; thereby providing a better match to the service innovation processes reflected in the data. For example, when innovation activities were identified that were not adequately covered by the dimensions and characteristics, the framework was refined and tested again against the full range of empirical data (step 5, Fig. 3-2). Applicability of the framework was iteratively increased, by regrouping the characteristics and assigning them to broader categories that were able to capture the data more precisely. This resulted in an abductive loop of refining and improving, both the service innovation patterns and the analytical framework. This continued until a sufficient level of confidence was achieved that both the typology and the framework were adequately reflecting the heterogeneity in service innovation processes. In the last iteration, the analytical framework comprised three dimensions and ten characteristics (B, Fig. 3-2), which allow the differentiation between the five patterns of service innovation processes (C, Fig. 3-2). In this constellation, the framework and the typology cover much of the heterogeneity of service innovation processes, without being overly complicated.

3.5 Case Studies

This section introduces the two main case organizations of this study and offers a description of their respective history, organizational structure, and position in the market. The selection of cases for theory development is an essential aspect of case study research (Eisenhardt 1989). As outlined in section 3.4, XTEC was selected as a first case at the beginning of the study to secure sufficient access to empirical data. The second case SIMULI was then selected based on practical and theoretical considerations in the course of the study. Tab. 3-3 provides an overview of the two case organizations.

Tab. 3-3 Case Organizations

Cases	Workforce	Organization	Core Competencies
XTEC	Approx. 500 in Germany	Site-oriented with several branch-specific CEOs	Interior, exterior, chassis, project management
SIMULI	Approx. 1,000 in Germany and 1,000 in other countries	Cross-site oriented with several cross-site managers	Interior, control devices, chassis development, optical systems, composite, acoustics, material test, and simulation

3.5.1 Case Organization XTEC

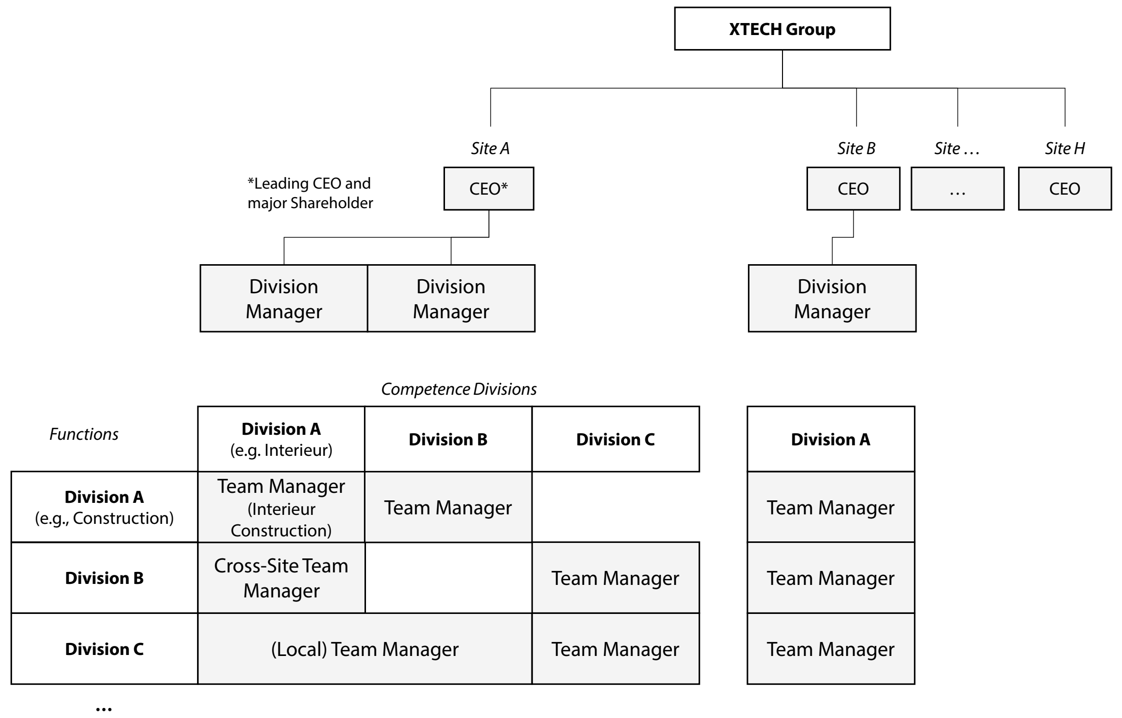
XTEC is a German provider of premium engineering services. Founded in the mid-1990s, today, the organization employs more than 500 engineers and technical experts at eight different locations across Germany. Regarding size and market position, the firm ranks among the smaller ESPs in the German market. Yet, XTEC is too large to be considered a niche provider. Traditionally, the firm is recognized in the market for its expertise in the construction and design of parts and components for the vehicle exterior and interior, as well as for their competencies on lightweight construction, based on innovative materials. Although a specific

OEM[12] became a significant shareholder in recent years, XTEC generally operates independently in the market and maintains business relations with several OEMs.

Concerning the organizational concept, XTEC functions as a group of different service branches. provides a model of XTEC's organization. On the first level of the management hierarchy, several *Branch Managers* (CEOs) are responsible for individual sites. One of them is a shareholder in the company and plays a leading role in the group. Below this level, responsibilities are assigned according to a matrix organization. The first dimension of the matrix organization comprises *core competencies* that correspond to different technological areas of the automobile, such as interior and exterior. The second dimension is based on *functional activities*, such as construction, simulation, consulting, or project management, which also represent individual service offerings in the marketplace. Based on this matrix organization, for example, teams exist for interior-construction and interior-simulation (cf. Fig. 3-3). Each of these teams is assigned a *local team manager*. In this way, most responsibilities in the organization are site-specific. Only a few cross-site functions exist, for example, there are a few *cross-site team managers*, who coordinate competence development and communication at group-level. The organizational concept gives the individual sites a high level of autonomy and agility. As a result, the competence focus and strategic orientation vary between sites. Furthermore, sites differ significantly in size. While some have more than 100 employees, featuring a wide range of competencies and resources directly on site, there are other smaller sites with only around 30 employees, whose competencies and resources are limited.

Fig. 3-3 Model of XTEC's Organization

[12] To ensure anonymity of the study participants, the OEM is not named



During the financial crisis in 2009, XTEC experienced economic difficulties, which inspired the management board to develop a comprehensive group strategy. A critical aim of this strategy was to focus on specific core competencies. One measure was to end the former business with personnel leasing and to concentrate on team-oriented and self-responsible service provision. In recent years, competencies and service offerings were also systemically enhanced, for example, with additional service offerings, such as project management, innovation management, and consulting. In this respect, a dedicated aim of the group strategy was to develop operational capabilities that allow the whole range of services to be offered at each of the groups' sites. Another essential pillar of the group strategy was ensuring they were *made in Germany*. While XTEC does also offer its services to international customers, all engineering activities are carried out in Germany.

3.5.2 Case Organization SIMULI

The second case organization is SIMULI, a medium-sized ESP and an established partner of the German automotive industry. The organization has more than 2,000 employees, half of whom work in Germany, close to the development and production centers of the large OEMs. The other half are located at foreign sites – mostly Eastern Europe and the UK. However, the business focus of SIMULI is the German automotive market. In recent years, German OEMs have accounted for more than 90% of total sales, whereby the remaining markets are attributable to suppliers, ESPs, and customers from the aviation industry.

The origins of SIMULI date back to a small engineering office that was founded in the mid-1970s. Initially, the company was mainly involved in construction and technical calculation tasks for the aerospace industry. In recent decades, the business focus has shifted to the automotive industry. In parallel, new branches have been established across Germany, and the service portfolio was expanded to new automotive market segments, such as material testing, engineering of acoustic, electronic and optical systems, lightweight construction, project management, and prototyping. However, the business focus has remained on the market for calculation and simulation activities, where SIMULI has a distinct reputation. After several changes in shareholdings, SIMULI is now part of an investment group, whose expectations of growth and return on investment are essential premises for the strategic course of the organization. SIMULI features a diverse competence portfolio, which allows the firm to support their customers throughout the various phases of vehicle development. Activities span all phases of automotive engineering, from concept ideas in early development phases to the implementation of comprehensive technical solutions for series development, as well as support and consulting, during series production. Although SIMULI has shown extensive growth in recent years, the firm has not yet reached the size of other ESPs, who develop whole vehicle variants under their own authority, typically have several thousand employees, and act more globally.

During the financial crisis in 2009/10, SIMULI converted from a site-based organization to a cross-site concept. Fig. 3-4 illustrates the new organizational structure. The concept assigns responsibilities according to a matrix structure that is organized along engineering functions (e.g., simulation) and technological areas of the vehicle (e.g., interior). Central to this concept are cross-site responsibilities and *team managers* are the only management layer in which local responsibilities are assigned. The next hierarchical level above are cross-site *department managers*, for example, for functions such as simulation, followed by four *division managers*, who report directly to the CEO. The CEO is supported by a human resource manager and a commercial manager. SIMULI has recently established several *Centers of Competence* (CoC)[13] that have become a distinctive feature of the organization (cf. Fig. 3-4). For example, there is a CoC for interior engineering, the responsibility of which is to integrate and coordinate different related functions and activities, such as interior construction, interior simulation, and interior test. A key objective of the CoC is the firm-wide anchoring of competencies, the

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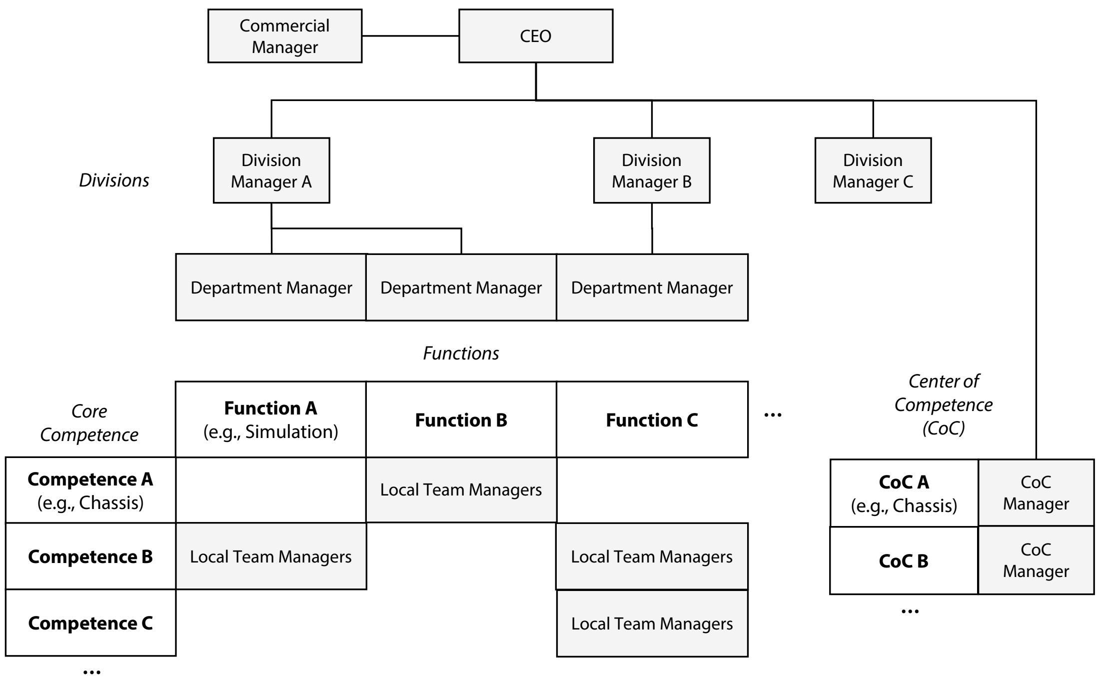
[13] A center of competence is generally understood to be an organizational unit, which bundles different tasks that characterize the core competence of an organization (Krüger and Homp 1997, p. 210)

creation of interfaces between complex (and interdisciplinary) market requirements, and the internal division of labor by department.

Fig. 3-4 Model of SIMULI's Organization



3.6 Data Sources

This study was conducted using four different sources of empirical data: *preliminary interviews* (1), *in-depth interviews* (2), *archival data* (3), *field observations* (4). The availability and consideration of these different sources of data allowed this research to achieve a state of triangulation between methods and sources, which is considered a quality criterion of empirical research (Yin 2014). The following sub-sections explain the four different forms of empirical data.

3.6.1 Preliminary Interviews

The research process began with a phase in which nine preliminary interviews were conducted with managers and employees at XTEC. Most of these meetings and interviews were structured as open discussions – some of which involved multiple participants. The meetings lasted between 15 and 30 minutes. At the request of the informants, the interviews were not audio-recorded and were instead documented using notes and handwritten protocols. The notes that were taken during the preliminary interviews were revisited at a later phase of the study to further enrich the empirical foundation of the findings.

Tab. 3-4 lists some typical questions that were asked during these preliminary interviews. In summary, the preliminary interviews were conducted to familiarize the researcher with the research domain, in preparation for the in-depth interviews in the subsequent phases of the study.

Tab. 3-4 Typical Questions during Preliminary Meetings and Interviews

Questions and Follow-up Questions
What is your position and role in the organization?
To which phases of the automotive value creation chain do you contribute with your service offerings?
What are typical steps and challenges during project acquisition?
What are the critical customer requirements during service provision?
How do you ensure the quality of the services provided?

In the course of the interviews, a large number of different topics were identified, many of which were introduced by the interviewees themselves. Tab. 3-5 provides an overview of the interviews and the different topics discussed.

Tab. 3-5 Preliminary Interviews and Key Topics

Date	Participants	Key Topics
10-07-2014	Technology Consultant	• Changes in the role of ESPs during service provision • Cross-site collaboration becomes increasingly vital • The link between innovation and knowledge dissemination
10-09-2014	Technical Professional	• Cross-site collaboration during service provision • Growing project sizes and general market trends
10-16-2014	Innovation Manager	• Customer-provider interactions during service provision • Growing importance of consulting services • Combining resources and competencies
10-21-2014	Engineering Professional	• Role of external resources and collaborations with partners • Learning and competence development activities in the organization • Increasing cost-pressure
10-22-2014	Head of Engineering	• Internal instruments for service innovation • Internal collaboration mechanisms • Innovation potential of novel competence combinations
10-28-2014	Branch Manager (CEO)	• Growing pressure to combine and integrate competencies and resources across business units and service branches • Difficulties and challenges of cross-site collaboration
10-29-2014	Division Manager	• Challenges related to the tailoring of services to customer needs • Project acquisition process • Project management activities during service provision
11-13-2014	Branch Manager (CEO)	• Differences between development phases at the OEMs • Importance of customer intimacy in innovation processes • Technological trends and their influence on the ESP market
11-14-2014	Branch Manager (CEO)	• Role of networks in innovation processes • Increasing market pressure on ESPs to innovate their services

3.6.2 In-Depth Interviews

The primary instrument of data collection was the conducting of in-depth interviews. The interviewees were managers and employees of OEMs and ESPs. Throughout the research, in total 37 in-depth interviews were conducted, which comprised 32 telephone interviews with individuals, three face-to-face interviews with individuals and two telephone group interviews with two respondents each.

Interviewees were selected with the intention of considering different roles and perspectives on service innovation processes. All interviewees were expected to be involved in topics relevant to the innovation and provision of engineering services. Interviewees were identified via career-oriented social networking sites, such as XING or LinkedIn, and were invited to take part in the study via E-Mail. As an incentive, participants were rewarded with a summary of the research findings. In addition to the interviews with XTEC, more than 150 potential interviewees were invited to take part in the study throughout the research process, which resulted in 26 interviews and a corresponding response rate of 15%. The selection of the interviewees corresponds with convenience sampling (Richards & Morse, 2007; Morse, 2007). This form of sampling was chosen since other types of "*text-book theoretical sampling methods*" are difficult to apply in business contexts, due to limited access to organizations (Länsisalmi et al. 2004, p. 249).

The participants were mostly high-ranking managers, with a long experience of working in the automotive industry (cf. Tab. 3-6). In the interviews, this was demonstrated by the informants' extensive knowledge of the AES industry.

Tab. 3-6 Overview of Organizations, Interviewees, and Roles

Type	**Employees**	**Organization**	**Roles (# interviewees)**
ESPs	0 – 1,000	XTEC	Branch Managers (CEOs) (6), Technology Consultant (1), Innovation Managers (2)
		MCRAFT	CEO (1), Head of Strategy (1)
		IDESIGN	CEO (1)
	1,001 – 5,000	SIMULI	Business Unit Managers (5)
		XTR	Division Manager (1), Team Manager (1)
		YEDGE	Business Unit Managers (2)
	5,001 – 15,000	TAGOW	Branch Manager (CEO) (1)
		ZMETAL	Branch Manager (CEO) (1)
OEMs	10,000 – 1,000,000	DRIVE AG	Engineering Executive (2), Purchasing Executive (3)
		AUTO AG	Engineering Executive (2), Purchasing Executive (1)
		BRUM AG	Engineering Executive (2)
		XRAD AG	Engineering Executive (1)

Eighteen interviews were conducted for ESPs. Roles included *CEOs*, *branch managers (branch CEOs)*, *business unit managers*, *team managers, technology consultants* and *innovation managers*. For OEMs, 11 interviews were conducted. OEM interviewees were mainly *Engineering Executives*, who, for example, were responsible for the interior, exterior or chassis engineering. Appendix B provides a description of the background of the participants of XTEC and SIMULI. Additionally, some participants were *Purchasing Executives*, who were involved in purchasing decisions or had a strategic purchasing function within the organization. A list of interviewees with respective role titles is provided in Appendix C.

Interviewees were selected from different organizations that varied in size. XTEC, MCRAFT and IDESIGN rank among the smaller participants in the market. Mid-sized ESPs, such as SIMULI, XTR and YEDGE, have between 1000 and 5000 employees. Whereas TAGOW and ZMETAL, two organizations represented in the study, have more than 5,000 employees. These two ESPs rank among the largest players in the market. In order to ensure the anonymity of the ESPs and OEMs, who took part in this study, only limited information on the different organizations can be provided.

The interviews themselves followed semi-structured guidelines that contained between 10 to 20 questions. Open questions were used to allow the interviewees to respond in their own words and to enable an exploration of selected topics in greater depth (King 2004a, p. 17). Furthermore, the interview guidelines were adapted according to the individual perspectives of OEMs and ESPs and to consider the individual role of the interviewee. For example, the interview guidelines took into account different perspectives of specialist departments and purchasing departments on external service providers. Two exemplary interview guidelines that were used in different phases of the study are provided in Appendix A. Interviews lasted between 25 and 94 minutes, totaling more than 30 hours of interviews. On average each interview took about 46 minutes. All interviews, except two (which were declined by the interviewees) were audio-recorded and transcribed in the German language. Translation into the English language was carried out in a later phase of the study (for a list of translations see Appendix E). The two interviews that were not audio recorded were documented in detailed notes. A list of interview transcripts is given in Appendix D.

At the beginning of the interviews, the respondents were asked to introduce themselves and to describe their role in the organization. The course of the interviews was then based on the questions in the guidelines. The semi-structured form of the interviews offered the opportunity to respond flexibly to specific topics and also to focus on different topics in the interviews. With the reorientation of the study throughout the research process, the questions and the key topics evolved throughout the different phases of the research. Furthermore, during the different interview phases, the guidelines were also not static, but were continually improved and reoriented (King 2004a). Questions were reformulated when they appeared incomprehensible to participants and new questions were added to cover topics that were not included previously. Additionally, questions which were found to be less relevant were removed. To support this procedure, respondents were asked to provide feedback on the relevance and completeness of the topics discussed at the end of each interview.

3.6.3 Archival Data

As prescribed by the literature on case study research, the empirical foundation of the analysis was enriched with several forms of archival data (Yin 2014, p. 109), in particular, company documents and industry-specific information. Some of these documents were directly provided by the case organizations; others were obtained through an internet search and from websites of OEMs, ESPs, public institutions, universities, and consultancies. These documents included:

- Process models,
- Press releases,
- Internal process instructions and guidelines,
- Organizational charts, describing the responsibilities of the case organizations,
- Marketing materials, e.g., PowerPoint presentations, describing the service offerings of the case organizations,
- Industry reports on technological trends and market developments. For example, the study by Kleinhans et al. (2015) on the German AES market.

The consideration of these different forms of archival records, together with the case organizations and their relationships within the business environment, helped to contextualize the research findings by creating a more comprehensive understanding of the AES industry. Fig. 3-5 provides an example of project management guidelines, provided by XTEC[14].

The document (Fig. 3-5) provides an overview of the steps taken during the planning and preparation of development projects. It also illustrates some of the difficulties that may arise before project implementation while also making some interactions transparent that occur between the provider and the customer during this phase. The document is part of a set of documents (Corporate-Map), providing guidelines and checklists for recurring business and management activities.

Similarly, other documents such as press releases, chronologies of the organizational development, as well as descriptions of competences and service offerings provided complementary insights that helped to develop a more precise understanding of the research subject and describe the two case organizations.

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[14] For the purpose of this study, the document has been translated into the English language.

Fig. 3-5 Example of Project Management Instructions as Provided by XTEC

Process Instruction		**Page 1 of 3**
Project Management	**Responsible:** [redacted] **Location: Corporate-Map**	

Project Acquisition:

Plan your project:
- Do we have know how?
- Do we have capacity?
- Do we have the technical requirements (hardware / software, measurement technology ...)?
- What does the customer want?
- What does the customer need?

Write an offer:
- Are the dates fixed?
- Is the offer understandable, clear, meaningful?
- Do we offer what the customer needs and wants?
- Is there a single-item calculation in Excel?
- Is there a schedule in MS Project? (The Excel table is based on this)
- Is the request complete?

Track Your Order:
- Did the customer receive the offer?
- Is everything clear and understandable?
- Until when does he decide?
- Call again!

Project preparation:
- Who is the Project Manager? → name
- Does the offer still match the actual extent? → if not, write modified offer
- Do the dates still fit to the original offer? → If not, note date shifts and inform the customer

3.6.4 Field Observations

Besides the interviews various field observations took place on-site at the ESPs. The importance of field observations as an additional source of evidence in case study research has been widely recognized in the literature. For example, Yin (2014, pp. 113–114) emphasizes that field observations are often a valuable complementary source of information that serves the aim of better understanding the subject and context of the research.

In the first phase of the research (cf. section 3.4.1), several visits to XTEC's locations allowed the researcher to conduct preliminary face-to-face interviews directly on site. The time spent in the office environment of XTEC provided an opportunity to discuss various topics with employees and managers, conduct the interviews and additionally, enabled the researcher to gain an impression of everyday office life at an ESP.

In the third phase (cf. section 3.4.3), XTEC's sites were revisited, this time for the timeframe of a full week. During this time, different sites were visited and several employees (including quality managers, technical experts, projects managers) provided an introduction to their specific field of expertise, together with an explanation of various engineering activities and related management tasks. For example, technical experts outlined the typical course of engineering projects, pointed out strategical challenges and aims of the organization, showed which software was used to carry out different engineering tasks, and described pain points of the collaboration with the customer. On this occasion, there was also an opportunity to visit a so-called Innovation Studio and to observe several internal meetings and workshops. The interactions with employees and managers in their immediate business environment gave a sound impression of the company's culture and their method of doing business in the AES industry. These activities were however limited to XTEC.

The informal talks and field observations were recorded in the form of notes and used as supplementary information in later phases of the research process. Although observations were mostly informal, the insights gained were highly useful to familiarize the researcher with the research context and to help obtain a realistic impression of the AES industry.

3.7 Data Analysis and Presentation

The analysis of the empirical data was an iterative process that involved multiple rounds of interview screening for relevant text passages, continuous comparisons between interviewee statements and theoretical concepts, as well as with knowledge from the literature (cf. Gibbs 2014). This was a constant process throughout the different phases of this research, beginning with a broad range of topics and eventually narrowing the analysis down to service innovation. In particular, the S-D logic understanding of service innovation has helped to focus the analysis on a smaller set of key topics. The assignment of codes to relevant text passages followed a systematic approach of linking similar statements to ideas and concepts. This clustering occurred both within, and across, data sources and cases.

This research has employed the MaxQDA software for qualitative data analysis; specifically to manage the amount and complexity of data and the respective links between codes and text-passages (cf. Gibbs 2014). The management of data and code structures with MaxQDA supported the goal of establishing a *"chain of evidence"* and maintaining it over the course of the research (Yin 2014, p. 127). This chain begins with the documentation of the data (audio files, interview transcripts, and notes) and their entry into the database of the research project in MaxQDA. The chain continues via data coding and the linking of the codes with the concepts developed in this research, up to the use of selected quotations, when reporting the results of this study.

The process of analyzing and organizing the empirical data adhered to the techniques of template analysis (King 2004b). According to King (2004b), the idea of template analysis is to develop a code template. The codes of the template reflect the themes and concepts, which the researcher develops throughout the research process, and establishes a link to the underlying data. The first principle of template analysis is hierarchical coding, so that similar codes are clustered and assigned to codes on higher levels of a hierarchical structure. A second is parallel coding (King 2004b, p. 258), which is the assignment of multiple codes to the same text segments. As the process of data analysis and coding progresses, the coding template is continuously refined and adapted to reflect the results and concepts emerging from the research process. Fig. 3-6 shows an extract of the code template used for the analysis.

Fig. 3-6 Extract from the Coding Template Used during the Analysis

Case Analysis	0
Within-Case Analysis XTECH	0
Business Environment	157
Resource Integration Practices	102
Value Propositions	84
Service Innovation Procedures	73
Archive	150
Within-Case Analysis SIMULI	0
Business Environment	95
Resource Integration Practices	52
Value Propositions	43
Service Innovation Procedures	68
Archive	26
Synthesis	0
Interaction Modes	73
Roles in The Renewal of Institutions	71
Recombinatory Practices	159
Archive	131
Patterns of Service Innovation	0
The Life Cycle Pattern	34
The Association Pattern	57
The Copycat Pattern	27
The Exploration Pattern	60
The Co-Innovation Pattern	38

The process of analyzing the empirical data began with the identification and coding of various themes considered to be relevant to the initial research aims of the study (recombination). Thematically related codes were assigned to higher-order categories. For example, text passages describing an increase in project sizes were assigned with the code "increase in project sizes" which was assigned to the code category "market change." The codes adopted the terminology and concepts used by the respondents and were closely linked to the topics of the interview guidelines. With the increasing focus of the study on service innovation, the analysis concentrated more closely on the processes of service innovation. In line with the broader view of S-D logic on service innovation, the focus was on change processes that took place in the organization of ESPs and their business environment. Comparability between XTEC and SIMULI was supported by structuring the analysis according to four common themes: *business environment*, *resource integrations*, *value propositions*, and *innovation procedures*. These key topics also provide the structure for the case organization presentations in the following chapter.

A further analytical process was primarily concerned with the elaboration of the analytical framework to prepare the groundwork for detecting service innovation patterns. As suggested in the literature, the code template was continually adapted to the research process and the conceptual findings, so that new codes were inserted into the template and previously defined codes were modified, deleted or reassigned to new code categories (King 2004b, p. 262). For example, new codes were assigned to incorporate the concept of institutionalization. The analysis involved a continuous movement between the different cases, the theoretical literature, and the emerging theoretical concepts, i.e., analytical framework and patterns. Dimensions and characteristics of the analytical framework helped to detect and distinguish specific patterns of service innovation processes. Simultaneously, the application of the framework to the data and the identified patterns helped to increase the applicability and robustness of the analytical framework. The foundation of the empirical data was thereby gradually expanded until finally the entire range of interviews was considered in the analysis. This process proceeded until the conceptual findings gave a sound impression and matched with the empirical data.

3.8 Chapter Conclusion

This chapter has presented the research design of this study and outlined the research process which took place during the different phases. This study applies a qualitative method, in combination with an abductive approach, to case study research, which fits the exploratory nature of the research aim. As sources of information, this study has drawn on four types of empirical data: preliminary interviews, in-depth semi-structured interviews, archival data and documents, and field observations. As encouraged by the abductive case study approach, the data analysis, the literature research, and the conceptual work did not proceed in a linear process but were carried out in an intertwined manner (Dubois and Gadde 2002, 2014).

Consequently, reorientations to the objectives of the study, the focus of the empirical data considered, and the scope of the analysis occurred.

The following three chapters present the findings of this study. Chapter 4 begins with a separate analysis of each case organization. It includes a description of the business environment of the two organizations and their respective methods of providing and innovating engineering services. Chapter 5 then compares the innovation behavior of ESPs across cases and synthesizes three dimensions that can be used to describe and distinguish specific types of service innovation processes in the AES industry. The three dimensions provide a uniform structure for the identification and delineation of service innovation patterns in that they emphasize essential similarities and commonalities between service innovation processes. Chapter 6 draws upon these previous findings and presents an empirically grounded typology that differentiates between five patterns of service innovation.

4 CASE DESCRIPTIONS

4.1 Chapter Introduction

This chapter presents the two primary cases of XTEC and SIMULI. The detailed textual descriptions, which focus on the within-case analysis first, are based on the data collected during interviews with several employees and managers of the two organizations. The descriptions form the basis for the comparative analyses across and within-cases (case synthesis), which can be found in the fifth chapter of this study. According to Eisenhardt (1989, p. 540), the within-case analysis is central to theory development, as it allows both researcher and audience to familiarize themselves with each case as independent entities before patterns and theory are generalized across cases. The analysis of specific organizations may also be considered vital because innovations in KIBS industries happen in processes that are typically informal and interlinked with day-to-day service provision (Toivonen et al. 2007).

The following section describes the approach taken for the within-case analysis and explains the common structure of the case descriptions. Where possible, the case descriptions refer to interview quotes. The subsequent section then describes the two cases of XTEC (section 4.3) and SIMULI (section 4.4) before section 4.5 concludes this chapter. Since some of the respondents from SIMULI and XTEC reported on similar topics and trends, there is a certain overlap of the two case descriptions which could not be avoided.

4.2 Approach to the Case Descriptions

As mentioned in section 3.7, the description of the two case organizations is structured along four essential categories: *Business Environment (1)*, *Resource Integration Practices (2)*, *Value Propositions (3)*, and *Innovation Procedures (4).* The categories were chosen under theoretical and empirical considerations with the aim of providing the relevant background information necessary to understand service innovation processes from the perspective of S-D logic. Each category covers a particular area of the S-D logic interpretation of service innovation processes (cf. Lusch and Nambisan 2015; Vargo et al. 2015; Vargo and Lusch 2011). Consistent with the dynamic institutional view of innovation in service ecosystems, the focus of the four categories is specifically on change.

- The first category describes the *business environment* (1) of the two case organizations and addresses the call in the S-D logic literature for a broader and more dynamic understanding innovation, which takes account of the interrelations between the innovation activities of actors and the context by which these activities are guided, constrained, and enabled (Vargo et al. 2017; Wieland et al. 2012). Accordingly, the first category aims to provide the contextual information that makes the innovation behavior of ESPs more understandable, by illuminating how managers and employees of the two case organizations perceive the current transformation of the AES industry context.

- *Resource integration* (2): This category was chosen to account for the central concept of resource integration to service provision and service innovation (Lusch and Nambisan 2015; Vargo and Lusch 2011). As mentioned previously, in KIBS industries, service innovation and provision are often closely intertwined processes that are difficult to distinguish due to a low degree of formality (Toivonen et al. 2007). Changes in resource integration practices are an indicator of service innovation. Accordingly, the second sub-section of each case description provides a comprehensive view of changes in interactions and resource integration practices.
- Central to S-D logic is the idea that service innovation is driven by the aim of actors to develop more compelling *value propositions* (3) that enable them to co-create more value for themselves and others (Barile et al. 2012, 2016). At the same time, the S-D logic emphasizes the need to understand how actors access and evaluate value propositions, and how value propositions evolve. Accordingly, the third sub-section describes changes in the value proposition of engineering service offerings.
- *Innovation procedures* (4): This category complements the broader conceptual view of S-D logic on service innovation with innovation practices at the two case organizations. Accordingly, the fourth category describes which opportunities and means managers and employees can identify for themselves to actively develop new competencies and value propositions. Additionally, this category provides information on the various tools, techniques, and methods that ESPs use for this purpose.

The four key categories provide a shared structure for the following descriptive analyses of the XTEC and SIMULI cases.

4.3 XTEC Case Description

The case study of XTEC provides a comprehensive view of the digital transformation in the AES industry and its influence on the market for engineering services. Respondents commented on various trends in their business environment and described the impact on their role in collaborating with customers during service provision. Findings show that XTEC has evolved into a new role in the marketplace, which is more oriented towards collaboration and innovation.

4.3.1 XTEC's Business Environment

This section describes trends and changes in XTEC's business environment, which are necessary in order to understand the company's resource integration practices, value propositions, and innovation procedures.

Processes of Converging Markets

The interviews with managers from XTEC reflect on a convergence among the traditional market segments for engineering services. A characteristic of this development is the boundaries that formerly separated specific competence domains, such as different architectural areas of the vehicle, have become blurred and have been replaced by new structures that bundle responsibility, engineering activities, and control in the development of complex functional systems. In this way, the scope of engineering projects has increased. Related to this general trend, the interviewees described the following more specific developments.

First, knowledge demands in traditional market segments, such as interior or exterior development, are changing regarding content and scope. Interviewees reported that service offerings are no longer exclusively specialized in mechanical engineering; instead they have become interlinked with other knowledge areas and, in particular, with those related to electronics.

> *"One may say that a bumper is no longer a bumper. Within our competence of exterior engineering, our competence in the area of bumpers has developed towards sensor technology, etc." (XTEC, Person 1.1)*

> *"Topics are increasingly interlinked. In the old days, someone built a propulsion system, and someone else developed a body structure on top of it. Then at some point came the self-supporting bodywork, which integrated everything into itself as a functional unit. Now, this is going on and on, and more topics are being added. This means that the overall construct is becoming more and more complex." (XTEC, Person 5)*

Second, respondents reported that it is no longer sufficient for them to maintain a narrow focus on their own competence domain. Instead they note an increasing need for a more comprehensive understanding of the development landscape with its complex interdependencies between vehicle systems, functional requirements, and OEM-specific project management requirements. One reason for this is that OEMs have a growing expectation that their ESPs should assume a role which extends beyond implementation:

> *"In many areas, there are now young managers at our customers, who often expect elementary advice. They expect us to look at the whole package. […] A part of the responsibility and control shifts from the customer to us. [...] [Our customers] increasingly request us to*

take over the control. There is also an increasing demand for us to use our own impulses and ideas. We must be able to make meaningful statements." (XTEC, Person 5)

For XTEC this means that their customers need them to offer pro-active advice in the development of solutions for complex functional and technical problems.

Third, interviewees outlined a shift in the focus of OEMs, from traditional mechanical engineering towards new competence domains related to electronics, software, and services. As OEMs have reduced their involvement in the coordination of engineering projects and have transferred more responsibility to their ESPs, XTEC's employees have become more involved in the coordination of topics among stakeholders within the OEMs' internal organization and with external partners (such as suppliers). Coordination work requires a broader understanding of the complex interrelationships within the development process, as well as of the roles and objectives of the actors involved.

Finally, interviewees described a shift in the principles and objectives for the design and division of labor between OEMs and ESPs. Whereas in the past, OEMs primarily aligned activities and demands with physical areas of the vehicle, lowering the interface complexity is now a more dominant concern. OEMs have attempted to achieve this by bundling activities and creating outsourcing packages that delineate the responsibility according to the systems, subsystems, and functionalities. As a result, engineering projects have become more extensive and complex and require XTEC to offer services that integrate and combine several of their competencies.

Processes of Diverging Markets

The outlined market convergence contrasts with an increasing heterogeneity of customer requirements, which suggests a divergence among market demands. Interviewees pointed out that differences in the position and strategy among OEMs would lead to increasing differences in the development of competencies and service offerings at XTEC's sites. Additionally, interviewees expressed the view that market attraction has been changing. Some segments that used to be niche markets have shown rapid growth in recent years and have become considerably more attractive. Other areas, however, are losing importance as XTEC, struggles to offer its services at competitive prices. The following two aspects illustrate the processes of diverging markets in more detail.

First, markets develop differently depending on the development phase. Traditionally, the focus of XTEC's service offerings has been the series development. However, engineering activities in this market segment are now generally subject to standardization, international competition, and cost pressure. As a result, XTEC faces pressure to shift its focus towards other market segments, such as concept development, where the demand for specialized engineering expertise and the ESPs' innovativeness is higher and enables greater profits.

Secondly, the service requirements of OEMs are becoming more and more diverse. For example, interviewees described that the design of engineering activities and project interfaces became more heterogeneous because OEMs evolved along different technological pathways and followed different developmental approaches. Markets thus became more OEM-specific and the boundary conditions and challenges at XTEC's nearby sites became more individual. The diverging development paths of the OEMs also influenced the development and innovation of services. The increasing market diversity opened up new opportunities to identify and offer innovative competence bundles that represent more compelling value propositions to customers.

> *"One cannot compare [location A and DRIVE AG] and [location B and AUTO AG]. […] My colleagues in [location B and C] have recently built up the simulation and cannot make a single offer anymore without including this competence. This is not the case at [AUTO AG]. […] [AUTO AG] has a big simulation department of its own. […] They outsource this too, not in a package, but to specialist firms. We have often tried to offer this in combination but have never received such a request." (XTEC, Person 6)*

XTEC managers expressed the view that differences in development opportunities at the individual OEMs are very much dependent on how well the OEMs perform in the market. Interview comments suggest that especially those OEMs that currently lag behind their competitors provide the most significant opportunities to offer innovative services, as they are more reliant on external innovation impulses (and thus more open to external ideas) than the market leaders.

Dynamism and Uncertainty

In recent years, the business environment of XTEC has seen a considerable increase in dynamism and complexity. Several respondents reported that automotive technology and the associated demand for engineering skills are changing exponentially and require XTEC to deal with a growing uncertainty regarding technological and market-related developments.

One reason for this is the changes in the AES market have become more interlinked with non-automotive technological advances and socio-technical trends in the context of the global economy. Interviewees expressed the view that the demands for engineering services and the respective service offerings evolved in specific trajectories that are now increasingly influenced by non-mechanical topics and trends. For example, autonomous driving and electrical drives have become the primary drivers of a broader transformation in the automobile industry; this transformation raises numerous questions:

> *"Do I need chassis health monitoring in the future? How can one get the electronics into the vehicle structure? What has to be changed? The vehicle structure for electric drives has already been subject to change. […] The architecture of an electric vehicle can be entirely different from those of a vehicle with a combustion engine. How do we react to that? Also, how do we get involved in the field of electronics and software?" (XTEC, Person 5)*

Another trend pointed out by the interviewees is the gradual uncertainty of their business environment. Interviewees reported that the OEMs were no longer able to make clear statements about their future requirements and service demands, and they kept technological options open for as long as possible without committing themselves to a specific pathway. As examples, the interviewees cited the OEMs' reluctance to commit to electromobility or to communicate a strategy for dealing with the challenges and opportunities of digitalization. The following comment echoes this development:

> *"[DRIVE AG] is now in a crisis mode and prioritizes digitalization and electro-mobility. However, these terms are entirely open and interpretable – anything can come out of this. They first have to establish what this means for products and sales. […] [AUTO AG] has just opened an innovation department. Speaking to them means we are going in circles. They ask me what innovations exist, and I want to know the same from them." (XTEC, Person 2)*

For XTEC this means that their primary customers no longer offer the same orientation as in the past, which makes it more difficult for managers to plan for the future. As a result, it becomes essential for XTEC to keep an eye on markets and technologies beyond traditional industry boundaries. Respondents highlighted the need to engage with topics and trends in a broader context and to understand them. In particular, digital trends have become more dominant topics in management discussion. Together, these developments have led to increased competition in many traditional market segments (e.g., in interior engineering). To avoid pure price competition, XTEC managers underscored the need to continually develop new and more compelling value propositions and to engage more actively in service innovation.

4.3.2 XTEC's Resource Integration Practices

Findings show that XTEC is integrating more and more resources and competencies in networks. On the one hand, networks are essential for XTEC's capacity to combine competencies and resources in the provision of more extensive service packages. On the other hand, XTEC highlights the significance of cooperations and networking activities with various external partners to develop more compelling value propositions.

Reconfiguration of Roles

Since the financial crisis in 2007, XTEC has developed a more distinct focus on team-oriented service provision. However, past projects were often characterized by little responsibility for XTEC, and close guidance from the customer. In this role configuration, the primary job for XTEC was the implementation of engineering activities, while OEMs were responsible for most other essential activities of project management. For example, it was the OEM's responsibility to plan and moderate committees to facilitate decision-making processes and allocate the project requirements to the different stakeholders. The following comment summarizes this role configuration:

> *"Five years ago, we did a lot 'painting by numbers' according to the premise of our customer: 'Do it that way! Do it this way!' Everyone in our industry comes from this traditional service business." (XTEC, Person 6)*

However, this role configuration has completely changed in recent years. OEMs have withdrawn from their former coordinator role and now share the responsibility for the coordination with their ESPs. Interviewees indicated that this shift is also related to an increasing imbalance of expertise and experience between ESPs and OEMs:

> *"We have changed from actual service providers to a development partner. […] Today we have people with ten to fifteen years of professional experience in a certain domain in projects and their counterpart at the OEM is a young engineer from the OEM, who has joined the DRIVE AG one year ago. This has changed the relationship considerably, which means that we are no longer only a partner, but the coach in the project. We tend to become the project lead." (XTEC, Person 6)*

The more independent role of XTEC in the provision of engineering services also means the demands regarding the skills and expertise of XTEC's employees has grown. While the professional workforce has so far had a primarily technical background, there are now more engineers required that combine technical expertise with project management competencies to coordinate requirements and manage the communication in the complex development environment of the OEM.

> *"We had to build up personnel that differs from the typical CAD engineer. […] We need a high goal orientation and reliability. We need project management tools, and we need to know how to use them. Also, we need to be able to do a little project politics […]." (XTEC, Person 3)*

Changes in the role of XTEC in engineering projects are also related to changes in XTEC's relationships with the OEMs. Several managers reported that their employees would frequently have a contact person at the OEM who had less experience than they do. The OEM expects comprehensive advice and guidance. For example, XTEC must now support decision-making processes by elaborating decision templates with several alternative solution paths and further they must contribute more actively to the project success. In this role, XTEC needs to be able to make reliable statements about the impact of decisions on higher-level development systems in which their activities and decisions are interdependent with those of many others. Understanding these interdependencies and the activities of other actors is thus essential.

Network Orientation

A key topic in the interviews was found to be the importance of networks for XTEC's capacity to engage in service innovation. Networks were mentioned by several interviewees, both regarding internal, as well as cross-organizational, networks. For example, the following comment highlights the role of internal networks for XTEC's agility in the sensing and seizing of business opportunities:

> *"That we are performing well today is also the result of our extensive networking. […] In collaboration, we are quite strong. As far as networking is concerned, we play in the Champions League. We work on the networks every day. For example, [the CEO] writes a circular mail: 'I have contact with him and him, does anyone know him?' Within a few minutes, someone answers, and we immediately have a clear direction on how to win them over. It will work out within a few days. We are very agile." (XTEC, Person 1.2)*

Although the managers described XTEC's network orientation as superior in comparison to most competitors, they also pointed out that networking activities need to increase even further. They see the importance of networks for competitiveness and survival in the market is increasing and point out three main reasons: First, more and more inquiries require a mix of capacities and competencies that cannot be achieved by individual sites, thereby requiring cooperation among sites or with external partners. Second, market requirements are more diverse and change rapidly. XTEC needs to find missing resources and competencies more frequently through collaborations with specialist firms. Third, remaining on top of trends and changes in a broader automotive context has become essential for ESPs. Networks are considered indispensable for obtaining vital information.

In response to these trends, XTEC has recently made new efforts to improve the organizational capacity to integrate resources and competencies in networks. As one measure, XTEC has begun to expand the former organizational hierarchy with another layer of cross-organizational responsibilities:

> *"In some areas, the [overlapping] structure already exists. We are now also drawing on this overlapping structure in the field of chassis construction. To bring these individual domains [i.e., sites], which already exist, closer together." (XTEC, Person 1.3)*

So far, XTEC's sites have operated with a high degree of autonomy, which has created considerable heterogeneity in the organization (e.g., regarding aims and competencies) and to internal obstacles to collaboration. Among others, the new overarching governance structure has established cross-site processes for the coordination of requirements among different teams and departments and has laid the foundation for joint innovation projects that integrate resources and competencies throughout XTEC's organization.

As a second measure, several new cross-functional teams were established in recent years. The teams are an attempt to further improve organizational learning and knowledge diffusion in the organization, which are considered essential for XTEC's capacity to develop new competencies and value propositions. Team members dedicate a share of their working time to the purpose of the teams and enjoy more autonomy in their activities than most other employees. Respondents described the role of three teams:

- The *technology team* comprises highly experienced experts that offer support and advice to project teams across the organization– in particular when teams encounter problems that require a high degree of creativity and interdisciplinary expertise. In these cases, the technology team becomes a hub for the firm-wide integration and exchange of knowledge and skills.
- A team of *technology scouts* scans market-related and technological trends and is responsible for the dissemination of respective information throughout the organization. In this way, the team informs the workforce about innovative topics and trends and facilitates a shared worldview among the workforce that eases and encourages collaboration.
- The *innovation team* gives additional innovation impulses by scanning foreign markets and industries for relevant technologies and ideas that may be useful in the automotive context. For this purpose, the team maintains relationships with a wide range of actors, including universities, start-ups and IT firms. The ideas and topics are often linked to digitalization and may stem from distant non-automotive markets and industries.

According to the respondents, the three teams assume a central role for XTEC's innovativeness and agility in the market. They bring together new constellations of employees, teams and external actors, enabling them to interact with innovative topics and stimulating innovation. For example, the teams network with each other to facilitate the exchange of information and knowledge, which in turn further increases their impact on the organization.

Innovation Studio

One of the most striking innovations in XTEC's service offerings in recent years has been the Innovation Studio. This has led to significant changes in the way XTEC interacts with customers and integrates resources into networks. As a cross-sectional function in the XTEC organization, the studio integrates and combines several resources and concepts:

- A key component is a *creative room* that is specifically designed to stimulate creative thinking and collaboration. It is distinct from standard meeting rooms at the OEMs as it offers users a relaxed atmosphere that fosters communication, unconventional thinking, and human interaction. Additionally, it provides the user with a variety of creative tools, such as whiteboards and flip charts.
- The studio offers a creative environment for the application of inspired techniques, as part of a *Design Thinking*[15] methodology. The methodology invokes a collaborative and creative process that aims to experiment with resources and practices to arrive at innovative solutions for complex problems and breakthrough ideas. Workshops are professionally moderated and help customers to articulate their needs and problems and leverage innovation potential.
- *Networks* are a vital resource in the Design Thinking process because they enable an on-demand integration of specialist knowledge and skills, from both internal and external experts, to solve complex problems and develop innovative solutions.
- The Innovation Studio features *advanced methods for building and testing prototypes* that, for example, make use of additive manufacturing equipment. The Innovation Studio, therefore, creates an intuitive hands-on approach that allows quick and direct feedback on ideas and technical solutions to be obtained.
- Processes and results are stored for *documentation and recording in a database,* for example, photos of process results, models of technical solutions, and textual descriptions that are created in the Design Thinking process. The database is a growing source of inspiration for subsequent workshops.

[15] Design Thinking broadly refers to creative strategies in the process of solving complex problems. Design Thinking is also considered a mindset and a process that brings together key elements (room, team, process) with a variety of supporting tools (Brown and Wyatt 2010; Plattner et al. 2010).

Interviewees acknowledge that these concepts and topics are not entirely new, nevertheless the Innovation Studio combines them in a novel and unique way. It enables the co-creation of innovative outputs in a creative environment and under consideration of industry-specific requirements.

XTEC managers described the diverse roles of the Innovation Studio, both for the provision of engineering services and for the capacity of the organization to engage in service innovation processes. Comments, such as the following, highlight this diversity:

> *"[The Innovation Studio] is not a core competence, but a cross-cutting function that affects all of our other core competencies." (XTEC, Person 3)*

On the one hand, the Innovation Studio is a service offered to external customers (OEMs), who use the studio to examine problems more carefully and to find innovative solutions for these problems. Possible outcomes include new technical solutions, but also concepts and innovative service offerings that may once again lead to subsequent engineering or consulting projects. On the other hand, the Innovation Studio is described as an offering to teams and employees of XTEC, who use it to solve complex problems and to obtain additional inspiration to develop service offerings and technical solutions that are innovative.

The interviewees gave various reasons to justify the success of the Innovation Studio in the market. One, for example, is that there are only few comparable offerings:

> *"The Innovation Studio and Benchmark Hall receive much attention from our customers. They like the idea very much. For the simple reason that the customer [the OEM] does not have anything comparable." (XTEC, Person 3)*

Additionally, interviewees highlight the unique value proposition of the Innovation Studio, which combines broad technical expertise with a methodology enabling actors to innovate and leverage their resources and those from XTEC's network (including universities and start-ups).

Furthermore, the studio has become a resource in its own right. It can be integrated into regular customer projects, for example, to develop a fresh perspective on complex problems. Respondents further reported that the studio supports XTEC in the acquisition of projects, in that XTEC uses the studio in the co-creation of new offerings for the customer. The Design Thinking concept invokes a collaborative process, in which XTEC and their customers interact and communicate more openly than is possible in regular engineering projects. This often generates in-depth knowledge on customer needs and is, hence, central to XTEC's innovation activities.

4.3.3 XTEC's Value Propositions

In recent years, XTEC's service offerings were extended and have become more diverse. While the firm has traditionally focused on the implementation of specified engineering requirements, now the implementation is often only one of many aspects in a more comprehensive value proposition in which new offerings, such as consulting and innovation become more dominant topics. Changes have coincided with a shift in XTEC's market focus from the series development to the upstream phases of the automotive development. A further aspect is XTEC's involvement in networked value creation processes.

Changes in Value Propositions

Traditionally, the focus of XTEC's value proposition in the marketplace was the implementation of engineering activities. Comments such as the following show that the implementation is now increasingly complemented with several new topics and aspects:

> *"There has been a whole range of new services in recent years. For example, the Innovation Studio and a stronger focus on project management. Also, the workshops on Design Thinking and the university links." (XTEC, Person 5)*

In particular, interviewees report an increasing significance of the following four topics:

- *Innovation*: Respondents report that their customers would frequently approach them because of their proven capacity to innovate jointly with their customers, by using a systematic methodology that makes outcomes and propositions comprehensible to the customer. The Innovation Studio and its various features (e.g., Design Thinking and prototyping) are considered central in this regard.
- *Scouting activities*: OEMs expect their ESPs to stay ahead of trends and developments and to benefit from latest technological advances. Links to universities and start-ups are considered crucial in this regard and are now more actively highlighted by XTEC in its service offerings.
- *Sustainable value creation*: Interviewees pointed out that it is no longer sufficient to simply implement technical requirements, but that their customers would normally expect them to achieve sustainable improvements, for example, by optimizing workflows in the process environment of the OEM or by outlining ways for the reduction of costs in vehicle development and production.
- *Consulting and advice*: More and more projects contain a budget for consulting activities. For example, some of XTEC's recent projects began with a preliminary study, which assessed the feasibility of a specific technology or explored potential technological options. In other projects, consulting activities were often stand-alone offerings.

Depending on the context, the different aspects can either be requested as stand-alone offerings or as an element of a more comprehensive service offering. For example, interviewees described projects in which scouting activities were the core of the value proposition, while in other projects scouting was only a side aspect. OEMs demand service offerings in various combinations and require XTEC to be highly agile in mobilizing and linking the necessary resources and competencies. In this regard, interviewees indicated that the agility to quickly mobilize and compile resources and competencies in individual offerings has become an essential value proposition in the marketplace.

Value Creation in Networks

XTEC's value creation activities are no longer only directed at the OEMs but are more frequently linked to interactions among a diverse range of actors in networks, including universities, start-ups, OEMs, IT firms, and suppliers. In recent years, XTEC has intensified its cooperation with partners in networks. The value creation activities in these networks are not only apparent from interactions between XTEC and a specific customer, but typically involve more complex relations in multi-actor constellations. Such networking activities include the exchange of information with other ESPs and the collaborative offering and provision of projects. In this regard, interviewees characterized the relations between XTEC and other ESPs as both collaboration and competition, i.e., coopetition[16]. XTEC has also intensified its relationships with universities in recent years. The interviewees further mentioned an increasing exchange of knowledge and information in networks with start-ups and IT firms, which is facilitated through the activities of XTEC's interdisciplinary teams. XTEC assumes an active role in these networks, for example, by coordinating the activities of other actors or by facilitating the exchange of knowledge and information.

Interactions in networks not only create value for XTEC and the OEMs but also for the other actors involved. The following remark is just one example of how XTEC creates value in networks and in cooperations with universities:

> *"Networking is essential, because through networks one can sense what customers want […] We benefit from integrating the universities into research activities that we now have, in order to explore and discover new technologies. If one is connected to many people, one can always get an impulse. Then someone sees or knows something, for example, at a conference*

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[16] Coopetition refers to markets that are characterized by simultaneous cooperation and competition. The term was shaped by Nalebuff and Brandenburger (1996), who found that under certain circumstances rivals may achieve a mutual benefit if they decide to engage in cooperation.

and says, 'this is an interesting offer, check it out.' So, one does not have to do everything alone." (XTEC, Person 9)

The interviewees stated that cooperations are central to XTEC's capacity to stay ahead of technological developments and to accumulate new knowledge and skills by integrating their own resources, for example, knowledge on technical problems, with those of researchers and students. The other actors involved also benefit from these cooperations in various ways. The OEMs, for instance, benefit from the additional innovation impulses and technological developments (e.g., new materials) that emerge from such collaborations.

The interviews indicate significant links between XTEC's value creation activities in networks and the way XTEC contributes to processes of service innovation. Particularly apparent is that XTEC has found methods of making use of external resources to become more innovative and to increase the value that the firm offers OEMs. Some of these links are somewhat vague. For example, interviewees pointed out that the employees and teams who interact with universities tend to be more open to change and responsive to innovation opportunities. Other activities are extremely precise. For example, interviewees also reported that XTEC uses collaborations with universities to develop technologies and prototypes, which they offer to their customers.

Changes in the Market Focus

The changes in XTEC's value propositions go hand in hand with a shift in the focus of service offerings to new market segments. XTEC's traditional focus has been on series development projects, which account for the most significant share in the AES market. In recent years, however, a growing number of XTEC projects have been taking place in the upstream phases of automotive development (e.g., conceptual development and system specification, cf. section 2.2.3), indicating a reorientation of XTEC. The following comment describes this reorientation:

"We are naturally keen on the very early development stages, where there is still life in it and which are characterized by higher financial flexibility. In the earlier phases, one can earn more money and charge higher rates. We can no longer only do series development. Other service providers can offer this mass business cheaper. [Here] we cannot carry out the series development anymore – for cost reasons. […] we focus on the early phases […]." (XTEC, Person 1.1)

One reason for the shift in XTEC's market focus is that the traditional core market of series development has seen a massive increase in cost pressure. In these market segments, larger service providers can offer extensive packages at considerably lower costs, by, for example, offshoring engineering activities to low-wage countries. Additionally, the requirements in series development are typically precisely specified, which reduces the potential to capitalize on the creativity and innovativeness of XTEC's own employees, making differentiation against the competition difficult. By contrast, in upstream phases, requirements and engineering processes are less formal. Especially in the phase of concept development, the requirements regarding the knowledge and skills of the employees are typically on a higher level than competitors can yet provide. Furthermore, there are more opportunities to offer services that combine resources and competencies in innovative ways, which aids XTEC's strategic orientation.

4.3.4 XTEC's Innovation Procedures

The interviews with XTEC reflect various scenarios regarding the source of ideas and impulses and how the organization engages in activities that lead to service innovation. Some innovation activities are primarily reactive and aimed at keeping pace with continually changing market requirements. Other activities reflect a more active role, such that XTEC becomes the main driving force behind service innovation.

Service Innovation Interlinked with Service Provision

As is customary for ESPs, XTEC does not organize its innovation activities in planned R&D processes. Instead, innovation is considered a task that is often performed on-the-job by employees and managers in addition to their regular project work. This means that employees and managers are encouraged to innovate and to identify innovation potential without being triggered or steered by planned innovation initiatives or internal innovation projects. Innovation is therefore treated opportunistically, which leads to innovation processes that are characterized by a low degree of formality.

Consequently, recent changes in service offerings and service processes are not the results of planned innovation activities. Instead, the interview data suggest that changes arose from the need for XTEC to continually adapt to changing market requirements:

> *"Eventually, the impulses for any further development come from the market in the form of inquiries. Some time ago, we were requested to change the text in technical drawings, today the customer requests the development of a whole module. In this way, it has changed and will continue to change towards whole derivatives and vehicles." (XTEC, Person 6)*

The data show that XTEC's competencies and service offerings are continually evolving as employees and executives are confronted with ever-changing technical challenges and the requirements of their customers that entail a constant expansion of knowledge, skills, and practices. Interviewees describe three forces behind these constant changes:

- *Advances in automotive technology* lead to service innovation in the form of a series of smaller or more substantial changes in the requirements of the OEMs. Interviewees reported that new technologies, e.g., a new material or production technology, requires continuous learning and the development of new skills. New technical requirements often entail changes in how resources are integrated and combined. For example, the electrification of engines leads to new technical interdependencies that interlink XTEC's engineering activities with actors with whom they were not previously in contact.
- *Processes and organizational structures* in the OEMs' development environment undergo frequent changes. Respondents described that OEMs change their decision-making processes or enact new standards and rules for the awarding and billing of engineering projects. For XTEC, these changes often mean new roles in the interaction with the OEMs or other actors, including changes to internal processes and development approaches.
- It is essential for XTEC to *continually improve their efficiency in the provision of engineering services* by standardizing internal processes and developing routines in collaboration with customers and between internal departments. Concerning the fact that, today, services are often provided in a more independent manner, respondents reported that there is now more room for the use of checklists and software tools to standardize and automate recurring steps in the development. Furthermore, XTEC supports their customers in their desire to achieve process improvements.

The role of XTEC in such processes is somewhat reactive and primarily characterized by an adaptation of practices and offerings to new requirements. The underlying service innovation processes do not appear to be exceptional events but often unfold more subtly.

Autonomous Innovation Activities

Findings show that XTEC strives towards a more self-responsible role in service innovation processes. Managers argue that in times when the business environment is subject to ever more rapid changes, they must do more than just follow the market development, instead they must actively engage in service innovation. A specific aim is to loosen the traditional dependency of innovation activities from the support and interest of a particular customer.

In recent years, XTEC has taken several measures to improve its innovation capabilities and to assume a more sovereign role in the market. Measures included the introduction of an innovation budget that gives employees the opportunity to spend a part of their working time pursuing own ideas. Networks are highlighted as essential to take further steps in the innovation process. Employees are thus supported in their activities by mentors and the members of the innovation team who, for example, use their extensive network to engage with actors, both inside and outside the organization, who can then provide critical resources, such as knowledge, skills, and/or prototyping tools. Interviewee comments showed that these measures are already having a positive effect on XTEC's innovativeness:

> *"We have improved already, and first ideas from employees have already emerged, which have then been pursued further. This is positive for us and has even more potential." (XTEC, Person 4)*

Innovation activities initiated within XTEC's organization are deliberately kept open regarding objective and topics. A general aim is to build up new knowledge and skills that extend beyond the familiar subject and competence areas. Morover, the respondents provide examples for cases in which internal innovation activities have triggered the development of new technologies and prototypes that have been finally offered to customers, or from which new types of competencies and service offerings have emerged.

A significant communication-related challenge of autonomous innovation activities derives from the fact that the customer is typically not involved from the beginning. Thus, the idea needs to be sold to a customer in a later phase of the innovation process, which according to the interviewees is often tricky. In this regard, the interviewees emphasized the need to find someone who is willing to support the idea and take the necessary steps to enable its application and use:

> *"In the end, one must always have developed something visible that one can offer and communicate. If someone else perceives this, in the same way, he may also come back to it." (XTEC, Person 5)*

Interviewees noted that only if customers recognize a significant added value from the outcome (e.g., a technology or service offering), will they agree to embrace something new and take the associated risks of deviating from familiar ground.

Collaborative Innovation Processes

The data show that the processes targeting towards new value propositions and innovative service offerings always require some collaboration between XTEC and the customer, i.e., the OEM. Especially evident is that XTEC's innovation activities rely on first-hand knowledge of their customers on (frequently changing) technical requirements and individual service demands. Based on the data, three typical scenarios of collaborative innovation activities can be differentiated.

The OEMs themselves commonly trigger collaborative innovation activities. For example, the interviewees reported that their customers would frequently approach them with their own ideas, problems, or a general need to discuss a specific topic. In these cases, customers provided the initial idea or problem and particular requirements, which then became the focus of subsequent activities that, for example, propose to explore a technical solution further or elaborate a concept for a new service offering. If the customer is involved in the innovation activities from the beginning, there is a high chance that the outcome is finally implemented in the form of a project or technical solution.

XTEC also develops its own ideas and actively approaches customers in the search for a suitable application context or pilot project. The comment below shows that the success of this approach depends on whether XTEC finds someone at the customer side who is willing to persuade other decision-makers within the OEM organization.

> *"Of course, without being manipulative, you can put forward your ideas in such committee meetings. Then it is essential to find someone who takes on the idea and further supports it. Because for us it is difficult to almost impossible to implement it at the customer." (XTEC, Person 2)*

Interviewees mentioned some cases in which they were able to successfully convince the customer of new ideas and topics by demonstrating a significant additional value compared to previous solutions or similar offerings. However, several respondents reported that the OEM employees were often overly critical of external ideas and thus were more likely to reject them. The following comment echoes this view:

> *"If we go to the OEM and say 'we have an idea how the bumper can be made ten percent cheaper and fifty percent lighter", then they would find a hundred arguments to prove us wrong. Above all, this is because the idea is not theirs, but brought in from the outside." (XTEC, Person 4)*

This view is also described by other respondents who used the term Not-Invented-Here (NIH) to describe the well-known phenomenon[17] that organizations or groups tend to use in order to avoid adopting ideas or offerings when they have an external origin. The interviewees find that it is cumbersome to convince customers with own ideas and they outlined various cases in which this approach has led to unsatisfying results for themselves and their customer.

The NIH phenomena is a reason why XTEC prefers a third approach to jointly innovate with their customers, which is making use of Design Thinking and the integration of the customer

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[17] The term NIH is used to describe the phenomena that people, organizations, or institutions tend to take a stance of resistance when presented with ideas, products, or innovations with an external origin. (Clagett 1967, p. 1)

at an early stage of idea development and problem definition. The following comment refers to this approach:

> *"The basis of our Innovation Studio is that we do not call ourselves 'innovative' but that we bring the customer in an innovative atmosphere, with the right methods and the right procedures, so that he perceives himself as innovative. Then he can go back and say: 'I have an idea, I dare to extend it further and so on.'" (XTEC, Person 2)*

A difference between this approach and the traditional stance of proposing ideas to the customer is the involvement of the customer at an earlier stage. The definition of the initial problem and the development of ideas and solutions, as part of a Design Thinking process, are carried out in close collaboration together. The Innovation Studio plays a central role in this process, as it provides all the necessary resources in one place, such as, for example, prototyping, a creative environment, moderation, and methodology.

The degree to which collaboration scenarios occur depends very much on the disposition of XTEC's sites and the nearby OEMs. According to the informants, significant differences exist regarding the willingness of OEM managers and employees to deviate from familiar ground and to do things differently than they were doing before. Additionally, collaboration requires a direct contact with the customer, so that sites that are geographically more distant are likely to find it especially challenging to engage in service innovation processes more actively and often assume a role in which they merely evolve through adaptation.

Recombining Competencies and Knowledge in Networks

A recurring topic in the discussions about XTEC's innovation activities is recombination. Interviewees describe several links between recombinant activities and the emergence of new value propositions and resource integration practices.

> *"We currently have a project [...] in which we create new operational capabilities by recombining our existing competencies and knowledge - i.e., new operational capabilities from new combinations. People from different locations are involved […]" (XTEC, Person 1.3)*

Exploring and creating novel and useful combinations of resources and competencies is a top priority for XTEC in order to assume an active role in service innovation processes. To support recombinant activities, interviewees emphasized the need to lower the obstacles for the exchange of knowledge and information in XTEC's organization and to create an environment that facilitates and encourages interactions among the workforce and with actors from outside the organization:

> *"One needs people who network with one another. It only works in the free exchange. We are now working on a culture platform that brings people together across industries. It is precisely from this that new ideas and business fields emerge." (XTEC, Person 8)*

The interviewees pointed out that new competencies and service offerings are seldom the outcome of planned innovation activities, but more often the result of the willingness and capacity of employees and teams to extend their knowledge and skills to new areas. The following comment echoes this view:

> *"Employees have to share their expertise. The culture must be so that one offers their own knowledge and that one is not afraid of becoming obsolete tomorrow, but instead, that employees recognize that when they share their expertise we can create something new tomorrow and tackle new topics." (XTEC, Person 2)*

Strategy plays a central role in this agile innovation approach. Interviewees stated the strategy should preferably comprise a set of rules and principles, which openly guide the innovation activities of employees, such that specific pathways are encouraged but can occur more flexibly. A cornerstone of this approach is that opportunities are seized when they arise without being orchestrated in a top-down approach.

The interviewees highlighted that combining and recombining resources are essential activities in service innovation processes and often involve a network of actors. One participant, when asked about service innovation, described the development of new vehicle functionalities based on different existing technological parts of the vehicle architecture as follows:

> *"It does not always have to be new. By combining two existing systems with each other, one can discover and develop something new. For example, by using an existing camera in the vehicle for anti-theft protection, which adds a new feature based on an existing architecture." (XTEC, Person 9)*

In other cases, respondents showed that innovative results, such as new services or technical solutions often arise when employees integrate their in-depth expertise of technologies and customer problems with the skills and knowledge of other actors outside the company, (e.g., with universities or suppliers). The underlying processes are typically explorative and involve multiple iterations of trial and error that may also end in failure, which, however, is accepted.

4.4 SIMULI Case Description

The case of SIMULI illustrates industry-wide changes in how ESPs and OEMs organize their collaboration in the provision of engineering services. At the same time, SIMULI is frequently confronted with requests for service packages that are becoming more extensive and complex

– a development accompanied by increasing cost pressure and competition in SIMULI's core markets. SIMULI's innovation activities are mainly reflected in the continuous efforts to become more efficient in integrating and mobilizing various resources and competencies across the organization.

4.4.1 SIMULI's Business Environment

The interviews with SIMULI managers exhibit a dominant influence of recent regulatory changes. As a result, SIMULI managers paint a pessimistic picture of the German AES market and describe a comprehensive transformation of the role of ESPs in the provision of engineering services.

Changes in Collaboration Modes

In recent years, the packages of engineering activities, which OEMs outsource to their ESPs, have grown considerably in size and complexity, with far-reaching implications for the role of ESPs in the provision of engineering services. The way OEMs and ESPs organize the collaboration and distribution of work and responsibility is subject to an ongoing change.

The respondents at SIMULI pointed out that, in the past, it was often a priority for the OEMs to maintain control over all engineering activities themselves. For SIMULI, this meant that OEMs often assumed direct authority over SIMULI's employees and also took over the responsibility for the outcome of the engineering activities and the associated risks.

> *"[…] the boundary conditions were mainly 'always at the customer.' The customer said, 'I want an experimental engineer who works at my test facility, I want an electronics engineer who works on my auxiliary test ... and I want a quality engineer who stays right at my production plant.' […] Our workforce was at the customer's site, and the customer directed them to do this and that." (SIMULI, Person 2.1[18])*

These traditional roles of OEMs and ESPs are now suddenly changing. The informants report specifically on the impact of an industry-wide compliance initiative by OEMs, who now seek a clearer separation from the ESPs during service provision, which has recently become a new legal requirement. As one measure, the OEMs seek a more distinct spatial separation of their own workforce from the ESPs. Spatial separation means that the number of employees working on-site at the OEM has been reduced from 50% to less than 5%. As a result, a large share of SIMULI's employees has recently been relocated from the customer into SIMULI's own office space. The following comment describes this development:

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[18] The second number of the interview code expresses that the informant participated in multiple interviews.

> *"At the moment, there is a significant movement, so that the OEMs seek to reach a spatial separation between them and their external service providers. [...] What we have experienced for several months and since the beginning of this year is that the world of the OEMs has changed fundamentally." (SIMULI, Person 2.1)*

To underline the impact of this change, the respondents differentiated between an *"old world"* and a *"new world"* in the collaboration between them and their customers. Whereas in the *"old world,"* SIMULI often had little responsibility for the outcome of their services, in the *"new world"* they are now expected to assume full responsibility and risk for the course and outcome of service processes, and furthermore, they are required to contribute with comprehensive deliverables to the development process.

Changes in Outsourcing Practices

Changes in the roles between OEMs and ESPs in the provision of engineering services coincide with a paradigm shift in the outsourcing practices of the OEMs. While engineering activities were previously outsourced by the OEMs as small-scale packages to many different providers, respondents reported that now the OEMs' purchasing departments are often bundling activities and requirements in to larger packages that are then outsourced to a single provider. As the following remarks show, the scope of the awarded contracts has already increased significantly:

> *"Up to now, different groups in a technical department had to specify their own demand and accordingly created an invitation to tender. [...] Now everything is packaged so that we get a request from the department, in which we can recognize six individual tenders." (SIMULI, Person 2.2)*

> *"The trend that we observed one year ago has drastically increased so that we have to carry out massive packages. There are hardly any more inquiries where the customer demands a team of one to four employees. Now the customers outsource huge packages that demand 10, 20, 30, 40 or 50 employees." (SIMULI, Person 2.2)*

OEMs are also extending the period for which they award contracts to their ESPs. While a typical contracting period was previously between 6 and 18 months, respondents now report that there is an increasing number of projects that last between 24 and 48 months. Furthermore, individual projects require not only more resources but also several competencies. Therefore, it becomes vital to have a specific set of competencies available to be able to offer services directly to the OEMs:

"If, for example, one wants to carry out a project in pedestrian protection, then many tenders directly include the testing part. Without test facilities or a partner for this topic, one cannot offer this anymore. Before, one may have been able to win the tender without the testing part." (SIMULI, Person 1.1)

One reason for this development is that the design of compliance-conformant contracts requires a more precise specification of engineering activities, which increases the related specification effort for the OEMs. By bundling activities and requirements into larger packages, the number of tenders and the related effort for their specification and management can be reduced. Increasing the size of outsourced packages can further ease the division of responsibilities and engineering activities between different actors.

Cost-Pressure and Reconfiguration of the Provider Landscape

Changes in OEM outsourcing practices have increased the cost pressure in the market and led to an accelerating consolidation among incumbent ESPs. A prevailing view amongst interviewees is that competition among the incumbent ESPs is growing:

"Because everyone tries to win these greater packages at any cost, this has a massive impact on the prices. The reason is that there are hardly any more chances for positioning oneself in a technical department for the next five years. That is why everyone is disposed to reduce prices to the utmost." (SIMULI, Person 2.2)

As a result, a growing number of acquisitions, mergers, and market exits have reduced the number of smaller ESPs in recent years, leading to a market consolidation. Interview comments suggest that the consolidation in the ESP market is at least in part due to OEM attempts to increase cost pressure on ESPs:

"Previously, the trend was for OEMs to try maintain a pool of several providers, for each [competence] area. Now they are willing to leave the business to a single provider to gain a small price-advantage." (SIMULI, Person 4.2)

"In our conversations with the purchasing department, the purchasers stated that they are aware that they are reducing the number of providers in the market. They said that the situation was intentional and that they were tidying up so that only the big ones and those who manage this transition (regarding building up project management competencies and communication capabilities) will survive to make a profit. Not all providers will survive this." (SIMULI, Person 2.2)

The increase in the scope and complexity of engineering projects means a reduction in the number of potential ESPs that have the necessary range of competencies and the required amount of resources available to take over projects directly from an OEM. The tightening cost situation not only increases competition among the ESPs, but also collaboration. Respondents reported that small- and mid-sized ESPs are often not in a position to offer extensive projects, and further that their viability in the marketplace would thus increasingly depend on the capacity to complement missing resources and competencies in collaborations with other ESPs. SIMULI now also communicates and collaborates much more openly than before with other ESPs; however, mainly with smaller ESPs. Respondents commented that larger providers are less interested in such collaborations and systematically buy out smaller ESPs or try to force them out of the market in another way.

Respondents see these changes as an industry-wide trend but also indicate differences between market segments. In particular, differences exist regarding the speed at which OEMs and technical departments switch to legally compliant modes of collaboration. Respondents reported that these differences often lead to conflicts when SIMULI aligns their practices with new requirements and some departments attempt to continue with the old way of organizing collaboration. Furthermore, in some markets, the cost pressure is higher than in others. In particular, in markets that have seen few changes in recent decades, ESPs must be prepared to carry out substantial packages independently from the OEM and at a much lower cost than in the past. By contrast, in nascent market segments, such as those related to electronics and software, this tendency is less apparent because OEMs are often concerned with building up their own expertise. Then, the OEMs tend to involve specialized ESPs only on a very selective basis without delegating full responsibility and control.

4.4.2 SIMULI's Resource Integration Practices

Driven by the changes in the business environment, the manner in which SIMULI integrates its resources in the provision of engineering services has become more autonomous and self-responsible. Respondents reported various related changes, outlining the method SIMULI has adopted in order to have a more independent role during service provision.

Organizational Decoupling

The changes in SIMULI's business environment have led to a decoupling of the organization from the OEMs. Because the majority of SIMULI's employees are now located in their own offices and no longer at customer sites, communication with the OEMs has become more selective. Whereas, in the past, the OEMs' technical departments were often involved in the discussion of technical details at an operational level and sometimes supervised the implementation themselves, interviewees reported that the communication now focuses on a smaller number of specific managers:

"The aim is to ensure that all communication between customer and provider is managed by a single person – a single point of contact. Yet, the second level of communication at the operational level cannot always be avoided. However, the most relevant communication is now concentrated on a central person." (SIMULI, Person 3)

The degree to which customers are directly involved in the interaction with the ESP is limited to shorter periods of time, so that service production includes more extended periods in which SIMULI implements engineering requirements without customer involvement. This also means that OEMs frequently expect ESPs to assume critical positions in the development environment, in which they manage whole systems and modules and coordinate the communication at the intersection of numerous stakeholders and among different projects. Respondents reported that OEMs expect greater independence from their ESPs to relieve them of the project management workload. For SIMULI, it has become essential to achieve an efficient level of communication that supports a quick decision-making process based on decision alternatives. However, SIMULI managers also emphasized the need to give the customer a sense of control and to update them with reliable information on the project progress on a regular basis:

"Previously, under direct customer control and in the direct customer environment, there was constant course correction. If something was not as it should have been, it was quickly corrected. Now, one works for longer periods without customer contact, and thus there are also more substantial deviations." (SIMULI, Person 3)

While, in the past, OEMs assumed a role in which they coordinated dependencies between design decisions with other stakeholders (e.g., other projects and departments), now, as stated by SIMULI managers, OEMs are frequently handing over this responsibility to them. The development into a more independent role has not yet been fully completed. The interviewees see SIMULI currently in a transition phase, in which managers and employees learn to manage interdependencies, to carry the risk of design decisions, to develop new project management tools and thereby to increasingly provide service in full authority. The following comment refers to these activities in the current transition phase:

"At the moment, our goal is to learn, with some help from our colleagues in the calculation department, to recognize, define and create these tools. For example, it is really about programming tools in VBA to get the project management following this new perspective. Project management we can all do. However, so far, we have experienced it differently." (SIMULI, Person 2.1)

The more independent role during service provision also influences the networks in which SIMULI interacts with other actors during service provision. Managers outline that they come into contact with a more diverse range of actors within the organization of the OEMs and also with other ESPs and suppliers, which also creates opportunities to build up knowledge that SIMULI has not had before, and that can be used in the provision of services to other customers.

Organizational Reorientation and Networking

To respond to the changes in the business environment, SIMULI has realigned the organization towards a more independent role in the provision of service offerings that are more extensive and complex than they were in the past. At the same time, the fact that OEMs are less involved in the implementation of more extensive service packages gives SIMULI more freedom to design internal development processes according to their own ideas and preferences. Respondents pointed out that the organization of how and where engineering activities are implemented is more frequently decided by SIMULI, as long as customer expectations are met (e.g., regarding the communication, engineering quality, and project milestones). For example, the following comment identify that a typical approach for ESPs is to have a smaller number of individual project managers on-site at the customer, who manage the engineering activities of a team that is based elsewhere:

> *"One needs a project manager on-site at the customer, who knows the process environment and who can speak competently with the customer. Where the rest of the team is located tends to become less and less important." (SIMULI, Person 4.1)*

In this regard, SIMULI highlights the growing importance of having an international site, thereby enabling engineering activities to be carried out more cheaply. The trend towards the offshoring of engineering activities is also driven by recent advances in the IT infrastructure between OEMs and ESPs, which have simplified the data exchange between actors that are located in different geographical regions.

Another recurrent theme in the interviews is the development of new operational capabilities to better leverage the spectrum of resources and competencies available in the organization. Respondents reported a growing number of projects cannot be offered by individual SIMULI sites, but instead require a collective effort of multiple sites. Also, several sites are dependent on a shared access to critical resources, such as testing facilities that are capital intensive and thus not available everywhere. Respondents reported that a particular concern for SIMULI is to mobilize and integrate resources and competencies that are distributed across the organization:

"The networks must be actively encouraged, for example, by setting up cross-site responsibilities. If, for example, a department manager is responsible for a topic across several locations, then there is a natural interest for this person to encourage collaboration among different sites. […] The department managers are responsible for a complete topic with related profit and revenue targets. It does not matter where the service is produced. We have sales targets for the implementation of our strategy, which are not linked to sites but to customers and competencies." (SIMULI, Person 4.1)

Comments such as the above illustrate that SIMULI has enforced new internal rules and practices in the organization to ensure that managers act in the best interest of the entire group and thereby support the goal of interdisciplinary and cross-site cooperation.

Establishment of Competence Centers

A significant step to improve cross-site collaboration at SIMULI has been the establishment of several *Centers of Competence* (CoC) to promote the integration of resources and the exchange of information across sites and disciplines:

"Over the last three years, we have noticed that we have eight to nine areas of expertise. We call this CoC, a Center of Competence." (SIMULI, Person 3)

"Our internal organization experienced a substantial transformation. Customers have previously commissioned us separately; for example, simulation, construction, and electronics were contracted individually. Now, more and more inquiries encompass all three, so that we have created so-called 'centers of competencies', as new internal structures that brings together internal competencies on a product basis, for example, to create a product or a service in the acoustics domain." (SIMULI, Person 4.2)

Respondents highlighted the importance of CoCs for SIMULI's capability to mobilize and integrate competencies and resources, for the offer and provision of projects that are too complex to be handled by an individual site (based on capabilities) and thus require collaboration throughout the organization. Comments such as the following point out that the CoCs are essential in the organization of the communication between managers, who work at the customer site, and remote teams:

"The links between the sites and competence centers are increasing. For example, we have recently established a center for bodywork. If we received an inquiry to develop bodywork in the US, a potential scenario would be to send 2-3 intermediaries who take over the communication on the spot. The competence center would then search for the experience

and expertise in the firm to deal with this task. This means networking in both directions: across locations and disciplines." (SIMULI, Person 4.2)

According to the respondents, these measures have already had a positive impact on the organization, so that the collaboration and the exchange of information and knowledge between sites and business units have been increasing.

4.4.3 SIMULI's Value Propositions

In recent years, SIMULI has expanded its portfolio of competencies and service offerings in several ways. New service offerings are more comprehensive and present customers with a one-stop-shop experience. Additionally, it has become essential for SIMULI to offer additional value to customers, by combining resources and competencies in innovative ways. Simultaneously, SIMULI is becoming more competitive in relation to price.

Towards a More Distinct Focus on Competencies

The value proposition of SIMULI in the market is currently evolving from a resource orientation to a competence orientation. Traditionally, as a flexible way of expanding their engineering capacities with external resources, SIMULI's service offerings have been tailored towards the need of the OEMs. External engineering resources enable OEMs to compensate for fluctuations in the utilization of their internal engineering capacity and can be reduced quickly if necessary. Keeping control over the development activities was thereby essential for many OEM departments; on the one hand, to keep critical knowledge in the organization and, on the other hand, to be able to intervene at any time if something did not work. In this mode of collaboration, the value propositions of the ESPs centered on the implementation, i.e., the development of feasible technical solutions, based on specified requirements. SIMULI managers described this role as *"extended workbench"* and associate it with a value proposition with a focus that is more on the provision of resources (i.e., engineering capacity) and less on competence. However, respondents reported that the focus is drastically changing and that their value propositions are revolving more around the provision of full-grown engineering competencies:

"In recent years, we have changed our focus. We are now focusing more on competence issues than in the past. For example, we are no longer dealing with placement business." (SIMULI, Person 4.1)

"In simple words, we underwent a shift from the [engineering] capacity to the competence." (SIMULI, Person 3)

The comments also show that this change is about more than the scope of service offerings. Several additional aspects of the value proposition, such as trust, responsibility, and sovereignty in the communication that have previously been deemphasized in the service process have now become a focus in the value proposition:

> *"The customer wants to see that you understand what you are doing and can handle a complete project in your own responsibility. This has changed a lot." (SIMULI, Person 4.1)*

Managers expressed the view that only those ESPs, who prove able to work independently from the OEM, will survive in the marketplace. Now, SIMULI frequently assumes the responsibility for the overall result of the service process and assures that the outcome (e.g., a simulation result or design model) meets a variety of expectations. These include, for examples, defined project milestones and costings for the development and subsequent production. As a result, SIMULI must assume responsibility for a variety of project management activities that have previously belonged to an OEM. For example, SIMULI's project managers are frequently responsible for the coordination of critical requirements with OEM employees and third-party suppliers at different hierarchical levels. Comments such as the following show that a trusted relationship between OEM and ESP is a prerequisite in this regard:

> *"When the outsourcing packages are more extensive, the customer must have confidence in the project management of the provider. This is very important and must be presented to demonstrate the professional project management processes. [...] The customer must also have seen the project manager face to face, so that trust can develop and to convince the customer that he can achieve his goals with the service provider." (SIMULI, Person 3)*

The shift in the focus of value propositions towards more competence is made particularly apparent by the fact that ESPs have become more autonomous and proactive in their communication with the OEMs and no longer depend on the same level of guidance as in the past. Instead of being continuously involved, OEMs prefer to be guided through the service process by their providers in a step-by-step manner. For SIMULI, this also means their customers frequently expect them to propose their own ideas and suggestions; for example, by suggesting cost-saving methods or improvements to decision-making processes. The outlined changes in the preferences and needs of OEMs are reinforced by the latest industry-wide reforms, enforcing legally compliant contracts, cooperation models and the spatial separation between OEMs and ESPs during service provision.

Comprehensive Offerings

With the development of a more distinct focus on competencies, it has become essential for SIMULI to meet the needs of their customers more comprehensively. Respondents reported is the rising importance of being able to provide a broader range of competencies in specific combinations, as requested by the customer. In this regard, the interviewees highlighted the growing need for ESPs to offer their customers a single point of contact for several complementary customer needs. However, a certain degree of specialization in the market is unavoidable, such that not all competencies can be built independently, some have to be sourced from external partners:

> *"The massive package sizes require us to work with other partners in a team. We talk a lot and openly with competitors. We ask whether we can help one another on specific topics, for example by lending three employees that have a specific competence to another provider." (SIMULI, Person 4.2)*

The comment above shows that SIMULI also assumes a role in service networks, in which smaller and mid-sized ESPs share and complement resources and competencies for the collective benefit of the group. In addition, SIMULI has recently entered into a strategic alliance with another service provider, whose resources and competencies complement those of SIMULI, such that the collaboration benefits both organizations:

> *"The [partner firm] also recognizes this tendency [towards larger projects]. They say that they get fewer opportunities to get into a bidder circle because they do not have engineering competence. On the other side, we do not have all the test rigs. Therefore, we can help each other very well and provide the missing competencies." (SIMULI, Person 2.2)*

Moreover, SIMULI aims at closing gaps in resources to become even more independent from external partners and customers. In the past, development activities were often carried out on equipment that was provided by their customers. For example, physical crash tests were performed at external test centers, and virtual simulations were calculated on the external computing clusters. In the meantime, SIMULI has been building up these resources itself to assume a more independent and mature role in the market.

4.4.4 SIMULI's Innovation Procedures

Together with the change in the role of SIMULI in the provision of services, the way SIMULI is involved in innovation processes is also changing. While the scope for SIMULI's innovation activities has so far been limited, the trend towards a more independent role in the market has now opened up new opportunities for SIMULI to design service processes according to their own ideas and to use its own expertise and competencies in the development of new service offerings.

Innovation Constraints of the Old World

The interviewees described the old world of automotive engineering, in which SIMULI's role and business purpose was focused on the provision of engineering resources, i.e., individuals and small project teams, without assuming much responsibility for the outcome of the service itself. In this old business logic, SIMULI's capability to innovate and develop new service offerings was limited in many respects and placed the firm in a role in which its primary concern was to react and adapt to changing customer needs and market requirements. The following comment echoes this situation:

> *"In the old world, there was no way to innovate. We were merely directed, and followed a red line so that we did what the customer expected. There was no room for constructive suggestions. Instead, the customer had clear expectations how we had to do our work." (SIMULI, Person 2.1)*

Because the majority of SIMULI's workforce has traditionally worked at the OEM sites, these resources were tied to the individual requirements of the customer. For example, employees often had very customer-specific knowledge of workflows and development procedures that was usually not transferable to other customers. SIMULI had the knowledge of how to carry out specific engineering activities, but as the employees were instructed by OEM executives, they lacked the knowledge of how to organize and manage comprehensive engineering projects. Moreover, the employees were working at the customer site, so were typically unavailable to SIMULI's own innovation activities. These circumstances and premises were governed by a strict set of rules and norms, which were mainly defined by the OEMs' aims and preferences and over which SIMULI had negligible influence. SIMULI managers pointed out that under these circumstances they had little opportunity to engage in service innovation. Instead, the development of service processes and offerings was mostly instructed by customers, so that employees and managers were focused on keeping pace with the general market development by continuously adapting to new requirements and adapting to changes in the working conditions at the OEMs.

Loosening the Innovation Constraints in the New World

Due to changes in the boundary conditions for the provision of engineering services, SIMULI has more and more opportunity to innovate. Interviewees described a "new world of AES" in which many of the factors that have previously made autonomous innovation activities complicated have virtually disappeared. As a result, SIMULI frequently takes the initiative in developing competencies and service offerings.

By building up knowledge and competencies on organizing and managing comprehensive engineering projects, new opportunities for innovation have opened up. Respondents pointed out that the expertise and skills of the employees are critical resources in the innovation process, and the spatial separation from the customer gives SIMULI much more control over these resources than before.

> *"Furthermore, now that we do not work on the customers' premises, we can, of course, better use our expertise for other customers, because the expertise is in our organization." (SIMULI, Person 1.1)*

For example, employees can now pursue innovation activities in parallel to the daily project work, for example, by using their skills and expertise in the development of technical prototypes, which in turn become the foundation of new value propositions. Furthermore, SIMULI's development expertise becomes more comprehensive so that managers and employees learn how to organize and lead projects, in which complex technical systems are developed, to success. The following comments echo this development.

> *"From the moment when our employees are in our own office, I need to experience this self-responsibility to reach a particular goal. […] When we have done five years of chassis assurance for an OEM, then we can suggest another OEM award us with such a project with full responsibility. Currently, that would not be possible, because our employees were committed to a [specific OEM] and they were not necessarily willing to commute to the site of another customer." (SIMULI, Person 2.1)*

The changes in the business relationship between SIMULI and the OEMs has also generated new innovation opportunities. The respondents stated that they no longer only follow the ideas and suggestions of their customers but instead that the technical departments of the OEMs themselves have become more and more open to the ideas and suggestions of the external ESPs, like SIMULI. When asked about these innovation opportunities, one participant responded:

> *"In the new world, I see an opportunity that we will develop our own engineering competence so that we can work more self-responsibly and have more space to carry out engineering activities. For example, if we are contracted to design a chassis and we propose, 'do not take this path now, instead take the other to gain an advantage.' If it is successful, the OEMs are open to our suggestions." (SIMULI, Person 2.1)*

Respondents attributed this change in customer interaction to the fact that, in terms of knowledge and skills, OEMs are no longer superior to ESPs. Instead, the previous imbalance is becoming reversed, changing how employees are perceived by the customer and giving them more influence on their customer's activities and decisions.

Controlled Market-oriented Evolution

SIMULI takes a systematic approach to the development of new services and competencies. When asked about the development of new competencies and services, several respondents highlighted the need for strategic initiatives to steer the activities of managers and employees towards a particular aim and to provide the necessary resources:

> *"If you want to build up a new topic successfully, it always takes a certain amount of time. We cannot finish topics in a two-month rhythm and start new ones. One has to build up competencies, and one has to master the subject thoroughly. It takes a little time. However, of course, if a competency should no longer be relevant tomorrow, we would delete it overnight. […] Our executive board would ultimately decide on changes. […] I believe that we would not change the main direction completely overnight, but if there was to be an adjustment, that would be decided by the [management board] and by experts from the respective specialist areas." (SIMULI, Person 4.1)*

The market segments and customer requirements addressed are generally not entirely new. Respondents expressed the view that they had no influence on the development of the AES market itself and would, therefore, concentrate primarily on market segments that already exist or those whose emergence is foreseeable:

> *"If we develop a five-year strategy, then we are already talking to our customers while we select the topics. There are no surprises. We do not change the market. We do not create an entirely new market. Our customer is a major OEM or Tier 1 [ESP], and it is clear that the customer must have a demand or will have a demand soon. Most of the time we do not create entirely new demands." (SIMULI, Person 4.1)*

Accordingly, a primary challenge for SIMULI is to continuously evolve its competencies and services in such a way that the existing and future market requirements can be met, i.e., to ensure that resources and competencies can be mobilized to meet customer requirements and take over OEM projects. As shown by the following comments, the interactions with customers, especially those during service provision, are essential for SIMULI to obtain critical information on upcoming changes in preferences and requirements to which their own activities can then be aligned:

> *"Being close to our customers is, of course, essential for us. […] As a pure ESP, we do not produce own products, which could ultimately lead to innovation, but instead, we have to*

continually develop our competencies as the customer needs them in the next two years." (SIMULI, Person 5)

"By doing countless projects with our OEMs, we naturally have access to some information where we, for example, note if a budget is being cut. We interact with the OEMs at various levels. There are indicators regarding what one observes in the market. One can see where the automotive industry is heading." (SIMULI, Person 4.1)

Informants expressed the view that the primary challenge is not to understand what customers will request in the future, but to decide which competencies need to be built up and which need to be bought from external partners:

"[…] Of course, we look at the inquiries, and we talk to the customers, who usually tell us their opinion. […] This is not complex. One knows relatively quickly, what one should be capable of doing. However, the difficulty is to decide whether to build something up or to find a partner." (SIMULI, Person 5)

At the same time, the respondents show that the increasing scope of projects leads to continuous development of new skills and knowledge with each project:

"Today, a package is requested, and it comprises, in principle, demands for 50 individual competencies. Then there may be 30 of them that can be handled very well. There may be ten where competencies exist, that could maybe work. Then there are ten [competencies] that one has to buy externally or even has to build up oneself, and this is where it often gets complicated." (SIMULI, Person 5)

For example, projects are selected such that they support the achievement of strategic goals, meaning that the topics with which the employees come in contact will enable SIMULI to acquire new expertise in a particular field or strengthen the firm's reputation in the market. In this regard, respondents mentioned that the CoCs ensure that all activities are strategically aligned. Employees and organizational units can also pursue their own innovation path, for example, develop ideas and concepts for new solutions or services, but such activities must be aligned with the strategy.

Towards a More Self-Respondent Way of Innovating

The data show that SIMULI's innovation behavior in the market is subject to change. The impulses that lead to changes in service processes and offerings no longer come exclusively from the market, but increasingly also from SIMULI, who now assumes a more active role in the market than it was in the past. Comments such as the following demonstrate that SIMULI is no longer only responsive to customer inquiries, but instead proactively composes innovative service offerings and then suggests them to the customer:

"It also happens more often that we are convinced that we can do something better than others. In such cases, we proactively approach the customer and suggest that they outsource [formerly separated needs] as a package." (SIMULI, Person 4.1)

Respondents described different scenarios how SIMULI proactively proposes new service offerings. One scenario is to develop an innovative proposal for a specific call for tenders, which then leads to changes in the organization of engineering activities and a new way of co-producing the service with the customer. Another scenario is to stimulate changes in the outsourcing practices of the OEMs and then trigger longer-term change processes that can affect a range of downstream projects.

When SIMULI develops new value propositions, these are often larger packages of activities that were formerly separated. Respondents stated that they would systemically examine activities and areas of competence that surround their offerings to identify potential areas for expansion.

"We develop technology that we offer to the customer and try to show that we are better and offer additional value. Excellent knowledge of the customer is essential. We detect fields where the customer says that this is a topic of the future, or where the customer is not yet so well positioned. In the past, we have not done this at all. Now we are investing a lot of money in this area." (SIMULI, Person 3)

The development of more holistic offerings requires an in-depth understanding of how the different technical departments within the complex OEM organization divide the development tasks and activities and bundle them to larger outsourcing packages. For the purpose of developing more comprehensive offerings, SIMULI also uses cooperation with other ESPs:

"Something that we have never done before, offering something together with partners, is now increasingly happening. I can give three immediate examples, where we have offered something new in collaboration with partners that has not existed in the market before – to some extent technologically, but partially also through bundling of our competencies with those of a partner." (SIMULI, Person 1.2)

The above comment also shows that joint innovation activities with other firms are novel to the firm's market behavior. Managers described a planned and targeted approach to finding suitable partners. For example, when SIMULI has identified an advantageous competence bundle, it looks specifically for partners for a project or the realization of an idea. Not only other ESPs, but also universities can be partners in this regard. For example, respondents reported collaboration with universities to develop technical prototypes. When SIMULI approach customers with their own ideas, the firm uses a traditional sales approach that communicates a clear added value:

"It is a matter of being more active in sales and outlining our own competencies, regarding the advantages. That means that we have to do a lot of one-on-one interviews, where we look towards the next project and convince the customer of our team and the fact that we can improve one or two things in the project. Thus, one tries to present the additional value, the advantages, and to demonstrate one's competencies." (SIMULI, Person 3)

According to the respondents, it is essential to convince customers of the superiority of their own competencies and skills and the capacity to achieve additional value.

Cost Efficiency

SIMULI's innovation activities are also driven by continuous efforts to become more cost-efficient in the provision of engineering services. Interviewees reported that in recent years it has become essential for them to strive for efficiency and to optimize their engineering processes. Comments such as the following show that SIMULI takes an approach involving the relocation of specific process steps and engineering activities to sites abroad:

"It has become routine to standardize specific topics and transfer them to international sites. They will then be passed on to colleagues. Even now, not every department has a counterpart in a low-cost country. Colleagues are often asked to build up topics in [a foreign country]. It has become best practice. We know that we need to acquire a similar amount of experience abroad as we have in Germany." (SIMULI, Person 5)

Respondents indicated a high degree of systematics in this approach. SIMULI systemically analyzes services for outsourcing potentials and decomposes them into more fine-grained service modules:

"New topics are emerging. For example, we must, first of all, strive to build up these competencies in [city] or [city]. This is keeping us busy. Once we have defined and established standards and automated processes, it is the right time to hand over the topics to sites at our low-cost locations. […] This happens step by step. For example, we take in two people first and then four, we make a slow transition and slowly build it up. This has proved its worth to us." (SIMULI, Person 5)

Services are decomposed by first isolating smaller sets of operational processes and then bringing them into a standardized and outsourcing-friendly form. As soon as the firm's knowledge of managing these processes has reached a sufficient state of maturity to standardize processes and ensure the necessary quality, the modules are handed over to shared service centers located in a more cost-effective country. Once successfully standardized, modules become available as shared services to SIMULI's different sites, which results in cost advantages.

4.5 Chapter Conclusion

In summary, this chapter has analyzed how ESPs are involved in service innovation. The analysis of the two case organizations of XTEC and SIMULI followed a structure based on four common themes: *business environment*, *resource integration practices*, *value propositions*, and *innovation procedures*. As suggested by the S-D logic perspective on service innovation (cf. Lusch and Nambisan 2015), the analysis not only focused on the dedicated innovation activities of the two ESPs, but also looked at their role in the interaction with other actors from their networks, which give rise to new value propositions and resource integration practices. In this way, the two case descriptions develop a more comprehensive understanding of the nature and diversity of service innovation processes in the AES industry, beyond firm-centric innovation. The findings show that the innovation activities of ESPs are often driven by changes in their business environment and that the recent transformation of the AES industry also led to changes in the way ESPs engage in service innovation. Most innovation activities are thereby centered on collaboration and require interactions and joint innovation activities between ESPs and other actors in a network. Together, the two case descriptions provide a reliable and fruitful empirical foundation for further cross-case elaborations in the following chapter.

5 CASE SYNTHESIS

5.1 Chapter Introduction

Drawing on the case studies of XTEC and SIMULI, this chapter examines the different ways in which the two case organizations engage in processes of service innovation. The findings emphasize the diversity in service innovation processes in the AES industry and present three dimensions that are useful to distinguish different process types. One complexity may arise if the underlying activities and process steps are not entirely under the control of the ESPs. Instead, they are typically linked to changes in a broader context of markets and technology. Furthermore, the findings indicate that there are a growing number of opportunities for ESPs to innovate in a more autonomous way and to actively and independently drive innovation themselves. This chapter aims to explicate the variety of, and the differences between, service innovation processes, by synthesizing findings from within and across the two cases. Therefore, an analytical framework of differentiating dimensions and characteristics will be developed.

For this purpose, the chapter is divided as follows. The next section (5.2) outlines the abductive approach that led to the conceptualization of dimensions and characteristics, which form the main components of the analytical framework. Section 5.3 then offers more insights on innovation in engineering services, before introducing the framework, along with its respective dimensions and characteristics. The framework helps to describe and map different processes of innovation in engineering services. Furthermore, it provides a structure to the discussion of differences and commonalities in the innovation behavior of the two case organizations. Finally, section 5.4 summarizes the results and concludes this chapter.

5.2 Approach to the Synthesis

This section describes the approach that led to the development of the conceptual framework, with its several dimensions and characteristics. The analysis of the interview data revealed that service innovation processes in the AES industry are highly diverse and complex. Distinguishing and conceptualizing specific process types thus became a primary aim of the study. For this purpose, the analysis focused on identifying the differences and commonalities between innovation activities. Differences became especially apparent by the fact that interviewees outlined several activities that contradicted each other so that they could not be mapped to specific service innovation processes at the same time. For example, in some cases ESPs were making more active contributions to innovation processes, while, in others, it was the customer, who directed their behavior. Such differences that were related to the same topics were conceptualized as sets of interconnected characteristics.

In line with the idea of abductive sense-making, the data analysis led to a continuous matching and comparing of the empirical data, the analytical framework and the existing body of knowledge (Dubois and Gadde 2002). The choice of concepts was thereby specifically inspired by the S-D logic interpretation of service innovation. For example, the analysis made apparent that the different ways in which ESPs collaborate and interact with other actors form an essential differentiating parameter in service innovation processes. As the vital role of interactions is also highlighted in the S-D logic literature (e.g., Vargo et al. 2015; Vargo and Lusch 2014), the different ways ESPs interact with other actors in service innovation processes were thus distinguished from one another. Further, they were assigned to the overarching dimension "interaction modes." In this way, a large number of characteristics and dimensions were conceptually defined.

In a parallel activity, the dimensions and characteristics helped to detect and distinguish service innovation patterns that later became the foundation of the service innovation typology. However, not all of the dimensions and characteristics turned out equally useful, as some of the dimensions and characteristics were better reflected by the data than others. To reduce the complexity of the framework and to focus on those dimensions and characteristics that were capable of defining the categories of the service innovation typology, the framework was refined in several iterations, and the number of dimensions and characteristics was reduced. Some characteristics were also grouped under broader categories. Consistency in the analysis was ensured by rigorously applying the altered dimensions and characteristics to the whole range of underlying empirical data (Barnes 2005). This was done until the arrangement of characteristics and dimensions produced a robust result and was capable of delineating the various innovation pathways so that no further new characteristics could be identified. At the end of this process, the analytical framework comprised three dimensions and ten characteristics.

5.3 Results from the Synthesis

5.3.1 Overview

This section describes the dimensions and characteristics of the analytical framework, which captures the complexity of the diverse ways in which ESPs engage in service innovation. The diversity of service innovation processes can only be partially attributed to the differences between the two cases and is mainly substantiated through the fact that XTEC and SIMULI engage in several different innovation processes simultaneously. Similarities between these processes are limited to sub-areas, such as specific activities or roles, which, however, occur in different sequences and constellations without revealing a holistic pattern or process model. The high level of process complexity results, in particular, from the interrelation between service innovation processes and the broader changes occurring in automotive development. As outlined in the previous chapter, the emergence of new services often coincides with technological advances and market-related upheavals that inspire new customer requirements and trigger customer-led service innovation. The resulting innovation contexts are often in some way unique and typically require an individual customer-specific innovation approach. Furthermore, both cases have made apparent that service innovation processes are often coupled to activities that occur during daily business. The relevance of these activities to innovation processes may not be recognized by the employees. These process characteristics make the description and understanding of service innovation from a uniform perspective difficult, and thus call for the multi-dimensional analytical framework, which is presented in the following sections.

5.3.2 Dimensions of Service Innovation

Based on the analysis of the empirical data and under consideration of existing concepts from the S-D logic literature, the following three dimensions were identified as particularly relevant to capture the complex and diverse ways in which the two case organizations engage in service innovation:

- **Interaction Modes:** The S-D logic considers interactions as crucial to enable multiple actors, whose activities and practices are mutually dependent during service exchange, to co-evolve their roles (Vargo et al. 2015). Furthermore, it is through interactions in networks that actors decide on the acceptance or rejection of new value propositions. Hence, interactions play a significant role in the emergence of new ways of value co-creation (Vargo et al. 2015). The analysis of the two case organizations shows that service innovation processes always require interaction (or collaboration) between ESPs and other actors from their network. For example, interactions are required to co-develop new value propositions or to present, evaluate, and refine them, and to negotiate the terms of service provision. Based on the data, different types of interactions can be identified that are conceptualized as interaction modes. Interaction modes in service innovation processes can be defined as specific ways in which ESPs perform innovation activities that are oriented towards other actors from their network. For example, interaction modes differ regarding the goal of the interaction, their direction, and the actors involved.
- **Roles in the Renewal of Institutions:** Service ecosystems have become evident by virtue of an institutional logic that guides, enables, and constrains the interactions among resource integrating actors in the exchange and innovation of service (Vargo and Lusch 2011, 2014). Previous research has emphasized that actors contribute to service innovation processes by engaging in institutional work, i.e., by breaking, making and maintaining

institutional rules (Vargo et al. 2015; Lawrence and Suddaby 2006). In the analysis of the case studies, the role of institutions has become particularly discernible by a complex set of interrelated and enduring codes of conduct, norms of behavior, and standard everyday practices, which determine (i.e., constrain, enable, and guide) the offering, provision and innovation of engineering services. Some of these codes have become clear as codified rules, e.g., in contractual agreements, that are often determined by legal requirements. Others are informal or become noticeable as a typical mindset or a shared understanding among the ecosystem population, e.g., on how to approach a specific problem or to communicate something. Recent changes in the laws affecting the customer-client interface during service provision underline the link between service innovation and the processes of institutional disruption and renewal in the AES industry. Based on the analysis of the data, how ESPs contribute to such processes of institutional change is captured in three different roles.

- **Recombinant Practices:** Based on prior work from Arthur (2009), the S-D logic draws on the foundational view of innovation as combinatory evolution (Vargo et al. 2015). This view is grounded in the belief that almost any innovation can be dissected into preexisting building blocks (Lusch and Nambisan 2015). On a more detailed level, Beverungen et al. (2017) present a framework of four recombinant operations in service innovation (cf. Section 2.4.3). Recombination is particularly well reflected in the two case studies. Whenever interviewees described the emergence of new service offerings, these offerings could always be referred back to pre-existing building bricks. New service offerings are especially based on resources (e.g., knowledge and technology) and competencies that were formerly separate and are now brought together with other resources in new configurations. Furthermore, both case organizations frequently expand existing service offerings with new components, or aspects, or they combine formerly separate services into innovative bundles. Based on the empirical data, several recombinant practices can be distinguished.

The presented dimensions create the basic structure of a three-dimensional analytical framework with which differences in service innovation processes can be described. The three dimensions reflect different perspectives on service innovation, which are particularly prominent in the empirical data; furthermore, they mirror central aspects of an S-D logic grounded understanding of innovation. As suggested by the abductive approach, the analytical framework establishes a link with both empirical data and existing theoretical thinking (cf. Dubois and Gadde 2002). Tab 7.1 illustrates this triangulated relationship using examples from the data and references to the S-D logic literature.

Tab. 5-1 Dimensions and How They Reflect Empirical Findings and S-D Logic

Dimension	Empirical Data	S-D Logic
Interaction Modes	Interviewees emphasized that service innovation can only occur through interactions with actors and, in particular, require collaborative activities with the customer. For example, XTEC highlights the need to co-develop new services with the customer to ensure their specific requirements are met.	The S-D logic considers interactions crucial to enable different actors to co-evolve their roles and resource integration practices, which are mutually dependent during service provision (Barile et al. 2016; Vargo and Lusch 2011).
Roles in the Renewal of Institutions	The cases of XTEC and SIMULI show that ESPs contribute in different ways to the renewal of rules and normative practices that are not only relevant to them but also to other ESPs. At the same time, recent changes in regulatory practices highlight the relation between service innovation and changes in institutional rules.	Service ecosystems become most evident by virtue of an institutional logic that guides, enables, and constrains the interactions between resource integrating actors in the exchange and innovation of service (Vargo and Lusch 2011, 2014). Service innovation is interrelated with changes in institutional rules (Vargo et al. 2015).
Recombinant Practices	Interviews indicated that innovations in engineering services are often based on new combinations of preexisting resources and competencies. For example, XTEC has developed a technology demonstrator by combining resources and competencies in a new way, using different actors from within and outside the organization.	Based on prior work from Arthur (2009), the S-D logic views innovation as recombinant evolution (Vargo et al. 2015). This view is based on the premise that almost any innovation can be dissected into preexisting building blocks (Lusch and Nambisan 2015).

The following three sections deal with the dimensions individually and introduce the respective characteristics. To provide additional empirical support for the characteristics, each section contains a table with sample quotes from the interviews and with the relevant codes used in the analysis. As for the two cases, the characteristics vary in their empirical account. While some of the characteristics are equally reflected in both cases, others may only become apparent in one particular case or are perhaps more dominant in one case than in the other. In each section, additional tables summarize the dimension-specific differences and commonalities of the two case organizations.

5.3.3 Interaction Modes

When performing innovation processes, XTEC and SIMULI interact with other actors in networks in different ways and with different objectives. Based on the data, four different interaction modes can be identified. Tab. 5-2 provides a brief description of the four modes and links them to sample quotes from the interviews and to the respective open codes used in the coding process. It should be noted that the modes are reflected in the behavior of XTEC and SIMULI to varying degrees.

Tab. 5-2 Interaction Modes

Modes	Description of Modes	Sample Quotes	Open Codes
Adapting along Evolutionary Pathways	Bridging the minor gaps between what is needed in the market and what has already been offered. Aligning the development of competencies and resources in such a way that the organization is prepared to meet future market demands.	"[…] *we must continually develop our capabilities in the way that we meet the demands that our customers will have in the next two years. The direction becomes apparent during discussions* […]" (SIMULI, Person 5)	Evolving from project-to-project, monitoring inquiries, antici-pations, strategical investments, scenario-planning, trend scouting
Outlining Value Co-Creation Possibilities	Creating own innovation impulses in the market by approaching OEMs with ideas and offerings, and by outlining the corresponding value that customers can co-create by accepting and supporting them.	*"We present things to the custom-er that he does not yet outsource. For example, we propose that he can develop an i-panel with us so that we do the prototypes right away. For some of our customers, this is very interesting."* (SIMULI, Person 1.2)	Proactive propositions, exploiting opportunities, obtaining customer commitment and support
Moderating Co-Creation Processes	Guiding shared processes of learning, and developing solutions with several members in groups (e.g., employees of the customer).	*"In our innovation rooms, one can work creatively together with the customer in a more pleasant atmosphere."* (XTEC, Person 7)	Design Thinking, moderation, Innovation Studio, coaching, joint-innovation
Brokering Knowledge	Dissemination of knowledge and technology in networks by giving other actors access to resources they are not yet aware of, or could not otherwise gain access to.	"[…] *we were requested by the customer to explore a new mat-erial. We concluded that it was not yet ready. Nevertheless, we pursued this further […] Finally, we provided a report to the customer on the future potential."* (XTEC, Person 2)	Trend scouting, networking, patents and licensing, exploring and researching, start-ups, research collaborations

Adapting along Evolutionary Pathways

A first mode, which is equally reflected in the cases of XTEC and SIMULI, relates to the need to keep abreast of the rapidly changing customer demands. Both organizations are under constant pressure to develop their competencies and service offerings in such a way that the organizations are capable of meeting the existing market requirements, while simultaneously preparing for upcoming changes in customer needs. Concerning the individual methods of adapting, XTEC draws on an agile approach, whereas SIMULI emphasizes the need for systematic and controlled strategic efforts. The case of XTEC suggests that competencies and service offerings are often not the result of strategic plans but rather emerge from the day-to-day business through activities, which involve trial and error, as well as learning through feedback. It is not so much the strategy that determines which competencies are built up or how services are further developed, but rather the individual business units who are actively encouraged to try new things and to further pursue those pathways which are successful in the market. XTEC's strategy is, in this regard, more a set of principles and the designation of market (or competence) specific no-go areas. The areas are defined with the aim of ensuring the group remain on track towards a beneficial role in the market of tomorrow. Also, XTEC promotes an organizational culture that embraces entrepreneurship, individuality, and physical rooms designed to encourage innovation. In contrast, the approach of SIMULI is based on systematic and strategy-oriented adaptation, so that the activities are directed towards planned outcomes. This approach focuses on anticipating upcoming market developments and planning specific activities that prepare the organization accordingly. In line with this approach, SIMULI carries out large-scale projects and offers its services in the field of series-development. The more systematic approach of SIMULI can also be attributed to the fact that the organization has more than twice as many employees as XTEC and thus tends to be less flexible in their behavior. However, both XTEC and SIMULI have in common that their market behavior is mainly reactive and they adapt primarily to changing customer requirements, without being able to influence market developments themselves.

Outlining Value Co-Creation Possibilities

Despite the recent increase in market dynamics, which is keeping XTEC and SIMULI equally busy dealing with the challenge of adapting to a fast-changing environment, the two case organizations are apparently intensifying their innovation efforts. Both emphasize that it becomes more and more crucial for them not to focus on adaptation solely. In fact, both cases provide empirical evidence that ESPs are no longer only following the market development but are also more often creating innovation impulses by outlining beneficial value co-creation opportunities to their customers. Respondents from the two cases mentioned several activities that can be assigned to this mode, ranging from the development and promotion of technological prototypes, through proposals for alternative solutions and development approaches for projects, to the pro-active offering of beneficial combinations of competencies and resources. In all these cases, the impulses for change came directly from the provider and were not driven by the interest of a specific customer. In this regard, SIMULI proceeds very systematically and attempts to convince customers by communicating a clear added value, in contrast to solutions used previously or alternative service offerings. XTEC, on the other hand, emphasizes the need to give customers a hands-on experience and to inspire them by visualizing the idea atypically, i.e., in ways that are unconventional and surprising to the customer. In the development of technologies and prototypes, XTEC, furthermore, prefers to work with other actors in the network and uses, for example, the innovative capacity of universities. In general, both ESPs emphasized the need to break out of the traditional reactive mode of merely waiting for new requirements to emerge in the market, but instead to take the initiative, e.g., by developing new ideas and prototypes. The various prototypes and technologies that XTEC has developed independently from a specific customer interest underline the increasing efforts that the organization is taking in this direction. However, managers have reported that customers would often react over-critically about ideas and value propositions with an external origin; for this reason, XTEC prefers a different mode, drawing on a collaborative approach, and this mode is used more frequently now.

Moderating Co-Creation Processes

Another interaction mode that was exclusively reflected in the case of XTEC is the moderation of co-creation processes in groups of actors, including the customer. XTEC directly associates this mode with the Innovation Studio that has been specially designed to support moderated innovation processes. In contrast to the previously outlined mode of approaching customers with ideas and value propositions, the moderation of joint innovation processes has the advantage that it overcomes the problem that customers tend to be overly critical towards ideas sourced from outside their organization. Instead of merely presenting the customer with an idea, XTEC describes that they are most successful when they bring the customer into the creative atmosphere of the Innovation Studio and guide them through the joint innovation process. The distinct nature of this approach is further emphasized by the fact that SIMULI does not mention a comparable mode of interacting with their customers. In this context, however, it should be noted that XTEC uses the studio especially in collaboration with a specific OEM who is also an XTEC shareholder. The shareholder setting creates the foundation for a distinct form of trust between the two organizations that forms the basis for extensive cooperation and communication. However, the use of the studio is not limited to this specific OEM, and XTEC reports that the studio is now increasingly used in collaboration with other OEMs as well.

Brokering Knowledge

Differences between XTEC and SIMULI become evident when considering the extent which the organizations network with other actors and actively use these relationships as a resource in service innovation processes. SIMULI emphasizes the importance of partnerships and alliances with partner firms. However, these collaborations are initiated with clear aims, for example, when SIMULI requires a specific competence to create a novel service offering. In contrast, XTEC's behavior reflects a managerial attitude that is more network-oriented. First, the organization interacts and collaborates with a diverse range of actors, e.g., start-ups, suppliers, universities, and large IT firms. Furthermore, compared with SIMULI, XTEC interacts more openly and seeks beneficial actor constellations without following predetermined aims. In such networks, XTEC adopts roles in which the firm creates value through the accumulation and dissemination of knowledge. In doing so, XTEC participates in actor constellations that provide the firm with potential application contexts (e.g., OEMs who need external resources and technologies); further the firm makes new contacts, with actors who offer innovative solutions or other types of value propositions and who seek new business opportunities. XTEC uses the industry-specific knowledge from the automotive industry on technical fields of application and customer requirements. Additionally, XTEC uses personal network relationships with start-ups and universities to bring together resources and actors in constellations and processes that lead to the emergence of new values. Such processes involve activities and interactions that unfold in a non-linear manner. While it is worth noting that some parts of XTEC's organization are more involved in these activities than others, this heterogeneity also gives XTEC a high degree of agility and capacity for action in networks. The managing directors and department heads act with a high degree of autonomy and can pursue their own innovation pathways without having to coordinate all decisions within the group.

Comparative Summary

Tab. 5-3 provides a comparative summary of the outlined results. The table illustrates that the modes in which XTEC and SIMULI interact with other actors are subject to significant differences. While the first two modes are equally present in both cases, the other two modes are mainly present at XTEC, indicating differences in the roles of the two case organizations in their interaction with other actors.

Tab. 5-3 Case Comparison with regard to Interaction Modes

Modes	XTEC	SIMULI
Adapting along Evolutionary Pathways	XTEC's approach to adaptation is agile and based on trial and error in day-to-day project business, as well as on learning through feedback. In this context, XTEC's strategy is more a guideline which excludes specific paths but encourages spontaneous developments and creates the necessary freedom to innovate.	SIMULI anticipates future market demands and implements planned efforts that move competencies and service offerings into the desired strategical direction. Strategic objectives typically guide the development of competencies and service offerings.
Outlining Value Co-Creation Possibilities	In the development of technologies and prototypes, XTEC prefers to work with other actors in the network. Offerings and ideas are presented in a tangible form, or visualized in creative and atypical ways. However, customers tend to be over-critical about ideas with an external origin.	This mode describes a systematic approach of convincing OEMs of an idea or solution by clearly communicating the additional value, in comparison to formerly used solutions or alternative value propositions in the market.
Moderating Co-Creation Processes	The moderation of collaborative innovation processes is XTEC's preferred way of developing ideas and service offerings. This mode is directly connected to the Innovation Studio, which has been specifically designed to support this role.	This mode was not reflected in the empirical data from SIMULI.
Brokering Knowledge	XTEC explores beneficial resource configurations in complex networks that cut through organizational boundaries. The diversity of actors in these networks is high. Networking occurs more openly and without predetermined aims. The network itself becomes a crucial resource in value co-creation and service innovation processes.	Networking activities and information exchange among different organizational units is coordinated by the CoCs and occurs rather systemically, i.e., based on plans and predetermined goals. The diversity of actors is comparatively low. Networking within the organization across sites is facilitated through the organizational structure.

5.3.4 Roles in the Renewal of Institutions

Tab. 5-4 gives an overview of three different roles in which the two case organizations contribute to and are involved in the renewal of institutions, i.e., in the disruption and creation of institutional rules. The different roles explicate the complex link between innovation in engineering services and processes of institutional change.

Tab. 5-4 Roles in the Renewal of Institutions

Roles	Role Description	Exemplary Quotes	Open Codes
Synchronizer	Adapting the own behavior and mindset to the rules and practices that guide, restrict and enable the exchange of service among a whole community of actors.	*"That we now have increased responsibility was merely a rethinking process. In the past, the customer was in control, and we did not have direct responsibility. The customer was in the driver's seat. Meanwhile we have to assume the driver's seat because the requests that we receive from our customers have changed."* (XTEC, Person 3)	Aligning mindsets, adapting to new rules, adapting practices, assuming more responsibility
Stimulator	Incentivizing other actors who have a distinct institutional influence, to deviate from former paradigms and practices.	*"It is common that we directly consult with the customer when we receive an invitation for tender and have to explain that when we set up this project in the proposed way, we will not be able to collaborate effectively. Then we propose more suitable, alternative ways of defining the contract."* (SIMULI, Person 2.1)	Disrupting institutions by succeeding with alternative ways of doing things
Co-Designer	Joint development and specification of rules and practices in cooperation with other actors in groups, e.g., in the context of consultancy services, that influence a more extensive range of actors.	*"Of course, there are always small fields of innovation, but they do not have a significant volume. Instead, we optimize one or two things, or here we simplify a step in the development. Then we implement the same at another customer."* (SIMULI, Person 5)	Helping customers to implement regulations, consulting, reinforcing institutional change, transferring rules and practices

Synchronizer

The two cases of XTEC and SIMULI show that ESPs only have weak institutional influence, which is primarily confined to their organization. Whereas the large OEMs can simply enforce new rules and norms (for the implementation of engineering services and the collaboration with their providers), the ESPs have no other choice than to synchronize with this complex rule system by adapting their managerial attitude (i.e., how managers approach problems and opportunities in the business environment and how they think about them) and organizational behavior. Synchronization was observed in the two cases of XTEC and SIMULI in various ways. In line with SIMULI's systematic method of evolving, the organization synchronizes in ways that are very structured and rely on the enactment of rules and norms to guide managers and employees in a defined direction. For example, in response to recent changes in the regulations surrounding the provision of professional services in Germany (cf. section 2.3.4), SIMULI has issued new internal guidelines to help managers in the challenging situation of switching to more independent modes of service provision. In this regard, interviewees reported tensions, and stressful situations, which may be viewed as a phase of intense efforts to stay in alignment with sudden changes in the institutional logic of the service ecosystem. Synchronization is equally reflected in the case of XTEC. In particular, it becomes clear that varying interactions between organizational units can lead to conflicting mindsets and rule settings within the internal organization, when managers and employees begin to associate themselves with institutional rules in different service ecosystems. For example, some parts of XTEC's organization engage in collaborations and interactions with start-ups and high-tech companies, and thus encounter their institutional logics, whereas other groups question the purpose of these activities and continue to associate themselves with a more traditional role in the market. Accordingly, different factions within the organization have emerged that associate and synchronize themselves with different institutions. While the employees and managers, who interact with a diverse range of actors, often begin to adopt a management attitude similar to those of start-ups, the traditional faction shows no such intentions. The diversity of outlook and behavior leads to growing tensions and conflicts in the organization, where it remains open which side will prevail.

Stimulator

New service offerings always require changes, in some way, to established rules and practices. Within their organization, ESPs can decide, with relatively few restrictions, how engineering activities are carried out. However, the processes and rules that concern the customer are not under their direct control and are widely governed by codified laws and rules that are established by the OEMs, e.g., in the form of contract agreements. Changing such institutional rules requires the approval and support of the OEMs. XTEC managers, for example, pointed out that they could only offer novel combinations of resources and competencies (i.e., in a bundle), if they convince the customer to create a corresponding tender that features this specific combination. More complexity arises from the fact that there are multiple stakeholders in the organization of an OEM, who decide on respective processes and outsourcing procedures, which furthermore require changes in the way different departments align their individual requirements. ESPs can stimulate such changes by giving their customers valid reasons to deviate from existing standards, e.g., by outlining value co-creation possibilities that show the associated risk of leaving familiar paths is worthwhile. However, even if a customer is willing to deviate from previous approaches, these changes will only sustain over time if the ESP repeatedly succeeds in demonstrating added value over previous approaches. XTEC's managers reported that they have been able to convince customers to bundle formerly separate development activities into a more extensive package. After realizing that the effort needed to control projects was reduced in this way and that XTEC delivered the expected quality, the customer decided to convert to the new outsourcing procedure. Similar patterns in the stimulation of institutional change are also evident in the case of SIMULI, whose managers highlighted opportunities to get customers to break with existing rules and norms and step into new territory – although always under the premise of having a particularly good business relationship. In this way, ESPs can instantiate co-evolutionary processes that are accompanied by institutional change and renewal.

Co-Designer

A further role of ESPs in the renewal of institutions, which is equally reflected in the cases of XTEC and SIMULI, is linked to the expansion of their service portfolio in recent years. The two ESPs no longer only offer technical implementation, but also services that focus on the design and optimization of the complex development environment in which such services are offered and provided. Especially consulting services have become more significant in recent years; these are offered either as part of more extensive service packages or as standalone offerings. For example, XTEC mentions a current project aimed at optimizing project management processes in the development environment of a large OEM. In addition to automating process steps, the project also includes a redesign of the associated project management workflow and processes for decision making and reporting. Process descriptions and workflows are codified rules and constitute a vital part of institutional arrangements. Similar activities are also mentioned by SIMULI, whose managers emphasized that consulting services are becoming increasingly common in regular engineering projects. In this context, the respondents mentioned the development of concepts that define the division of responsibilities and engineering activities between different internal and external development stakeholders. This also changes the way these activities are bundled and outsourced. After completion of the projects, the ESPs themselves work in the optimized system of rules and processes that they have designed and optimized, so that, for example, the self-designed reporting workflow later determines the cooperation between OEMs and their employees in the development processes. In this way, XTEC and SIMULI can influence certain parts of the institutions by working closely with their customers. Interviewees indicated the importance of this role for the independent development of new service offerings because it offers ESPs opportunities to purposefully influence institutional rules and practices in ways that support the development of innovative service offerings, e.g., by removing potential innovation obstacles or by clarifying possible requirements to new offerings in advance. On the one hand, ESPs can acquire knowledge about the OEM organization that helps to develop new services from the outset in such a way that they are compatible and meet customer-specific requirements.

Comparative Summary

In summary, XTEC and SIMULI contribute to the renewal of institutions in similar ways (cf. Tab. 5-5). In general, the two organizations have limited direct influence on institutional rules. Instead, they primarily synchronize with the institutional logic of an ecosystem, in which the OEMs determine most rules and practices. However, the two ESPs can also make active contributions to the renewal of institutions, either by co-designing them in collaboration with the customer in consulting projects, or by proposing and demonstrating the feasibility and added value of alternative institutional configurations. In this regard, XTEC's decentralized approach leads to higher heterogeneity in the organization and grants individual teams and employees more freedom to pursue their own innovation activities. In line with this approach, XTEC managers expressed varying viewpoints that are not consistent. For example, some XTEC managers stress that it was crucial for them to break out of the common mode of adapting to the general market development and create their own innovation impulses. In contrast, other XTEC managers doubt this viewpoint of their colleagues and state that it was more important for them to quickly adapt to changes in the market. The statements of SIMULI managers are more consistent and emphasize the need of collectively adapting the organization to the business environment through codified internal rules that guide the behavior of managers and employees across all sites. However, findings show that this also creates additional constraints for individuals and teams to actively engage in service innovation.

Tab. 5-5 Case Comparison regarding the Roles in the Renewal of Institutions

Roles	**XTEC**	**SIMULI**
Synchronizer	XTEC synchronizes through interactions and feedback in networks. Acceptance of ideas and behaviors from a diverse circle of actors leads to more heterogeneity regarding different attitudes and behaviors. The firm is tolerant of diverging pathways of the organization.	Emphasis on systematic and collective adaption to changes in institutional rules, which means that SIMULI synchronizes on an organization-wide level.
Co-Designer	XTEC and SIMULI offer consulting services that allow them to design and optimize the complex development environment in which engineering services are offered and provided. This gives them an opportunity to intentionally design rules and norms in order to encourage innovative service offerings.	
Stimulator	Many of the rules and practices that determine the provision of engineering services are governed by OEMs. The direct influence of XTEC and SIMULI on these institutions seems limited. One way to exert some influence is to incentivize the OEMs to leave familiar ground and to break with established rules and practices.	

5.3.5 Recombinant Practices

Recombination is visible from the empirical data in diverse ways, which are conceptualized as three recombinant practices (cf. Tab. 5-6). The recombinant practices play a central role in the innovation activities of XTEC and SIMULI. At the same time, these practices reveal differences between the two organizations.

Tab. 5-6 Recombinant Practices

Practices	Description	Exemplary Quotes	Open Codes
Associating Resources and Value Propositions	Combining and bundling previously separated service offerings. Bringing together formerly dissociated resources in new configurations.	*"An example of how we interweave competencies is that we are now suddenly given orders that other providers do not receive because we combine two of our core competencies. […] So far, we have only had our core competency in exterior. Now, OEMs only contract those providers that also have the competence of project management. […]"* (XTEC, Person 1.1)	Combined offerings, lowering interface complexity, assuming more responsibility
Transferring and Adapting Resources	Creating new value propositions by applying existing resources (in particular, knowledge and skills) in new application contexts.	*"[…] we considered what was needed to simulate on our own. We had some people who were interested in the topic with previous knowledge. […] For example, [an employee] has much experience in interior design. […] He can also help with the improvement of the [simulation] results."* (XTEC, Person 4)	Applying resources in new application contexts, transfer of knowledge and skills
Evolutionary Combining	Completing sequences of combinatorial steps (i.e., associating, transferring, dissociating and adding) as part of an evolutionary process in which the innovation outcome unfolds step by step.	*"In the beginning, there was a basic concept: freethinking plus workshops plus a garage. Then we noticed a lack of moderation. Therefore, we extended the concept to include moderation. Then we realized that one could not have workshops in the garage where construction work takes place at the same time. Therefore, we built a garage and separated it [from the workshops]. […] All these things were established over time."* (XTEC, Person 2)	Sequences of recombinant practices, learning processes, evolution, experimenting with resource configurations

Associating Resources and Value Propositions

Association is the first recombinant operation that is well reflected in the data. The persistent trend in the market towards more autonomous service provision particularly fuels the association of formerly separated competencies and resources and their bundling to service offerings that cover the needs of the customer in a more holistic manner. On the other hand, associating competencies and resources is directly related to the creation of service offerings that differentiate themselves in the marketplace.

Interviewees from both case organizations gave various examples of innovative service offerings, which feature a specific combination of resources and competencies that is new to the market. In particular, those combinations that cannot easily be offered by other ESPs hold some potential for temporary strategic advantages. For example, XTEC managers outlined that the firm has obtained such an advantage by combining its distinct competencies on project management and interior engineering with extensive OEM-specific process expertise. The resulting service offering is characterized by a mix of competencies and resources that are distributed among different actors in the organization, thus entailing changes in internal communication flows and service networks. Teams and departments from different sites that have previously acted independently, now need to coordinate their activities in the provision of more comprehensive service packages. Association is similarly reflected in the case of SIMULI, whose managers' reported that the bundling of formerly separated service offerings was currently one of the most significant trends in the market. Concerning the creation of comprehensive service offerings, SIMULI's cross-site orientation appears to be useful to mobilize and associate resources and competencies across organizational confines. For example, SIMULI's cross-location hierarchy makes it easier to create workflows for collaboration between different locations by simply delegating activities in a top-down manner. Such activities seem to be more complicated at XTEC because they require close coordination between different managers at individual locations, who each have equal rights in the hierarchy and are not always in agreement when it comes to decisions. Beyond the creation of more comprehensive service offerings, the association of resources can also be observed on a more fine-grained level of the organization. In both cases, respondents pointed out that complex problems can often only be solved by bringing together different actors inside and outside the organization, who associate their in-depth expertise on different topics in the development of ideas and solutions. In this regard, XTEC's managers expressed the view that, in particular, interdisciplinary and atypical constellations of actors, with expertise from diverse fields of interest, produce the most innovative outcomes.

Transferring and Adapting Resources

Another recombinant practice, which is well reflected in the interviews, is characterized by the fact that the two case organizations create new services by transferring their engineering expertise and competencies, from existing fields of application into new contexts, with which they have not been associated before. The analysis shows that transferring is always linked to some form of adapting existing, and generating new, (explicit) knowledge. As projects are typically characterized by unique contexts, the transfer of knowledge and the adaptation to new challenges are part of day-to-day project business. When interviewees described the processes that lead to the emergence of new service offerings, these processes always involve a combination of existing resources (e.g., knowledge) and new knowledge that is generated in the service innovation process. For example, interviewees point out that the boundary conditions and challenges with which the ESPs are confronted would usually involve individual technical problems, which derive from changes in the design and architecture of automobiles and their related production processes. Offering services to new customers thus typically requires the ESP employees to adapt their skills and knowledge to the specificities of the application context.

XTEC and SIMULI proceed very similarly. In both cases, interviewees described situations in which the transfer and adaptation of resources and competencies led to entirely new value propositions that are distinct from previous offerings. For example, XTEC managers described how the in-depth expertise of employees was integrated into the process of building up a competence on (technical) simulation that was new to the firm. In this case, the pre-existing knowledge about mathematical calculations on the strength of components was applied and adapted to the application context of the technical simulation. Similar examples were identified in the case of SIMULI. Here, managers described a case in which the organization transferred existing expertise on the installation of cooling water hoses in vehicles to the context of in-car electronics, which then led to the development of a new competence on the installation of cable harnesses. In all cases, new services emerged from a transfer of resources into a new context that is only distantly related to the old context.

Evolutionary Combining

In addition to the two recombinant practices described above, recombination is also visible from the data in the more general form of evolutionary combining. This form refers to service innovation processes, in which, not just one single recombinant operation, but a whole series of recombinant steps are carried out on the way to an innovative outcome. In these cases, ESPs perform a series of recombinant activities to refine and develop a new service in multiple iterations. In this way, various intermediate results emerge; these in turn find their way into the recombinant process before the creation of a viable service offering (viable, in that it enables the ESP, the customer and other stakeholders to create a sufficient level of value).

There are differences concerning the clarity with which the two organizations reflect processes of evolutionary combining. Processes of evolutionary combining are particularly apparent in the case of XTEC, whereas SIMULI, in contrast, highlights individual recombinant operations. Differences appear to exist, in particular, due to the different innovation approaches of the two case organizations. In the data, evolutionary combining is often reflected in service innovation processes that involve a certain degree of experimentation, so that the outcome is not foreseeable from the outset of the recombinant activities and thereby involves some risk of failure. An excellent example is the development of XTEC's Innovation Studio. Here, various recombinant activities were carried out with the aim of creating something new; however, the outcome was barely foreseeable and evolved in several iterations of combining and recombining resources and value propositions. In the case of SIMULI, recombination is primarily apparent as part of planned processes that aim to achieve a predetermined goal, that is, to some extent, predictable. In contrast, the service innovation processes described by XTEC managers show that evolutionary combining often occurs due to exploratory innovation activities, which are path-dependent and determined by the course of the process. XTEC's organization seems to promote and facilitate such innovation processes, in that it creates a high degree of freedom in the organization that allows managers to experiment with new topics and services, thereby encouraging them to take entrepreneurial risks.

Comparative Summary

In summary, recombination is particularly well reflected in the case studies of XTEC and SIMULI. Tab. 5-7 summarizes the differences and commonalities.

Tab. 5-7 Case Comparison regarding Recombinant Practices

Practices	XTEC	SIMULI
Associating Resources and Value Propositions	Association is reflected on different levels of social structure: First, in the creation of more holistic value propositions, and, second, in the exploration of innovation opportunities among employees and organizations.	Association is mainly reflected in the creation of larger service bundles that cover the needs of customers more comprehensively and that are based on different competencies and resources that were formerly offered separately.
Transferring and Adapting Resources	The association of resources is, in both cases, mainly reflected in the process of adapting to new market conditions and customer requirements. Both case organizations highlight the importance of transferring and adapting resources and, in particular, knowledge and skills from one application context to another, in order to build up new competencies and knowledge that then enable the development of new value propositions.	
Evolutionary Combining	Respondents described innovation activities and change processes over longer periods of time and in a broader context (e.g., multiple actors and multiple projects). In this broader context, respondents often emphasized the incremental and evolutionary development of services in iterative recombinant steps. This perspective comes from XTEC's network oriented and exploratory approach of searching for opportunities to combine and integrate their own resources and competencies with those of other actors.	Respondents look at innovation in services from a close personal perspective (e.g. on their individual innovative projects or steps taken in the development of new services), so that evolutionary combining is not so well represented in the data. The data suggest that such a narrower perspective is also in line with SIMULI's controlled and collective approach that encourages managers and employees to orient towards clear and economically sound objectives and often leads them to focus on their own area of knowledge and activity. Evolutionary combinatorial activities are often more risky and difficult to plan and are thus frequently avoided.

5.4 Chapter Conclusion

This chapter has presented a framework with several dimensions and characteristics for the analysis of service innovation processes. The findings were derived from a case synthesis that investigated the innovation activities of the two case organizations, XTEC and SIMULI. Tab. 5-8 provides a summary of the framework. The dimensions and characteristics reveal different ways in which the two case organizations engage in service innovation.

Tab. 5-8 Dimensions and Characteristics of the Analytical Framework

Dimensions	Characteristics	Description
Interaction Modes	Adapting along Evolutionary Pathways	Bridging the minor gaps between what the market needs and what has been offered in the past, while in parallel aligning the development of competencies and resources in such a way that the organization is prepared to meet future market demands.
	Outlining Value Co-Creation Possibilities	Creating innovation impulses in the market by approaching OEMs with ideas and offerings and by outlining the corresponding value that customers can co-create by accepting and supporting them.
	Moderating Co-Creation Processes	Guiding shared processes of learning and developing solutions with several members in groups (e.g., employees of the OEMs).
	Brokering Knowledge	Dissemination of knowledge and technology in networks by providing other actors with access to resources that they do not yet have or would not have access to otherwise.
Roles in the Renewal of Institutions	Synchronizer	Adapting one's own behavior and mindset to the rules and practices that guide, restrict and enable the exchange of service among a whole community of actors.
	Co-Designer	Joint development and specification of rules and practices in cooperation with other actors in groups, e.g., in the context of consultancy services, that influence a broader range of actors.
	Stimulator	Incentivizing other actors who have a distinct institutional influence, to deviate from former paradigms and practices.
Recombinant Practices	Associating Resources and Value Propositions	Combining and bundling previously separated service offerings. Bringing together formerly dissociated resources in new configurations.
	Transferring and Adapting Resources	Creating new value propositions by applying existing resources (in particular, knowledge and skills) in new application contexts.
	Evolutionary Combining	Completing sequences of combinatorial steps (i.e., associating, transferring, dissociating and adding), as part of an evolutionary process in which the innovation outcome unfolds step by step.

On the one hand, the comparison between the two case organizations shows that they are not so different in their innovation activities, as both firms must align their innovation activities to overarching developments in markets and technology. Variances in their innovation behavior are mainly related to the different organizational orientation of the two firms. XTEC innovates in a more agile way, which makes the innovation activities and the outcomes more diverse and difficult to predict. SIMULI, on the other hand, innovates in a way that is more formal and structured, where innovation activities are mapped out in plans and focused on predefined goals. The dimensions and characteristics that were introduced in this section help to disentangle some of the complexity in service innovation processes. Based on different combinations in which the characteristics of the three dimensions occur in practice, the next chapter offers a more detailed description of five specific types of service innovation processes in the AES industry. The process types explain and clarify how dimensions and their respective characteristics can be observed (and their respective combinations) and how they are interrelated.

6 FIVE PATTERNS OF SERVICE INNOVATION

6.1 Chapter Introduction

The synthesis of the two individual cases in the previous chapter has shown that innovation in engineering services occurs in diverse ways that are often complex and in which ESPs assume different roles. The previous chapter has also introduced an analytical framework to unravel and differentiate between these individual innovation paths (cf. Tab. 5-8). While analyses, according to the three dimensions, may illuminate differences between service innovation processes, current discussions on S-D logic propose that interactions, institutions, and recombinant activities in service innovation processes are deeply intertwined (Lusch and Nambisan 2015; Vargo et al. 2015). This suggests that there is a potential to learn about innovation in engineering services by illuminating the interrelation of characteristics from the analytical framework. This chapter aims to elaborate such a holistic understanding by presenting five patterns of innovation in engineering services: The *Lifecycle Pattern*, the *Association Pattern*, the *Copycat Pattern*, the *Co-Innovation Pattern*, and the *Exploration Pattern*. The five patterns were compiled into a typology that illustrates combinations of characteristics, as reflected in specific service innovation processes from the empirical data (Tab. 6-1).

Tab. 6-1 Typology of Service Innovation Processes

Patterns	**Interaction Mode**	**Roles in the Renewal of Institutions**	**Recombinant Practices**
Lifecycle Pattern	Adapting along Evolutionary Pathways	Synchronizer	Evolutionary Combining
Association Pattern	Adapting along Evolutionary Pathways / Outlining Value Co-Creation Possibilities	Synchronizer / Stimulator	Associating Value Propositions
Copycat Pattern	Outlining Value Co-Creation Possibilities	Stimulator	Transferring and Adapting Resources / Associating Value Propositions
Co-Innovation Pattern	Moderating Co-Creation Processes	Co-Designer	Evolutionary Combining
Exploration Pattern	Outlining Value Co-Creation Possibilities / Brokering Knowledge	Stimulator	Evolutionary Combining

This chapter presents conceptual and contextualized descriptions of the five patterns that make the steps and activities in specific service innovation processes more understandable and explicit. This chapter proceeds as follows. The next section describes the approach that led to the conceptualization of the five patterns. In the subsequent sections, each pattern is introduced separately. For each pattern, an explanation is provided as to how the different characteristics are reflected. Finally, section 6.8 concludes this chapter and provides an overview of the systemic levels to which the different patterns can be assigned.

6.2 Approach to the Conceptualization of Patterns

With the aim of detecting and conceptualizing patterns of service innovation, the analytical framework was applied to the interview data by mapping the dimensions and characteristics to the respective text passages that describe service innovation processes. The development of the framework and the detection of patterns were interlinked activities that informed each other. On the one hand, the dimensions and characteristics of the analytical framework provided a structure for detecting and conceptually describing patterns in service innovation processes. In turn, mapping the dimensions and characteristics to service innovation patterns generated insights that led to the successive refinements of the analytical framework itself.

The scope of the analysis was thereby initially limited to the two main case organizations (XTEC and SIMULI), so that the focus was on detecting and describing those patterns reflected in the two specific cases. Later the scope of the analysis was extended to the interviews with additional case organizations.

Once a pattern was detected in the empirical data, the interviews were screened for related information with the aim of gaining a more comprehensive understanding of the specific service innovation process. The procedure led to the identification of an initial number of ten service innovation patterns. However, not all of these patterns were equally represented in the data, so that it was decided to focus on those patterns that were most significant and for which a sufficient amount of data was available to enable a rich conceptual description. Patterns with significant overlap, for example, regarding activities or characteristics, were grouped into more generic patterns. In this way, several patterns emerged in which the activities, circumstances, and roles were logically aligned with each other and which were rooted in corresponding code categories in the interview data. Finally, this process led to the identification of five patterns of service innovation and their compilation into a process typology (cf. Tab. 6-1).

6.3 Lifecycle Pattern

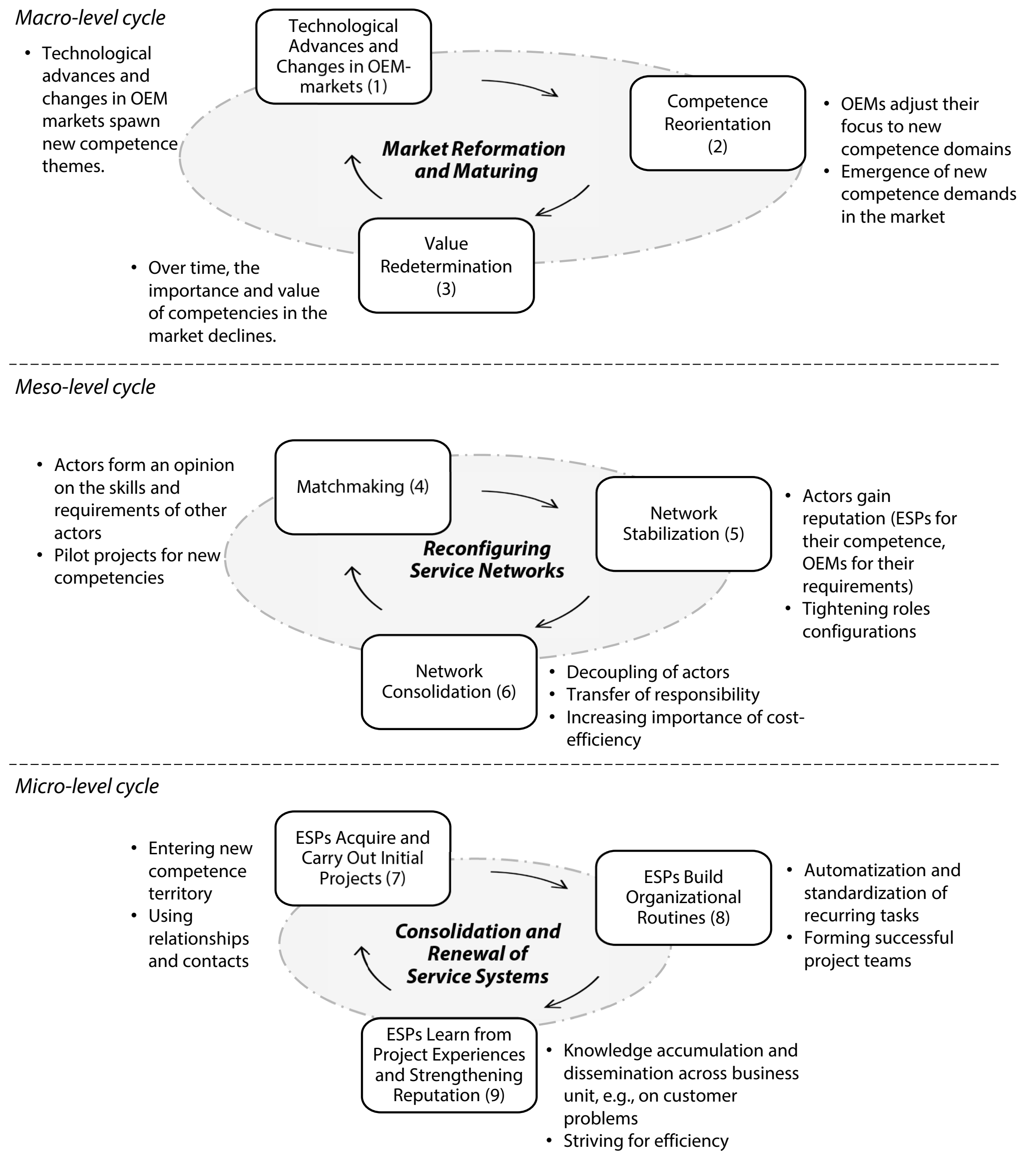
6.3.1 Overview

The *Lifecycle Pattern* refers to the interrelation between changes on three different systemic levels of a service ecosystem, which originate on the macro-level and drive cyclic configuration processes on the meso- and micro-levels. The Lifecycle Pattern highlights that ESPs interact in an adaptive manner. This is because innovation in engineering services is fundamentally driven and constrained by the manner in which the markets change and evolve (*Adapting along Evolutionary Pathways*). From this broader perspective, the role of ESPs, in the renewal of institutions, is characterized by ongoing attempts to keep managerial attitudes and behaviors of the organization in alignment with changing institutions. This includes, among other things, a regular adaptation of internal rules and norms (*Synchronizer*). Furthermore, the Lifecycle Pattern examines the long-term development of engineering services and competencies in the AES industry. The Lifecycle Pattern makes apparent that the foundation of engineering services is knowledge and skills, which over more extended periods are repeatedly reconfigured and recombined (*Evolutionary Combining*).

The Lifecycle Pattern describes general mechanisms of change in the AES industry that determine the value and viability of engineering competencies in the marketplace. The provision of engineering services is heavily reliant on integrating operant resources (in particular knowledge and skills) that are aligned to different areas of automotive technology (e.g., to the functional systems of the vehicle; cf. section 2.2.3). The forces that determine changes in these areas are linked to complex transformational processes at the level of globally networked markets, industries and economies. Examples are changes in customer preferences or regulatory requirements in the OEMs' own sales markets. Such developments create new technological challenges and service demands at the OEMs, which then become the foundation for new competencies and service offerings in the market. In this way, the essential force behind innovation in engineering services is located at the systemic macro-level of the service ecosystem. This produces impulses for change that disperse, in a top-down style, into the meso- and micro-levels of service networks and service systems in which they lead to a continuous reconfiguration and consolidation of actors and resources.

Fig. 6-1 illustrates this relationship between the technologically driven *reformation and maturing of markets* for engineering services (macro-level), the *reconfiguration of service networks* (meso-level), and the *consolidation and renewal of service systems* in which engineering services are provided (micro-level). Each level features different phases that together build the systemic perspective on the ecosystem lifecycle. The Lifecycle Pattern distinguishes itself from the other four patterns, in that it is the only pattern with an explicit reference to the systemic macro-layer of the service ecosystem. In the following sections, changes on the three different levels and their interrelations are explained in more detail.

Fig. 6-1 Lifecycle Pattern



6.3.2 Market Reformation and Maturing

The forces behind innovation in engineering services are mainly located on the macro-level of the service ecosystem and are interrelated with a multitude of contextual factors. In particular, technological progress and changes in the sales markets of the OEMs have a significant influence on the demands for specific engineering competencies and related service offerings. They trigger different forms of market-driven innovation. For example, the effects of recent changes in exhaust emission regulations have led to a spike in demand for competencies and expertise in the market of battery systems and electronic engines and, thus, have built the basis for new service offerings from specialist firms. Similarly, the race for

OEMs in the development of autonomously driven cars has led to a new need for expertise in various related areas. Market-related changes can shift the focus from one technology to another and drive innovation in engineering services. In turn, other competencies, such as those in the field of mechanical engineering are subject to increasing cost-pressure. The following comment shows that competencies have a specific time span in which they can be covered by smaller and often specialized ESPs, before they tend to become subject to increasing competition:

> *"When a new topic comes up, then depending on how complex the topic is, for perhaps five to ten years the whole thing is covered by specialist firms. When the topic then becomes more standardized, and when there is process automation, and so on, then the whole thing tends to be globalized." (SIMULI, Person 5)*

Findings show that now and then new topics emerge in the market and create opportunities for new service offerings, while old topics decline in importance (Step 1, cf. Fig. 6-1). In this regard, themes and competencies vary in their dominance, so that some topics grow to enduring areas of competencies in the market while other topics and competencies remain in the niche or disappear again after some time.

The areas of competence in which ESPs can offer their services are not only determined by the technological development but are also dependent on the competence profile and outsourcing strategy of the OEMs. OEMs realign their competencies from time to time to adapt to the changing requirements in their business environment, which means that they shift their focus to new competence fields and in turn lower their involvement in older domains, which are then subject to an increased outsourcing to external ESPs. In general, OEMs try to concentrate their resources on topics of relevance to strategy or market differentiation. Accordingly, the OEMs try to build up new and often innovation-relevant topics within the organization themselves, so that ESPs can rarely build up and offer competencies in these areas. In contrast, competence fields that have become more mature tend to be assigned to external partners in larger packages and thus also offer better business opportunities for them. A competence reorientation of OEMs (Step 2, cf. Fig. 6-1) thus often means the emergence of fresh market opportunities for ESPs, enabling them to enhance their service portfolio with new offerings, which sets in motion a phase of accelerated service innovation.

Changes in automotive technology and market requirements of the OEMs influence how OEMs assess and determine the value of service offerings in the market (Step 3, cf. Fig. 6-1). Findings show a particular time span exists, in which engineering competencies (and the services they enable) can be provided by the ESPs, with their local German workforce at competitive prices, before service processes tend to become more standardized and are subject to increasing cost-pressure and international competition. As a result, ESPs in Germany often focus their competencies on fields that are no longer entirely new, but which are not yet subject to standardization.

At the time of the interviews, this cycle of new topics appearing, being passed on to external ESPs, and finally becoming commodities was particularly noticeable. For example, in recent years, OEMs have decreased their involvement in several mechanical engineering topics (e.g., simulation and engineering of exterior parts) and have begun to reallocate resources to competence fields associated with digital themes, such as driver assistance systems or mobility services. In turn, in many of the traditional competence fields, ESPs increasingly assume tasks that were formerly carried out by the OEMs. The following comment refers to this cyclic process:

> *"Regarding competencies, […] the classic topics of automotive engineering such as construction, trial, testing, even technology-application are becoming more and more a commodity[19]. On the other hand, new topics, such as software development, connectivity, HMI, autonomous driving take on a new role and are thus also more in demand and better to sell. […] In the past, you were worth your weight in gold if you knew how to spell CAD workstation. Now, construction services are not worth much anymore. It is a dramatic change. This is as with any service lifecycle: once everyone can do it, it is not worth that much anymore." (XTR, Person 2)*

The following section outlines how these cyclic forces from macro-level influence service networks on the meso-level.

6.3.3 Reconfiguring Service Networks

The emergence of new competence requirements in the market, i.e., when OEMs decide to outsource new topics, initiates a phase in which new constellations of actors and roles emerge. OEMs scan the market for potential development partners and assess their capacity to fulfill their service demands. In doing so, they evaluate the respective list of references of the ESPs and use their knowledge and personal contacts to build an opinion. ESPs on the other hand, need to consider whether the new subject area is aligned with their strategic objectives and whether it fits into the existing competence portfolio. Based on these activities, a kind of matchmaking between the actors takes place in this phase (Step 4, cf. Fig. 6-1), from which initial configurations of actors and first projects emerge.

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[19] Commoditization is the process of turning a customer-specific product or service into a form that serves a more general purpose (cf. Miles et al., 1995, p. 77)

In new fields of competence, there is a tendency for the configurations of actors and roles in service provision to stabilize over time, when these configurations occur repeatedly in similar ways (Step 5, cf. Fig. 6-1). The relationships of service networks in the AES industry are based substantially on trust between actors and their mutual knowledge of each other's needs and competencies. Knowledge and trust are primarily built up through the exchange of services (i.e., projects) and the co-creation of value in cooperation with other actors. Interviewees' comments show that actors who have worked well with each other in the past are likely to come together in similar configurations.

> *"The requests that we regularly receive from the customer show how we are perceived in the market. Most convenient is to wait for the inquiries and just respond. [...] because of our excellent reputation in the market, we repeatedly receive the things in which we are good at already. To some extent, this is good and our financial results confirm this, etc. However, it also leads to inertia." (XTEC, Person 2)*

The above remark also shows that ESPs with strong core competencies tend to repeatedly attract topics and tasks that they already master, but which offer few opportunities to advance competencies and knowledge. ESPs, who have successfully demonstrated their capacity to create value for their customers over long periods, strengthen their market reputation for these competencies and generate additional project references that increase their chances of acquiring projects with similar demands. In turn, ESPs, who cannot demonstrate their qualification by referring to relevant projects, have little chance of obtaining a project in this field.

> *"When you get to a new customer, the first thing they ask is, what kind of projects have you done?" (SIMULI, Person 1.2)*

In this way, it becomes more difficult for new parties to enter competence fields that have already existed for some time.

Over longer periods of time, networks typically enter a phase during which the constellations of actors and their roles during service provision tend to consolidate and become more independent form one another (Step 6, cf. Fig. 6-1). A characteristic of this phase is that communication between ESPs and OEMs tends to be reduced and the periods in which the ESPs works independently from the OEM become longer. In turn, this makes it easier for OEMs to bundle activities into more extensive outsourcing packages that are then typically assigned to larger ESPs, who can offer the services at lower costs than the smaller ESPs in the market.

6.3.4 Consolidation and Renewal of Service Systems

Respondents from ESPs reported that they usually develop new competencies through carrying out a pilot project with one of their key customers, with which they have a particularly trusted relationship (Step 8, cf. Fig. 6-1). Entering new fields of competence requires ESPs to have good relationships with their customers so that they the initial confidence to cope with new challenges. This often involves an adaptation of existing competencies and resources to the particular challenges associated with the new competence field. One of the most significant challenges for ESPs, when developing new competencies is, however, to build up the reputation, in those new competencies, in order to be recognized by customers in the market.

The interviewees, on the whole, demonstrated that cost-pressure in the market is high. The following comment shows that ESPs strive for continuous improvements and efficiency in service production to remain viable in the marketplace:

> *"Another trend that concerns us is that we always need to increase efficiency and returns […] For example, if offerings are repeatedly similar, then I can use the same building blocks. So how can I do this in a reasonable IT structure, how can I summarize technical content as building blocks?" (XTR, Person 2)*

Rather than being separate processes, learning and incremental improvements in resource integration practices are an integral part of service exchange itself. In other words, ESPs do not only integrate resources to co-create value but also to become more efficient in resource integration (Step 8, cf. Fig. 6-1). Rather than being separate processes, learning and incremental improvements in resource integration practices are an integral part of service exchange itself. Instead of assigning the responsibility for innovation to a single R&D department, ESPs distribute this role among the workforce who are involved in the regular project business. The following comment shows that the development of new competencies requires ESPs to cope with a high level of uncertainty and risk. The ESPs cannot yet draw on routines and standards that are important for a smooth interaction, but can only develop over more extended periods of service exchange in similar actor constellations:

> *"If new topics come up, we must first build up these competencies [at our sites]. We have our hands full simply satisfying our customers. Once the competence has been established to the extent that standards have been defined and processes automated and so on, then the right time has come to pass them on to the low-cost locations." (SIMULI, Person 5)*

As shown by the above quote, over time, ESPs gradually improve their service processes and become more efficient in the provision of services (Step 9, cf. Fig. 6-1). This process often goes hand in hand with increased outsourcing to countries with lower personnel costs. Improved efficiency can often be achieved by explicating implicit knowledge. For example, ESPs introduce checklists to avoid common errors or automatize recurring tasks using software tools. In particular, as ESPs are now gradually cultivate their own software development competencies, new topics can be standardized and automated more quickly than in the past.

The findings indicate that competencies remain in this phase for a longer period. In this regard, respondents expressed the view that there will be no change in the fact that vehicles require a chassis of some kind; therefore, the necessary development expertise will continue to be in demand in the future. However, in several of the established competence fields, cost-profit margins are subject to considerable pressure, thus indicating a late phase of the competence lifecycle. ESPs, therefore, often need to make the conversion to a different service provision model that integrates a significant share of resources from abroad and then to focus their workforce in Germany on new competence domains. Several interviewees show that this can be a tough challenge – mainly because a strong reputation in one competence domain can impede the attempt of ESPs to enter another. At the time of the interviews, this problem was particularly evident in connection with the ESPs' efforts to build up competencies in fields related to digitalization. In this regard, the XTEC managers expressed the view that their strong reputation in the market in the field of mechanical engineering would increasingly become a hurdle to enter new competence fields.

6.3.5 Summary

In summary, the presented Lifecycle Pattern shows that there are cyclical forces at the macro-level of the service ecosystem that determine the pace of change in which engineering services are innovated. Furthermore, these forces set certain restrictions for innovation trajectories. This is because the competencies which are in demand in the market are determined by a variety of factors, on which ESPs have only limited influence. The market thus determines the areas in which ESPs encounter opportunities to build up new competencies and develop new service offerings. Accordingly, the Lifecycle Pattern explains how engineering services (as well as the service networks and systems through which they are provided) evolve under the influence of cyclical forces at the higher levels of a service ecosystem. In particular, technological advances and changes in the OEMs' own sales markets lead to the cyclical shifts in the competence focus between OEMs and ESPs. While the OEMs concentrate on strategically relevant topics, those topics that shift out of their focus are transferred to the ESPs, who carry them out more conscientiously. Such cyclical changes lead to continuous reconfigurations on the meso-level, so that OEMs and ESPs need to search for new beneficial value co-creation constellations. Service systems also go through different phases at the micro level. When new competencies emerge in the market for engineering services, this is followed by a phase in which ESPs must first learn to deal with new requirements and cultivate efficient routines in the development. Over time, such service systems become more consolidated and ESPs face pressure to become more efficient during service production. At the same time, ESPs must reorient themselves gradually towards new competence domains that are in an earlier phase of their lifecycle.

6.4 Association Pattern

6.4.1 Overview

This pattern describes the association of value propositions and competencies in the creation of more comprehensive service offerings. The pattern reflects two interaction modes: The first derives from the fact that the association of value propositions and competencies is driven by a reformation of traditional market structures that exerts pressure on ESPs to adapt (*Adapting along Evolutionary pathways*). The second shows how ESPs assume a more active role in the market in which they bring further comprehensive service offerings to other customers (*Outlining Value Co-Creation Possibilities*). The Association Pattern shows in many respects how ESPs need to remain in synchronicity with changing institutional arrangements (*Synchronizer*). New institutional rules put pressure on ESPs to assume more responsibility for their services than they did in the past. With the development of ESPs into a more autonomous role in the market, there are more opportunities for them to encourage OEMs to enact rules and norms in ways that are beneficial for both OEMs and ESPs (*Stimulator*). As the name of the pattern implies, the service innovation process is primarily characterized by the recombinant practice of *Associating Value Propositions* (and competencies).

Engineering services are exchanged in ever larger bundles and on the foundation of multiple competencies. A primary driver behind this trend is that many of the traditional engineering competencies and their underlying market segments have undergone decades of incremental improvements, without undergoing more extensive disruptions throughout this time. While a variety of interview comments indicate that the outlined development is a broader and endurable trend in the market, it is important to note that not all markets are equally affected. As previously mentioned in the Lifecycle Pattern, competencies have a lifecycle in the market. Services that have reached an advanced stage of the lifecycle tend to become more standardized, so that ESPs and OEMs become more independent from one another during service provision. These competencies are, therefore, predestined to be outsourced and integrated into larger service bundles. In this regard, ESP respondents reported that OEMs were currently increasing their efforts, in many of the traditional competence fields, to reduce their involvement during service co-production, by bundling their demands into larger packages that are then awarded to a lower number of ESPs. Comments, such as the following from OEMs, confirm this view:

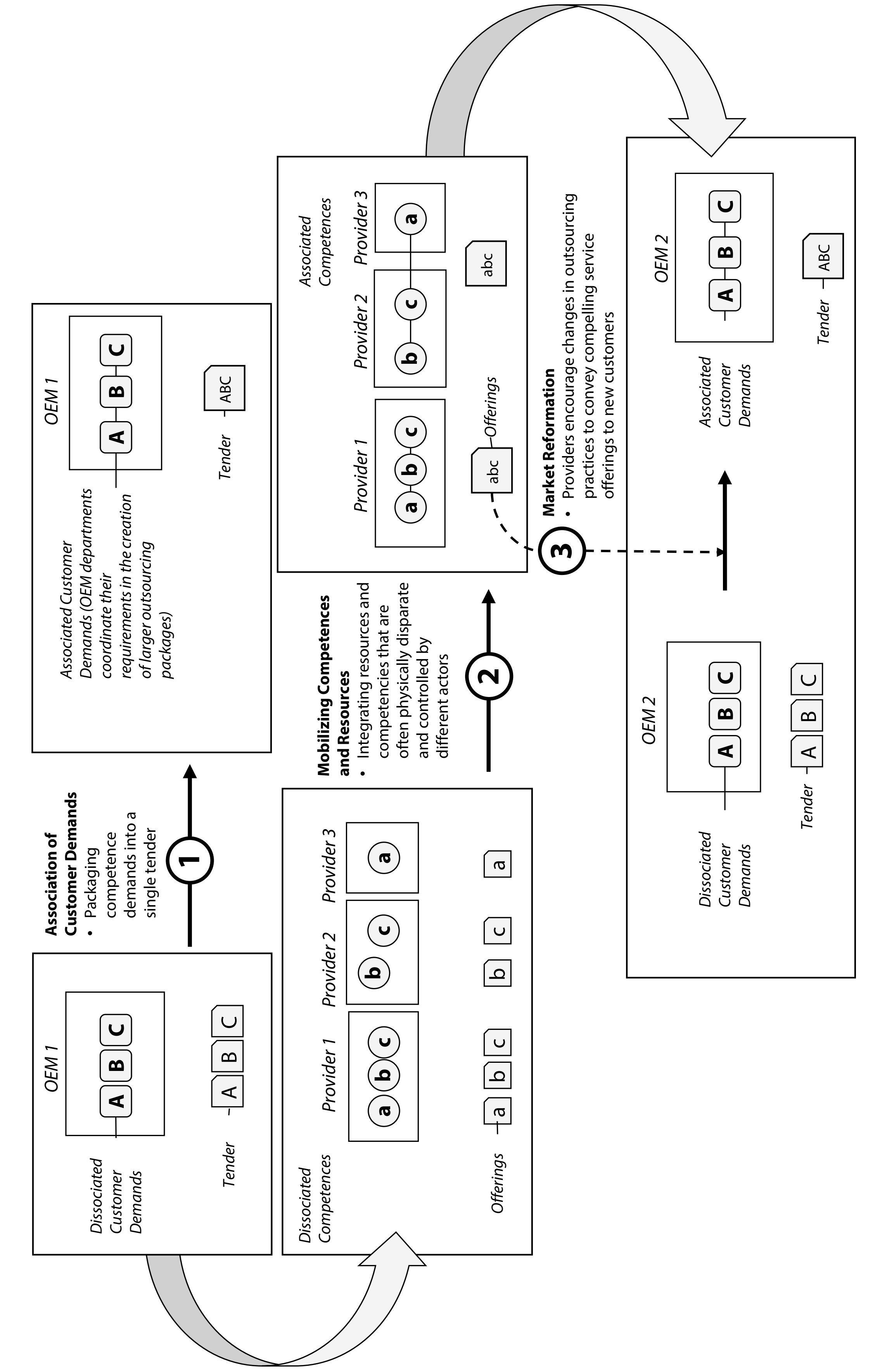
> *"The ESPs will change from a role as an extended workbench into a role in which they assume full responsibility […] We firmly believe that it makes good sense to transfer complete packages to the service providers, who are then also entirely responsible for partial- or full-service packages." (AUTO AG, Person 1)*

The association of customer demands sets in motion a process of reconfiguring service systems and service networks. Service systems become more comprehensive and complex, in that they mobilize and integrate a more diverse range of resources and competencies, which are often distributed under the control of different actors. Service networks also undergo a reconfiguration because there is a growing need among ESPs to collaborate with partner firms and to complement missing resources and competencies. This reconfiguration is driven by the OEMs but also supported by the ESPs. As ESPs learn to handle the complexity of larger projects, they offer beneficial service bundles to other OEMs in the market and, in this way, reinforce the reconfiguration of service networks.

Fig. 6-2 describes the Association Pattern based on three consecutive steps, followed by a more detailed description:

- Association of Customer Demands
- Mobilization of Disparate Resources and Competencies
- Stimulating Market Reformation

Fig. 6-2 Association Pattern



6.4.2 Association of Customer Demands

In recent years, the principles according to which OEMs divide development tasks and activities between themselves and their ESPs have undergone considerable changes. The main reason for this is that, in recent years, due to a spike in car variants and their respective development work, the effort for the coordination of development projects has drastically increased. As a result, OEMs are less interested in a personal involvement in all development activities. Instead, respondents reported that it was a top priority for them to reduce the complexity of the interfaces in the projects by bundling interdependent activities in such a way into contracts that they can be carried out by a single ESP autonomously and with minimal coordination efforts from the OEM. One interviewee from an OEM said:

> *"We select service providers according to competence and price. We try to avoid the creation of too many interfaces. The aim is to minimize these [interfaces] and to use suppliers as economically as possible." (BRUM AG, Person 1)*

The bundling of previously separate requirements into larger contract packages demands closer coordination between the OEM's internal departments and teams in the specification of procurement requirements. Such changes in outsourcing practices, on the one hand, have a direct impact on the ESP offerings and on the other hand, lead to new forms of collaboration during service provision. Respondents from the ESPs reported that the OEMs would increasingly confront them with tenders that bundled multiple competence requirements, which were formerly represented by individual teams and departments:

> *"So far, the OEM told their technical departments, 'okay, each group has to identify a need and creates their own tender accordingly.' Now, everything is packed into one package, so we get a request from the department [XYZ]37, where we can recognize six different tenders, where [XYZ]370, [XYZ]371 to [XYZ]376 come together. This has a massive influence on the provider market." (SIMULI, Person 2.2)*

This bundling reduces the number of contact persons with whom the ESPs communicate during the service process. Fig. 6-2 provides an example illustration of this transition: OEM 1 has three different competence demands, A, B, and C, which are initially tendered separately and are offered by ESPs, 1, 2 and 3, based on their competencies (a, b, c). Step 1 marks the transition to a new situation in which the various calls for tenders are combined into a single call for tenders. As a result, all ESPs face the challenge of providing the requested combination of competencies and resources, as part of a more extensive and complicated service package.

6.4.3 Mobilizing Competencies and Resources

The association of customer demands has a significant influence on actor constellations and resource integration practices in service systems and service networks. Because customer requirements are to a certain degree OEM-specific, sites at different locations often differ regarding the availability of competencies and resources. For example, interviewees from SIMULI outline that the equipment for acoustics or material tests requires substantial investments and is, thus, only available at a few sites. Similarly, knowledge of a particular kind may only be available from a few experts in the organization. The new market situation – namely the demand for more extensive service offerings, which involve combinations of several competencies – presents ESPs with a challenge to mobilize these resources and competencies efficiently during service provision. In this regard, several interviewees commented that there is often an initial need to establish the respective routines for cross-organizational collaboration and resource integration. Comments, such as the following, pointed out that in particular for smaller and mid-sized ESPs it is becoming more and more necessary to collaborate with partners to mobilize resources and competencies in the appropriate amount and combination:

> *"[…] the trend is that there are more and more situations where firms are not capable of offering it all, and have to cooperate with a competitor to combine and put together some competencies. Especially for the small and medium-sized companies, this is often the only way to remain viable." (SIMULI, Person 2.2)*

Interviewees furthermore expressed concerns that the trend towards larger projects coincides with an increase in cost-pressure and competition in the market. Fig. 6-2 provides an illustration of these situations and the corresponding behavior of ESPs 1, 2 and 3. In continuation from the previous step, the ESPs face the situation that customer demands, which were previously separated, are now merged in to larger tenders. Accordingly, ESPs react in different ways (cf. Fig. 6-2, Step 2). How ESPs respond to these challenges is fundamentally dependent on their specific situation, with respect to the competencies requested and which are available. Based on the activities and situations outlined by the int-erviewees, some characteristic behaviors of ESPs can be identified and described.

- **Building up competencies and acquiring external resources:** Because competence bundles also expand the extent of resources that ESPs require during service provision, the trend towards larger packages is fueling the growth of all ESPs in the market. The number of employees at many ESPs has multiplied in recent years. At the same time, the number of mergers and acquisitions has increased. Especially midsized and larger ESPs can accelerate the process of building competencies by acquiring organizations and resources in the market. Smaller ESPs also hire more employees, but keeping up with growing demands is often difficult for them (expressed through brackets in Fig. 6-2 for ESP 3).

- **Cross-site collaboration and breaking organizational silos:** As previously mentioned, the resources and competencies of the ESPs are often very unevenly distributed within the organization and under the control of different internal actors, who have traditionally operated separately. To provide more extensive service packages, ESPs are more frequently seeking to break these silo structures and, instead, to promote the creation of crosscutting routines and workflows for the efficient integration of resources and competencies across different departments, teams, and sites. ESPs thus need to establish processes that allow a more extensive range of actors to collaborate effectively and to integrate diverse resources in the provision of more complicated service offerings. For example, ESPs must improve the communication infrastructure between sites and across different teams.
- **Collaborations in networks:** In general, the interviews show a significant increase in communication and cooperation among smaller and mid-sized ESPs. For them, cooperation is often the only way to mobilize the required combination of competencies and the increased amount of engineering capacity which has been requested by the OEMs. Smaller ESPs often become subcontractors to mid-sized ESPs. However, also mid-sized ESPs, which have several competencies, need to cooperate among themselves in order to complement missing resources and competencies. While many of these collaborations are only temporary for individual projects, ESPs are also forging stronger bonds, (e.g., in the form of strategic partnerships).
- **Offering services to other ESPs and mergers:** Interviewees report that the smaller ESPs often have no other choice than to offer their services to more significant players in the market or to directly merge with them. Also, some of the smaller ESPs pursue a niche-strategy and concentrate their services on very specialized topics (e.g., specific manufacturing technology or materials), which are sometimes too small to be attractive for the more significant players in the market. However, interviewees expressed concerns as to the long-term success of such a strategy, as OEMs also tend to bundle smaller topics into larger packages.

Tab. 7-2 summarizes the characteristics of possible responses, as is also illustrated in Fig. 6-2 (ESP 1, 2, and 3).

Tab. 6-2 A Sample of Responses from Different ESPs

Example	Situation	Response
ESP 1	All competencies available (a, b, c)	• Building up competencies and acquiring external resources • Cross-site collaboration and breaking organizational silos
ESP 2	Certain competencies available (b, c)	• Building up competencies and acquiring external resources • Cross-site collaboration and breaking organizational silos • Collaborations and strategic partnerships with other ESPs
ESP 3	Specific competence available (a)	• (Building up competencies and acquiring external resources) • Offering services to other ESPs or merging with them.

6.4.4 Stimulating Market Reformation

The growing importance of bundles of services and competencies gives the engineering service market a new dynamic and creates opportunities for ESPs to gain an advantage over their competitors by obtaining the capacity to mobilize competence combinations, which benefit the customer but are rarely available in the market. Once ESPs have learned how to mobilize competencies and resources for the processing of larger service packages, by establishing the necessary infrastructure and routines during service provision, they also then have the opportunity to utilize these operational capabilities further by offering similar services to other OEMs.

However, the engineering service market is heterogeneous regarding outsourcing practices and OEMs bundle their competence demands in different ways. To transfer useful combinations of competencies from one customer to another, ESPs must first stimulate a reformation of the existing market structure. Respondents described activities that aim to change the way OEMs bundle and outsource their demands for external engineering competencies. Interviewees from different ESPs reported that they actively approach OEMs – either alone or together with partners – to propose advantageous combinations of competencies and to convince the OEM to adjust their outsourcing practices, i.e., by associating and bundling demands (cf. Fig. 6-2, Step 3). The following quote echoes this procedure:

> *"We have outlined to the customer that we were capable of implementing the full simulation, in addition to the design of a cockpit and asked them whether this would be interesting for them to award this in a package so that the number of interfaces is reduced through this bundling. Then, they said that they would discuss this with the simulation department to get them involved. Eventually, in this way, the project was also tendered and commissioned."* (XTEC, Person 4)

These changes in the OEMs' outsourcing practices affect the whole ESP market. ESPs may likely gain advantages over competitors if they manage to create bundles, which lower the complexity of interfaces and reduce the coordination effort for the OEM.

6.4.5 Summary

The presented Association Pattern describes the behavior of ESPs and OEMs in the context of a market trend towards more extensive and sophisticated service offerings that bundle and combine different competencies. Whereas individual competencies have previously often been requested separately by OEMs in the market and thereby have represented separate market segments, the Association Pattern describes the outcome of a persistent trend among OEMs to group formerly separated competence demands into larger packages. The Association Pattern exemplifies the different behaviors of ESPs in reaction to the association of market demands. In this regard, the pattern explains how ESPs respond to the bundling of formerly separated demands by organizing themselves in networked constellations and by altering organizational structures in ways, which allow the mobilization of competencies and resources across organizational confines. The pattern also illustrates how ESPs reinforce the trend towards larger contract packages themselves by offering successful service bundles to other customers from their network.

6.5 Copycat Pattern

6.5.1 Overview

The Copycat Pattern refers to the specific case of an ESP whose service offerings draw on a particular combination of competencies, some of which are provided from within their own organization, and others are purchased and integrated from an external subcontractor. In this specific context, the Copycat Pattern describes a series of interrelated steps and mechanisms, which enable the contracting ESP to replicate the competence of the external ESP. The term, copycat pattern, thus refers to the fact that the contracting ESP copies the competence of the subcontractor. The pattern reflects two different practices of recombination. First, it draws on a transfer and adaptation of resources to a new application context (*Transferring and Adapting Resources*). Also, in the specific cases that are reflected in the data, the newly developed competence becomes part of a service package that increases the chance of the ESP being awarded an initial project and thereby entering the market (*Associating Value Propositions*). The underlying service innovation processes are characterized by interactions between the ESPs and other actors from their networks, so that external resources are integrated into the competence development activities. Before the ESP can offer the copied competence in the market, it is first necessary to stimulate changes in the way the customer tenders and outsources services (*Stimulator*). To achieve this, the ESP must show the OEM the advantages of a bundled order placement (*Outlining Value Co-Creation Possibilities*).

In the current market situation, ESPs are frequently confronted with inquiries for competencies that they do not yet possess and for which the future market relevance is difficult to predict. Especially medium-sized ESPs do not build up all competencies in their own organization and, instead, often complement those competencies or resources through collaborations with external partner firms. While subcontracting enables ESPs to take over more comprehensive offerings, which they could not otherwise offer in the market on their own, several comments from the interviews also highlight related disadvantages:

> *"[…] the trend is that we build up the most significant competences ourselves because every interface to another firm is a potential source of errors – so that the quality becomes more difficult to manage, for example, to keep to deadlines, and so on. Each interface increases the complexity of the whole system. Hence, we build up any competence that is regularly requested." (SIMULI, Person 5)*

The comment above also shows that subcontracting is only a temporary solution during the time when it is not yet clear what role a new competence will play in the market. This view was echoed by other informants who explained that ESPs usually build up these competencies on their own when new competencies are repeatedly requested and become established market demands.

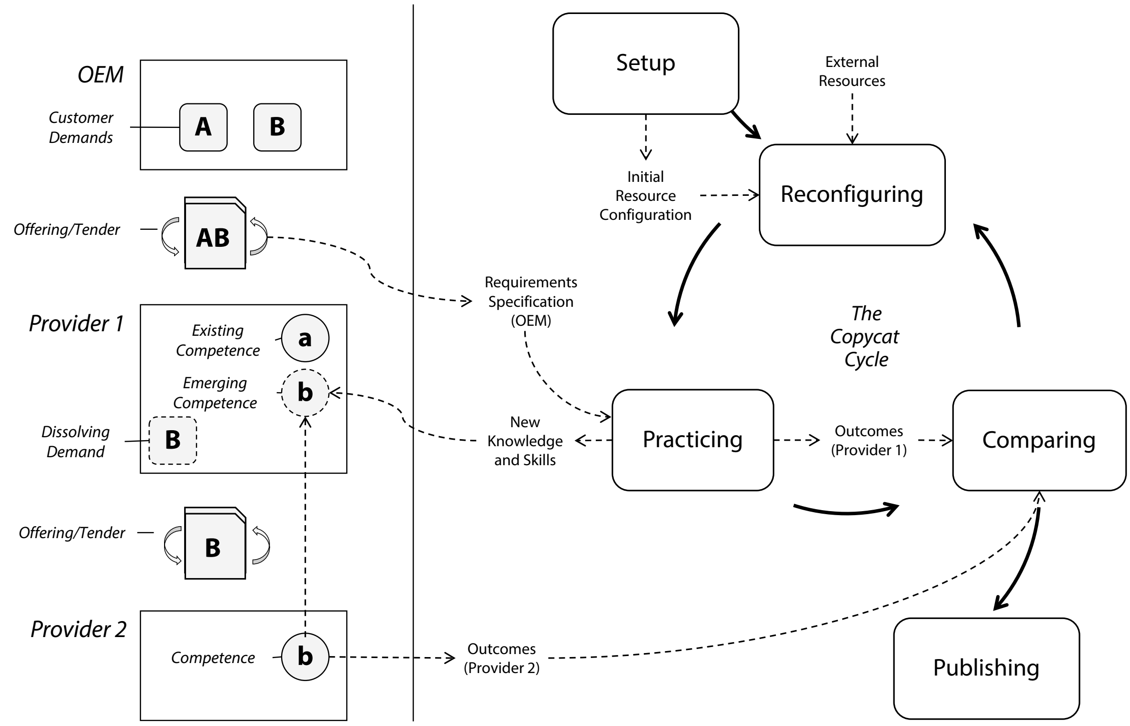
> *"Before we had built up our simulation competence, we had subcontracted it to our partners, so that we delivered the work of our partners to our customers. At some point, we recognized that it was not appropriate that we do not even understand what the other provider offers and we cannot judge their work on a professional level." (XTEC, Person 3)*

The Copycat Pattern describes a specific procedure in this regard. The pattern is supported by interview comments from different ESPs but is especially apparent in the interviews with managers from XTEC, which give a recent example of how they were capable of building up a new competence on technical simulation. Fig. 7-3 illustrates the Copycat Pattern as a cycle of three steps. The cycle involves multiple iterations, finally ending with the publication of the competence:

- *Setup:* An initial configuration of internal resources is compiled that becomes the basis for the development of the new competence.
- *Reconfiguring:* Internal resources are integrated with external knowledge and skills to reinforce the process of reconfiguring the initial resource configuration in a way that it matches with the new application context.

- *Practicing*: The implementation of real requirements enables learning by experience.
- *Comparing:* The data delivered by the subcontracted ESP, based on the same requirements, are compared with their own results, which reduces uncertainty.
- *Publishing:* The cycle ends when the comparison signals a sufficient level of expertise to publish the competence in the market by presenting it to the existing customers.

Fig. 6-3 Copycat Pattern



6.5.2 Setup

The process starts with an initial configuration of resources and actors, for example, employees and their corresponding knowledge and experience, which are related to the new competence. The following comment describes how XTEC set up such an initial resource configuration for building up a competency in technical simulation:

> *"[…] we considered what was needed to simulate on our own. We had some people who were interested in the topic with previous knowledge. Some of them also had experience in construction and were able to support the analysis of simulation results. For example, [an employee] has extensive experience in interior design. If one hands him a colorful image or a film of a simulation, such as the opening of an airbag […], he can assess whether that fits […] He can also help improve the results." (XTEC, Person 4)*

The development of the new competence requires sufficient freedom and time, which according to the interviewees, contradicts the current practice that employees and managers are continually involved in the daily project business.

6.5.3 Reconfiguring

When ESPs build new competencies, there is a gap between what the organization can already offer with its existing resources (e.g., employees, knowledge, skills or business relationships) and the knowledge and skills required in a new application context or competence field. Being successful in the new application area requires ESPs not only to transfer existing resources (i.e., the knowledge) to the new context, but also to reconfigure some other resources (e.g., regarding the number of necessary employees or contacts with the customer).

In the case of XTEC, this knowledge gap became apparent in that some employees already knew how to design car parts and components, but were not yet familiar with the subsequent steps of matching the components and parts against various requirements in a series of simulation activities. The next step was thus to start a process of reconfiguring resources into a state that allows for the challenges of the new competence domain to be mastered. For example, the reconfiguration involved building up new knowledge and skills but also comprised steps such as purchasing and rolling out new simulation software in the organization. In this regard, XTEC managers highlighted the importance to support and speed up learning processes, (e.g., by using external coaches):

> *"Some of our employees were also externally qualified, and we have brought together expertise from different internal fields. After the first round of qualification, we hired an external coach, who was available for support on a daily basis." (XTEC, Person 4)*

Through the use of external coaches, XTEC was able to lower the risk and insecurity in the initial phase of the new competence and to accelerate learning processes. In the course of this phase, the knowledge and skills of XTEC's employees were transferred to the new application context, (e.g., by making employees work with the new software and giving them opportunities to practice with examples).

6.5.4 Practicing

The findings show that practical learning is crucial when ESPs prepare to implement real customer projects in new competence domains. In this regard, ESPs exploit their roles as intermediaries, between the subcontracted ESP and the OEM, by using the requirements specification for training purposes. Respondents reported that they would establish a risk-free environment within the organization, in which employees can train on the implementation of engineering activities, which are part of the new competence domain. For example, XTEC used the customer input on geometrical data of the vehicle architecture and the specification of additional information on specific simulation cases (e.g., on the speed at which a car hits an object in the simulation of a crash test) to enable their own employees to train on real customer requirements.

6.5.5 Comparing

An essential mechanism of the Copycat Pattern is based on the fact that ESPs are not only in possession of the input data (that is handed over to the subcontracted ESP), but they can also analyze the results that the ESP delivers back to them.

> *"Then, we simulated traditional engineering projects in parallel [for training]. When we finally recognized that we produced the same results as the firm that is specialized at simulation and has extensive experience in this field, we said 'ok, now we are ready to offer this to the customer.' Since then, this has become a prosperous business." (XTEC, Person 4)*

The quote above shows that ESPs can compare the results of the subcontracted ESPs with their own implementation results, to gain insights into how well developed the knowledge and skills of their own workforce are in comparison to those of the other ESP. A discrepancy between these two results would indicate the need to train further. In this way, ESPs can significantly reduce the uncertainty that is often related to the process of developing new competencies.

6.5.6 Publishing

The Copycat Pattern ends with the publication of the new service in the marketplace. Once the results of the ESP match those were delivered by the subcontractor, new service offerings can be launched in the market. Publishing new competencies and service offerings require ESPs to acquire a pilot project and implement it successfully. In the example described by XTEC, the simulation services were no longer purchased externally but carried out themselves:

> *"There was a point, where we decided that from now on we would simulate ourselves. I remember receiving an e-mail from the customer, who threatened us that if we failed, we would be held responsible. […]. If we had not had the courage at that time to do this, and we had not believed in the capacity of our employees, and if our employees had not gone along with us, then this would never have worked out. However, we did have the courage, and our employees were confident. From then on, it was no longer a discussion with the customer on whether we should do the simulation ourselves or not. Today, we are established in this area." (XTEC, Person 3)*

As the quote above shows, the confidence of the ESP in their own capabilities is essential to keep the competence development process running. ESPs need to be sure that they can handle the requirements of the OEM and communicate this capability accordingly.

6.5.7 Summary

The Copycat Pattern has described a specific way of how ESPs proceed to build up a new competence by copying it from one of their subcontractors. The pattern dissects this approach as an iterative cycle in which ESPs carry out five interrelated steps (setup, reconfiguring, practicing, comparing, and publishing). The outcome of this procedure is a new competence that is not new to the market, but new for the organization of the ESP. By copying and incorporating the competencies from subcontractors, ESPs can unlock novel and innovative competence combinations, which other parties in the market cannot offer as a complete bundle. The Copycat Pattern can thus represent an essential step in a superordinate innovation process that leads to the detection of a novel and useful combination of competencies. This means the Copycat Pattern may trigger subsequent innovation activities and inspire the development of value propositions based on new competence combinations. However, the Copycat Pattern also highlights the specific risk for subcontractors to unconsciously support their contractees in acquiring new competencies and thereby making themselves expendable in the market.

6.6 Co-Innovation Pattern

6.6.1 Overview

The Co-Innovation Pattern is a result of an ongoing shift in traditional roles between OEMs and ESPs in the provision of services, which opens up new opportunities for both parties to innovate in close collaboration. The interaction modes between ESPs and OEMs are characterized by a moderating role of the ESP. Instead of dictating the steps or driving their own ideas in the innovation process, the role of the ESP is to carefully assist the customers in becoming innovative themselves (*Moderating Co-Creation Processes*). Trust in the ESPs helps customers in the renewal of rules and practices in ways that create beneficial boundary conditions for subsequent service provision (*Co-Designer*). This approach does often involve a more extended phase of recombinant steps in which the outcome of the process is iteratively refined in search for more compelling results (*Evolutionary Combining*).

Traditionally, the distribution of roles between OEMs and ESPs is such that the specification of requirements is carried out by the OEMs, while the ESPs focus on implementing these requirements. Given this distribution of roles, the boundaries for the design of service offerings are often predetermined, and they, therefore, reduce the potential for innovation to an existing task or problem. In recent years, however, the emergence of genuine partnerships between ESPs and OEMs has led to more versatile role configurations, such that ESPs have begun to depart from their previous focus on the implementation of OEM requirements, and now take on more new roles in which they advise customers on various technical or process-related topics. Among others, this has paved the way for more open methods of innovating in close collaboration. To gain a better understanding of how the ESPs can use resources and skills to help the customer, ESPs and OEMs take a step back before engaging in the development of a value proposition (e.g., a technical solution). Co-innovation has further been defined as a solution to overcome the phenomena that customers tend to be overly critical of ideas if they have origins outside their organization. The following comment summarizes the co-innovation idea:

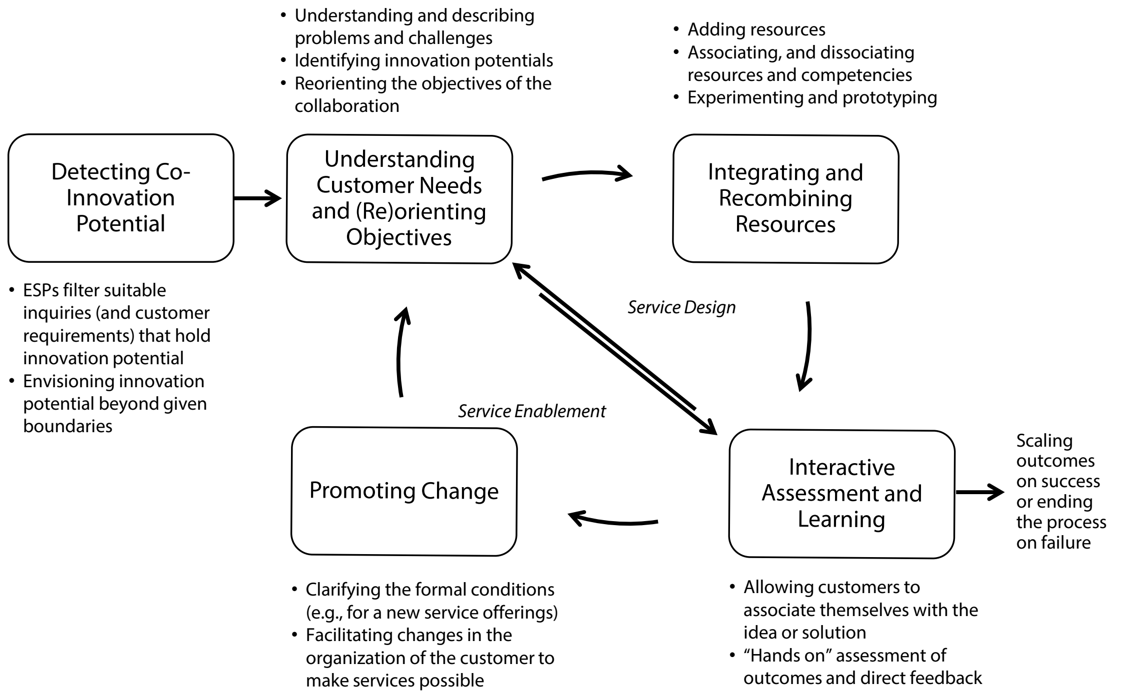
> *"What is currently the trend at our customers is that one does not come up with a solution – as some competitors try to – but instead one sits together with the customer and together we l brainstorm a method how to help the customer. Now, this is how we can support our customers best with our expertise." (XTEC, Person 8)*

The Co-Innovation Pattern refers to this specific context and describes a series of interconnected steps and innovation activities, which are jointly undertaken by an ESP and an OEM to develop innovative service offerings or technical solutions. An excellent example of such an open collaboration is manner in which the Innovation Studio (cf. section 4.3.2) emerged. The following description of the pattern thus references this case. Fig. 6-4 illustrates the pattern as a cycle of five interrelated activities:

- Detecting Co-Innovation Potential,
- Understanding Customer Needs and (Re)orienting Objectives,
- Promoting Change,
- Integrating and Recombining Resources,
- Interactive Assessment and Learning.

While the steps in the pattern all appear to be independently relevant, comments from the interviews indicate that they are often profoundly intertwined. They may also be carried out in a different order or simultaneously.

Fig. 6-4 Co-Innovation Pattern



6.6.2 Detecting Co-Innovation Potential

Inquiries are the starting point for further joint activities that do not directly begin with the implementation but, in fact, take a step back in order to challenge and refine the initial question or problem of the customer. The inquiries ESPs receive from their customers vary regarding their co-innovation potential, i.e., their suitability to carry out joint innovation activities. Before any innovation activities are undertaken in collaboration with the customer, there is thus a preceding phase in which ESPs attempt to identify those inquiries with a more promising co-innovation potential. According to the interviewees, inquiries, which are particularly well suited, are those in which the stated set of requirements gives the impression that the customer has not yet entirely understood his own needs or appears to struggle to describe them accurately. The reason for this is that precisely defined customer requirements often limit the space in which innovative ideas and offers can be developed to specific problems and tasks. For this reason, projects are particularly suitable for co-innovation activities that are located in the upstream phases of automotive development, in which many requirements for later development phases are still to be defined. Assessing and identifying such innovation potential requires both technical expertise and market knowledge but also a certain degree of creativity to envisage the potential beyond the boundaries of given requirements.

Once a suitable inquiry has been identified, the ESP invites the employees of the OEMs' technical department into a phase of jointly analyzing needs and discussing further steps on how to fulfill them. Participants reported that OEMs very much appreciated this support from their ESPs. The following comment describes this approach:

> *"The customer sends us an inquiry. We read the inquiry and have a few questions. Then we might notice that the customer does not have much of an idea what he really wants. Then we invite the customer to visit us." (XTEC, Person 8)*

This event marks the transition into the co-innovation cycle. In this cycle, the ESP and the OEM jointly design new service offerings (including technical solutions that then give rise to new offerings), which are tailored to the customers' needs. Furthermore, the parties jointly facilitate the necessary steps in the development environment of the OEM (cf. Fig. 6-4).

6.6.3 Understanding Customer Needs and (Re)orienting Objectives

The next phase has the objective of developing a deep understanding of the customer's problems and needs and therefore starts with a joint analysis. The XTEC employees emphasized the need for an open exchange of ideas with the customer in a creative environment that enables the customer to contribute his expertise to the analysis. In this context, respondents pointed out that OEMs have often been unable to articulate their requirements, leading to considerable effort on their part, to uncover the hidden problems or challenges, of which customers were not yet aware. In this regard, respondents also emphasized the importance of involving customers in the innovation process from the outset. On the one hand, if customer expertise is integrated, ESPs can develop a better understanding of their problem. In fact, understanding the problem often cannot be achieved without the customer's contribution. Moreover, if the customer is directly involved in the innovation activities from the beginning, the chances are better that he will feel a connection with the process outcome and supports the subsequent development and implementation activities.

To give both the OEM and the ESP an equal opportunity to participate in, and contribute to, the process, ESPs use professional moderators, who guide both their employees and those of the OEM through a series of workshops. The following comment describes the core idea of these activities:

> *"The studio is not purely [our] invention but has been developed with the customer. […] This works best when the customer is involved. The idea is that one sits down together with the customer and creates the offering jointly. […] Recently, we had a topic related to lightweight construction. We did a real brainstorming session with three colleagues [from the OEM] on how to organize such a project. The customer then is directly involved and contributes in an active role." (XTEC, Person 8)*

In the course of this process, the initial problem or set of requirements is usually refined, and the collaboration may be reoriented to address new aims and customer needs.

6.6.4 Integrating and Recombining Resources

The Co-Innovation Pattern comprises a phase in which the actors jointly develop a tailor-made service offering that meets the OEM's individual needs. Activities involve brainstorming, conceptual development and prototyping, and they are based on the analysis of the initial problem or question. These activities produce a variety of preliminary outcomes, such as ideas, technical concepts, and prototypes. The underlying processes are highly dynamic and collaborative, and require the participants to integrate different complementary resources. For example, customers use their knowledge of requirements and solution constraints to ensure that the process outcome meets their needs. ESPs integrate their knowledge and experiences from past projects to help the customer to articulate the problem. Furthermore, the process may include various additional resources, such as additive manufacturing for prototyping.

The Co-Innovation Pattern involves recombinant operations that are carried out in a spontaneously evolving and iterative process. In this process, each outcome determines the recombinant options in the next iteration and has the potential to redirect the innovation process towards new objectives or directions. The dynamic nature of co-innovation gives rise to processes of recombinant evolution. The following comment, on the development of XTEC's Innovation Studio, illustrates an example of this:

> *"In the beginning, there was a basic concept: 'free-thinking' plus 'workshop' plus 'a maker shop.' Then we noticed a lack of moderation. Therefore, we extended the concept to include moderation. Then we realized that it is not practical to hold workshops in a garage where construction activities take place in parallel. Therefore, we built an additional garage and separated it from the workshops. This is all part of the success: the combination of the Design Thinking model, workshops, networks that have emerged, a thinking space, plus the implementation. All these things were established over time." (XTEC, Person 2)*

The comment above also highlights the fact that co-innovation processes involve gradual decision-making and alignment of activities towards the exploitation of dynamically evolving opportunities. Instead of directly focusing on a specific goal, the course of the process is continually reoriented. Co-innovation processes thus typically involve steps and activities that are unforeseeable and are difficult to plan.

6.6.5 Interactive Assessment and Learning

To keep the co-innovation process in motion on track towards the development of beneficial solutions and service offerings, co-innovation activities require a continual evaluation of the current state of the process and the previously generated outcomes. In this regard, interviewees stressed the need to allow the customer and the other workshop participants to assess technical solutions and ideas directly and intuitively:

> *"You have to make it interesting to make the customer curious. One has to be quick […]. One needs to have examples, so relatively fast, classic Design Thinking, so not PowerPoint, but real topics and it must have a kind of uniqueness." (XTEC, Person 2)*

To achieve such a hands-on experience for the customer, XTEC, for example, uses different types of additive manufacturing technology to create prototypes from technical solutions with which the customers can interact and directly suggest ways for improvements. Furthermore, in the development of service offerings, different visualization techniques are used. Customers can use the resulting illustrations and visual representations of ideas and solutions for communication purposes in their organization, (e.g., to explain ideas to other stakeholders and decision makers). According to the interviewees, it is helpful to create an environment in which customers can test new offerings and solutions, and provide direct feedback. The following comment echoes this concept with regard to the development of the Innovation Studio:

> *"An employee set up the studio himself and did a lot of manual work on the furniture, etc. Then someone from [the OEM] liked it. He preferred to work from the studio rather than from his own office. This showed us that we had created a space for the customer that his large corporation does not provide. The orders came from where he was, and because he was with us, we also received the orders. We performed well and always did a bit more than he had expected." (XTEC, Person 1.1)*

Hence, to respond faster and better to the customer demands, the ESPs can create an environment in which their customers can test new solutions and service offerings without directly having to commit themselves to specific development projects.

6.6.6 Promoting Change

The co-innovation of engineering services can extend beyond the development of new solutions and service offerings. For example, new service offerings that are co-created with the technical department also need to pass through the OEM's regular procurement processes (cf. section 2.2.1), which poses a multitude of formal requirements specifying how engineering services are offered and provided. As innovative service offerings can potentially break with established conventions, there is a risk that they cannot be implemented as the co-innovation partners have envisaged them initially. Interviewees expressed the view that purchasing departments represent an obstacle to service innovation:

> *"The problem is that if we construct such a solution and develop an offering, the OEM's purchasers are unaware of this offering. Then we get stuck in the purchasing department." (XTEC, Person 8)*

For example, customers demand a comparability of service offerings, which means that a newly created service offering needs to be in some way comparable with other offerings in the marketplace. In this regard, interviewees emphasized the importance of carefully considering how to phrase the offering to avoid pitfalls. As another requirement, the purchasing department must be able to assign service offerings to different predefined service categories (e.g., different types of consulting services and engineering services), which are in turn linked to different sets of formal boundary conditions in the subsequent procurement processes.

> *"Only the standards stand in our way. For example, in the purchasing department, they do not know whether [the new offering] is a consulting or development service." (XTEC, Person 8)*

However, not all such requirements can be directly recognized and fulfilled in advance. To enable the provision of innovative services, it is often necessary to first negotiate and clarify different conditions. Such conditions range from budgetary restrictions in the technical department to the distribution of liability risks and responsibility between OEM and ESP. Activities, in this regard, comprise a clarification of various boundary conditions with different stakeholders and decision-makers (within the OEM's internal organization) to obtain their goodwill and support for the new offering before the official tender process takes place. A common view amongst interviewees was that ESPs are thereby dependent on the support of the technical departments:

> *"For entirely new topics, such as the Innovation Studio, it was a common approach to find an OEM co-promoter, who promotes the whole topic internally [in the organization of the OEM]. The idea was also co-developed with the OEM. This means that the budgetary conditions at the OEM were clarified in advance. In this way, the idea came partially from them." (XTEC, Person 4)*

ESPs are thereby often in a supporting role. For example, they help the technical department with the specification of documents and counsel them on diverse topics related to the design of contracts or the legally compliant organization of the collaboration. In the subsequent tender processes, which are then jointly initiated in this way, the co-innovating ESPs often have an advantageous role or a good chance of winning the contract. The initial project with a pilot customer is often the biggest obstacle in the development process that, if successfully overcome, often opens the door to further similar projects.

6.6.7 Summary

The presented Co-Innovation Pattern describes an unusually open and agile approach to service innovation, which is based on collaborative joint innovation efforts between ESPs and their customers. The outlined Co-Innovation Pattern has some similarities with Design Thinking but embeds existing components into a more comprehensive approach that is aligned with the specific requirements and conditions of the automotive industry. Similarities include the dynamic reorientation of the activities, process moderation, and the initial attempts to better understand and refine a problem before subsequent steps are taken, which is in line with some of the interview comments that indicate the use of Design Thinking techniques. At the same time, the Co-Innovation Pattern shows that a by-the-book transfer of Design Thinking techniques to innovation processes in the AES industry is not possible. In particular, the rules and formal constraints of purchasing processes, as well as the divide between technical department and purchasing department, make service innovation processes more complex and require ESPs to direct their activities towards different customers whose aims and needs are not only different but are often the complete opposite. The Co-Innovation Pattern illustrates how ESPs overcome some of these hurdles by embedding Design Thinking activities in a more comprehensive and industry-specific approach.

6.7 Exploration Pattern

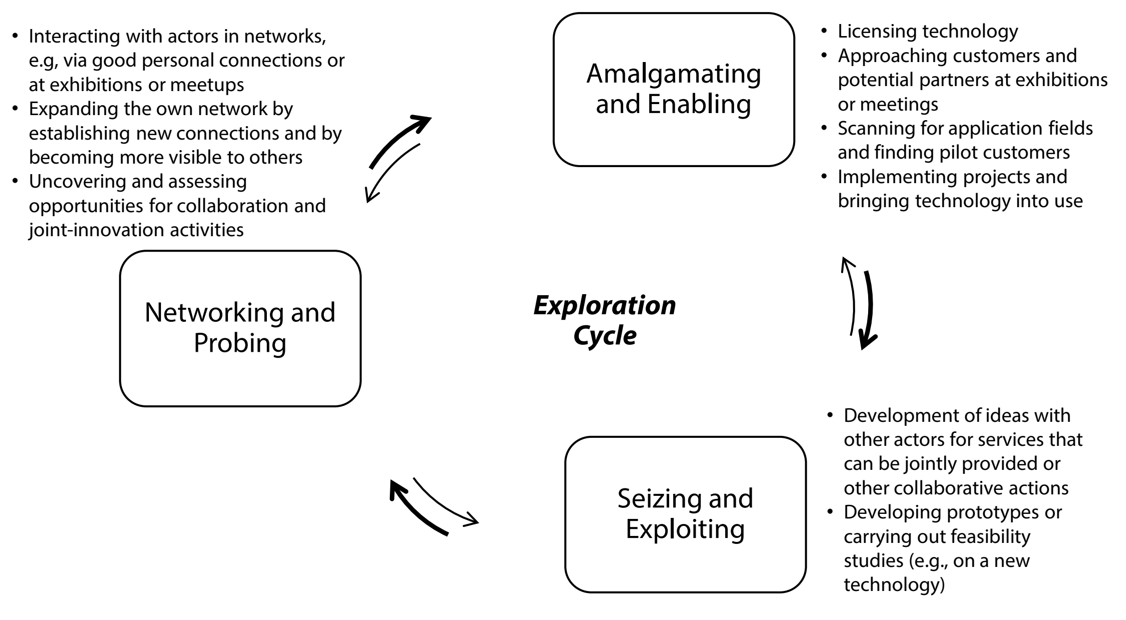
6.7.1 Overview

The Exploration Pattern describes how ESPs innovate in an open and exploratory way by searching for innovation and value co-creation opportunities in networks without being driven by the predetermined needs or interests of a specific customer. In such networks, ESPs take on a role as knowledge brokers, for example, by using their knowledge of technical problems, solutions, processes, institutions or networks in the automotive sector. They bring together resources and actors in new constellations that are beneficial for the actors involved and for the ESP personally (*Brokering Knowledge*). For example, ESPs integrate external resources and collaborate with different suppliers and ESPs in the development of new technological solutions and prototypes that then become the foundation of new service offerings. The customer is usually not initially involved in such activities, but instead joins the process at a later stage after some preparatory work has already been completed. Subsequently, the ESPs need to outline the respective value of their solution (*Outlining Value Co-Creation Possibilities*). The more unusual and innovative the outcome of this process, the more likely it is that the actual implementation will require changes to existing practices and rules, such as contract arrangements and cooperation modalities. Before a new service or solution can be implemented, it is, therefore, necessary to encourage the customer to deviate from existing rules and practices (*Stimulator).* As to the reflected recombinant practices, the underlying service innovation processes of the Exploration Pattern are often linear and may proceed over a longer period of time, during which a nascent solution is often refined in multiple iterations *(Evolutionary Combining).*

In this pattern, ESPs free themselves from the frequently made assumption that innovative services must inevitably be tailored to the needs of current customers; instead they can open up to customers and markets that are often not entirely, or only partially, foreseeable at the beginning of the innovation activities. The exploratory nature of innovation processes means that innovation activities are often difficult to plan and are not linear. As a result, it is only possible to describe different areas of activity between from which ESPs change back and forth, several times in the course of the Exploration Pattern. These activity areas include (cf. Fig. 6-5):

- Networking and Probing,
- Amalgamating and Enabling,
- Seizing and Exploiting.

Fig. 6-5 Exploration Pattern



ESPs may switch back and forth between different areas of activities, which correspond to different directions of proceeding through the exploration cycle. For example, interviewees described examples in which the first phase of networking was followed by a phase of jointly developing a technological prototype. In the course of this process, the ESP noticed a need to include a partner firm with knowledge in the field of electronics. As a result, this required another round of networking and searching for partner firms. The three different areas of innovation activities in the exploratory pattern are described in more detail below.

6.7.2 Networking and Probing

ESPs carry out exploratory innovation activities on the foundation of networks, in which they establish network relationships, explore and uncover innovation opportunities, and probe, with other parties, how resources could be integrated and combined to innovate and co-create more value. According to the data, there are different communication channels and occasions in which such activities take place.

On the one hand, interviewee comments show that such activities occur through regular communication to well-known partner firms from the AES industry, such as other ESPs or suppliers.

> *"One has many exploratory discussions, in which one considers where one could do something together; so what makes sense and what does not make sense? In this regard, we have specific partners." (SIMULI, Person 4.2)*

> *"[…] impulses indeed come from the outside. There are different channels. There is the standard sales channel, where we speak proactively with customers. Also, impulses come from networks, where one is in dialogue with [research] institutes, other companies, and sometimes also with competitors." (XTEC, Person 4)*

In these more traditional networks, ESPs uncover innovation potential through regular communication and interaction, based on personal contacts on different levels. Here, the communication is often guided by a particular problem or challenge in the market that brings different actors together in the search for a solution, or in the creation of a joint offering that combines different resources and competencies.

In addition to this regular communication within the AES industry, interviewees point to an increasing significance of more open communication between parties without predetermined topics or premises, such that opportunities for cooperation can be explored free from the constraints and obstacles of daily project business. This more open way of probing and scanning for innovation opportunities often occurs as a result of exhibitions or after-work meetings, which ESPs use as platforms to interact with parties, with whom they would not usually be in contact with. This can lead to dense and atypical constellations of resources, e.g., regarding knowledge from different technological disciplines and actors. In this context, several respondents testify that ESPs increasingly try to establish contacts in the start-up scene and with parties whose core competencies lie in the field of digital services and software:

> *"One tries to network with universities. Furthermore, we must now actively approach start-ups. Particularly [here] one has the access [to start-ups]. […] I think the first step is to recognize that it is important to network in this direction." (XTR, Person 2)*

However, some interviewees report that ESPs are often hardly recognized as potential cooperation partners by other actors outside the automotive industry and that it would thus become crucial for them to increase their visibility among a wider range of actors, e.g. by providing speakers for IT conferences or by stepping up their presence at exhibitions that are attended by non-automotive actors.

The outlined networking activities are often the starting point for joint innovation activities between ESPs and other stakeholders, such as start-ups, suppliers or universities. The contents of these activities are very diverse and range from the development of a technical prototype, the development of methods or software tools, to the integration of external resources and technologies into the provision of engineering services to the implementation. In some cases, the focus may also be solely on the exchange of knowledge.

The networking activities are carried out on a regular base in parallel to the usual project business. They can also play a significant role in the further course of innovation processes, for example, when it is necessary to find application areas for newly developed technologies and solutions, and pilot customers for new service offerings. Furthermore, the network constellations are not static and may also change dynamically over time. For example, depending on how innovation activities proceed, new actors or resources may be required to initiate the next steps, which may also entail further networking activities to establish contacts with the necessary partners.

6.7.3 Amalgamating and Enabling

Findings show that the second area of activity relates to actually completing the activities that aim to enable or test the feasibility of new value propositions. How precisely the objectives of such activities are defined often varies. For example, interviewees outlined activities that have a clear aim, for example, to create a solution for a particular technical problem. In other cases, these aims are only vaguely defined, and the activities are more experimental and explorative. For example, in some cases, interviewees described activities in the development of prototypes and technologies for which a market opportunity has not yet been identified. The activities have in common that they usually involve a network of actors and require the ESPs to amalgamate with or enter into any partnership with actors external to their organization.

Interviewees pointed to different cooperation variants. Depending on the type of actors involved, the degree of formality in the cooperation varies. Activities between ESPs and start-ups do initially often involve non-binding steps that occur on the sole basis of trust. For example, start-ups often have competencies, technologies, or capabilities (e.g., in the area of software development) that are of interest to the ESP, but for which they first need to identify a suitable application case. In contrast, when ESPs cooperate with universities, this usually happens on the basis of a contractual agreement. The following comment refers to one such collaboration.

"I did my Ph.D. on automatic transmission adaptation. Some time ago, we had recognized that this is a massive trend. Then I went to the university and worked on the topic in cooperation with [the provider]. […] Here [at the ESP], I could use the vehicles, and the university provided me with a scientific infrastructure. This is a classic example of a development that is not driven by the customer." […] (XTR, Person 2)

The comment above also shows that the innovation activities undertaken by ESPs with cooperation partners bring together complementary resources.

6.7.4 Seizing and Exploitation

Given the open orientation of the Exploration Pattern, the results frequently solve problems or tasks, which are not directly related to the needs or interests of a particular customer, but have general relevance in the context of the automotive development sector. To co-create further value, based on the outcome, ESPs thus face the challenge of identifying a specific application field and finding an initial customer.

The respondents emphasize the importance of their relationships within the organization and with relevant stakeholders in the technical departments of the OEMs to identify potential application cases and pilot customers.

"One needs to know which contact person one can approach for which topic. This happens via a personal network. Inspiring the upper hierarchy at the customer is essential. If it is then carried down from the top to the lower sections, it gets much easier [to put a project into effect]." (XTEC, Person 7)

"Then one goes on an acquisition tour and does some feasibility studies with a customer. In this way, a part of the [invested] money already flows back. One hopes that it can be applied in series development. Alternatively, one even develops a software tool, or a method or a process that can be purchased by the customer. This is a classic example." (XTR, Person 2)

Internal application fields are often easier to implement, are often used for testing, and further for developing tools and software solutions. For example, the respondents show that tools and software solutions developed in cooperation with universities are provided to the internal teams to facilitate their work and increase efficiency. The solutions may evolve further and can later be purchased by OEMs in the form of software licenses.

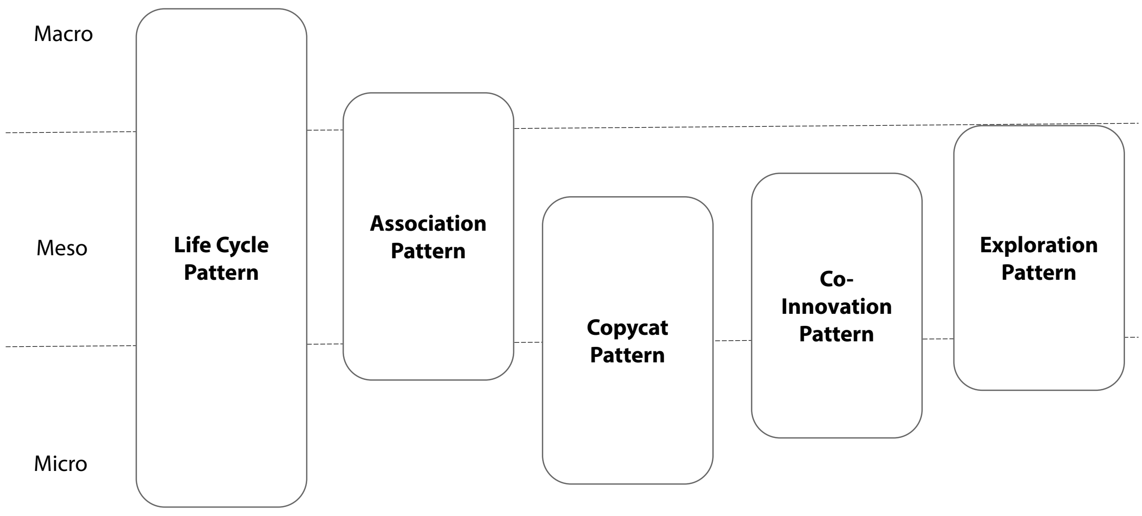
6.7.5 Summary

The presented Exploration Pattern has described a characteristic way how ESPs innovate in an autonomous manner without being driven by the predetermined requirements of a particular customer. As outlined in the pattern, innovation activities can be assigned to three different interrelated areas of activities: *networking and probing*, *merging and enabling*, and *seizing and exploiting*. The three activity areas have a commonality in that they build on networks from which the ESP obtains resources from other actors or integrates their own resources, with the aim of uncovering and exploiting innovation potentials. Such service innovation activities often coincide with changes in these networks themselves. The service innovation processes, which are reflected by the exploratory innovation pattern, are often characterized by high complexity and dynamism and often unfold in non-linear and highly iterative ways.

6.8 Chapter Conclusion

This chapter has presented five patterns of innovation in engineering services: The *Lifecycle Pattern*, the *Association Pattern*, the *Copycat Pattern*, the *Co-Innovation Pattern*, and the *Exploration Pattern*. The five patterns emphasize the diverse and often complex pathways in which engineering services are innovated. Rather than innovating in a specific way, ESPs engage in a variety of innovation processes in parallel, which can be interrelated and mutually dependent. Based on the conceptual viewpoint of the S-D logic, the patterns can be assigned to different systemic levels of a service ecosystem (Fig. 6-6):

Fig. 6-6 Assignment of Patterns to Different Systemic Levels



- The *Lifecycle Pattern* is the only pattern that fully spans all three systemic levels, i.e., micro, meso, and macro. The pattern comprises activities and steps that illustrate the interrelation between these levels. More specifically, it describes cyclical processes of change in service ecosystems, which arise from technological advances and market-related changes on a macro-level. The pattern furthermore highlights how these changes disperse into the lower systemic levels, where they determine the pace for the emergence, consolidation, and reconfiguration of service networks and service systems.
- The *Association Pattern* describes the behavior of OEMs and ESPs in the context of a market-wide trend towards more comprehensive service offerings. The Association Pattern and the Lifecycle Pattern are related in that the increased bundling of competencies is also a result of the fact that many mechanical competencies have reached a mature lifestyle stage and thus become predestined for standardization and the integration into larger contract packages. The Association Pattern relates to activities and interactions between ESPs and other actors in their network. In particular, it shows that the provision of more extensive and sophisticated service packages requires cooperation across locations and organizations. Due to this pronounced role of networks, the Association Pattern is anchored on the systemic meso-level with a slight overlap to the micro- and macro-levels.
- The *Copycat Pattern* describes how ESPs use their role as subcontractors to build up a competence formerly purchased from another ESP in the market. The respective processes involve interactions between the ESP and a relatively small circle of actors, that include the ESP from which the competence is copied, other ESPs, who support learning processes, and an initial customer. While the interactions emphasize the networked nature of this pattern, the learning and development processes mainly take place in the organization of the ESP. This is the reason why the Copycat Pattern is placed between the micro- and meso-levels.
- The *Co-Innovation Pattern* is an open and agile way of how ESPs innovate in close collaboration with their customer. This involves joint innovation activities among a narrow circle of employees from the ESP and the OEM. Activities are often extended to a broader range of actors (e.g., to gain access to necessary resources). While the interactions and joint innovation activities typically revolve around dyadic relationships (typically ESP-OEM), networks become more dominant within the organization (e.g., between employees from different organizational units). Given this, the Co-Innovation Pattern is located at the intersection between micro- and meso-level.
- The *Exploration Pattern* reflects a strong network orientation. The innovation activities described in the pattern are related to interactions and joint innovation activities between

ESPs and a diverse group of actors. More than the two previously described patterns, the exploration pattern is concerned with about the detection of innovation potentials by extending the network to new actors or by establishing new relations between actors that were formerly not connected. Although the interactions focus on the relations between two primary actors, the Exploration Pattern typically involves interactions between more than two actors. It is therefore firmly anchored in the systemic meso-level.

All five patterns underline the importance of cross-organizational networks in service innovation processes. When ESPs engage in service innovation, this always requires some form of cooperation and interaction with other actors external to their own organization, typically in a networked constellation with more than two actors.

7 DISCUSSION

7.1 Chapter Introduction

This study set out with the objective of investigating service innovation processes in the AES industry, in order to extend the current understanding of interactive and cooperative innovation activities among networked constellations of actors in service ecosystems. The two central contributions of this study are, first, an analytical framework, comprised of three dimensions and several characteristics of service innovation processes (chapter 5) and, second, a typology of service innovation processes (chapter 6). The analytical framework and the typology are interlinked in that the three dimensions and characteristics provide a systematic structure that is used to define five types of service innovation processes (i.e., patterns). Each process type includes detailed descriptions of service innovation processes in the AES industry that pinpoint interrelations in the occurrence of roles, interactions, and innovation activities.

To clarify differences and commonalities with the existing body of knowledge on service innovation and to describe pathways for further research, this chapter discusses the presented results in relation to the previous literature. Since the interpretation and research approach of S-D logic is in many ways distinct from the established literature of innovation management, the discussion is divided into two main sections. Section 7.2 begins with a comparison of the typology with the classic literature on innovation management. Given that numerous studies that highlight innovation in KIBS to be distinct from innovation in other service industries (e.g., den Hertog 2000; Muller and Doloreux 2007), the discussion is limited to KIBS-specific innovation research. Section 7.3 then considers the S-D logic literature and relates the empirical findings of this study to several essential S-D logic concepts, such as institutionalization, service ecosystems and A2A-networks, that have become the focus of recent academic debates on service innovation. Since the unifying perspective of S-D logic on innovation in service ecosystems is still primarily based on conceptual thinking, this research helps to substantiate and complement the current debate with empirical findings. Finally, section 7.4 summarizes the discussion.

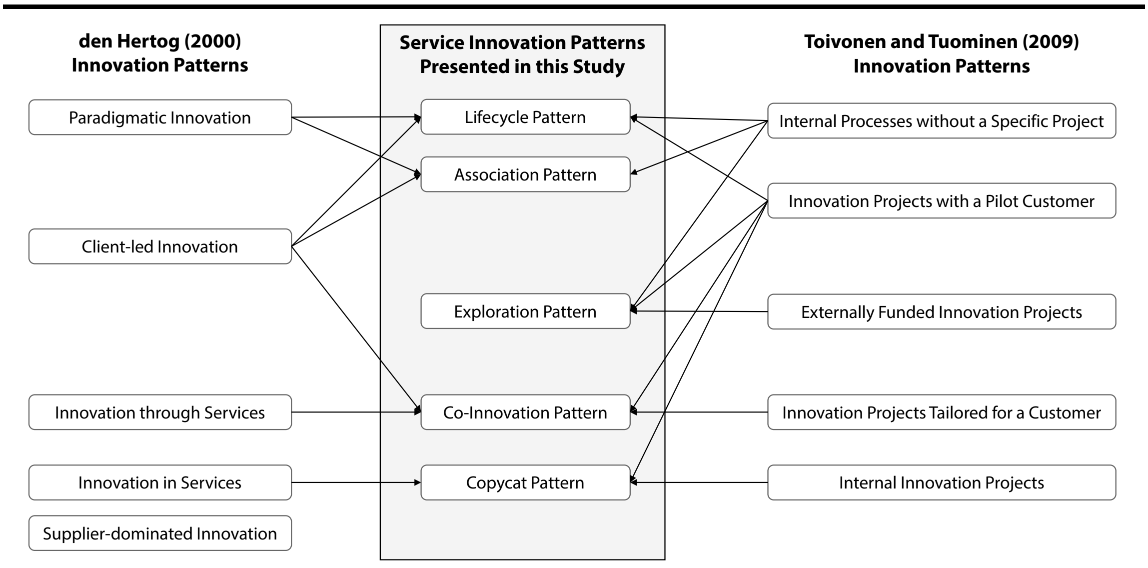
7.2 Relations to the Literature on Innovation Management

This section discusses the findings of this study in relation to various themes and theories from the established literature in innovation management. The discussion shows how the service innovation typology that was developed in this thesis supports existing theories and concepts, and extends them with more detailed insights on specific service innovation processes. As mentioned in the related literature chapter (cf. section 2.4), several previous studies have developed classification schemes that are founded on patterns noted in the innovation behavior of organizations. Based on the research approach (cf. Bailey 1994), these studies can be divided into taxonomies and innovation typologies (Hipp 2000), with the first category having received significantly more research attention than the latter. In the following, the two categories are discussed separately, starting with the relations to existing typologies. As the classification scheme presented in this study is considered a typology (due to the exploratory and qualitative approach taken (cf. Bailey 1994)), the relations to existing typologies will also be more extensively addressed.

7.2.1 Correlations to Innovation Typologies

Two frequently cited innovation typologies have been proposed by den Hertog (2000) and Toivonen and Tuominen (2009). The two typologies were previously introduced in section 2.5. They show some commonalities with the typology presented in this study. First, both typologies describe and distinguish patterns of innovation in KIBS. The typology proposed by den Hertog (2000) describes patterns on a conceptual basis and for KIBS in general, whereas the patterns proposed by Toivonen and Tuominen (2009) were developed through qualitative-empirical research in three different specific KIBS domains, one of them being engineering consultancy. Furthermore, both typologies provide information on the processes through which innovative value propositions emerge. However, they do not provide in-depth insights on activities or roles. The patterns presented in the current study incorporate many of the patterns from the existing typologies. However, they extend them by interlinking their aspects and characteristics through more detailed descriptions of interactions, roles, and activities. Fig. 7-1 illustrates these relations, which will subsequently be discussed, beginning with the relations to the patterns proposed by den Hertog (2000).

Fig. 7-1 Comparison of Service Innovation Patterns



Correlation to den Hertog's patterns

This section compares the patterns presented within this study with those conceptualized by den Hertog (2000). Several of the aspects described in den Hertog's patterns *(Innovation in Services, Client-led Innovation, Innovation through Services, Paradigmatic Innovation, Supplier-dominated Innovation)* are also reflected in the findings of this study (cf. Fig. 7-1):

- *Innovation in Services* describes innovations that are primarily created and implemented within the organization of the service provider. The current study found firm-centric innovations to be rather weakly reflected. That a substantial portion of the innovation activities takes place within the ESP's organization is only shown in the case of the *Copycat Pattern*. However, the internal innovation activities (i.e., the processes of learning and competence building) are supported by external actors, e.g., coaches who help to build up new knowledge and skills. Instead, the presented patterns show that the innovation activities of ESPs require interactions in a network of actors (e.g., in the *Association Pattern* or the *Exploration Pattern*).
- *Client-led Innovation* refers to innovation activities that are undertaken by service providers in response to precisely articulated customer needs. This pattern is echoed well by the findings of this study and becomes explicitly apparent in the *Lifecycle Pattern* and the *Association Pattern*. Both patterns describe how ESPs evolve service offerings and competencies by adapting them to incremental changes in customer requirements. Such activities are closely linked to service provision and unfold over more extended periods of time, often without being directly associated with innovation by the ESPs. In some way, the *Co-Creation Pattern* also includes client-led innovation, since the pattern is typically triggered when customers confront ESPs with a specific problem or need. Contrary to the assumption of den Hertog (2000), however, the problems or needs are freuqently not precisely articulated from the outset. Instead, the results of the current study suggest that in cases where customers do not yet entirely understand their own requirements, there is a marked potential to leave familiar ground and try novel things.
- *Innovation through Services* refers to the involvement of ESPs in innovation activities within the organization of their customers. This study offers little empirical support for this pattern, which is mainly due to the differences in the analytical focus. While den Hertog's (2000) patterns were more concerned with the changes that KIBS provoke, the present study has focused on changes that affect the engineering services themselves. Some parallels exist to the *Co-Innovation Pattern*, which invokes innovation processes in which ESPs support their customers to be personally innovative. However, these innovation activities typically occur in a dedicated environment outside the customers' organization.

- *Paradigmatic Innovation* refers to broader disruptive trends that affect all actors within a value chain. The role of paradigmatic innovation is incorporated in the *Lifecycle Pattern* and the *Association Pattern*. Both patterns have in common that they point to the underlying forces behind continuous changes in engineering services and to related competencies, which not only affect individual ESPs but instead are relevant to the whole AES industry. The current transformation of the automotive industry makes paradigmatic innovation particularly visible. One example is the shift in customer preferences in the OEM's sales markets, which changes the value of various traditional ESP competencies and accelerates the emergence of new technological competence demands in the market (e.g., those related to driver assistance systems and electromobility).
- *Supplier-dominated Innovation* refers to the emergence of innovation in response to the availability of new technologies that are provided by an external supplier. The findings of this study show that ESPs have only limited options to decide on the use of new technology. Instead, key technologies, such as the software to use for the exchange of data or to carry out engineering activities, are determined by standards or conventions created by the OEMs. These conventions are performed on a market-wide basis. As a result, the opportunities for ESPs to make use of technological developments faster than other market participants are limited to the fields in which technological change does not interfere with the technology used by the customer. These fields are restricted to a few niches (e.g., 3D-printing). Hence, the supplier-dominated innovation pattern is only minimally reflected in the findings of this study.

As shown above, the five service innovation patterns presented in this study incorporate many of the aspects described by den Hertog (2000). At the same time, they show several additional pathways through which service innovations emerge. As mentioned, some differences exist regarding the conceptual orientation of the patterns. While the patterns presented in this study focus on the changes in KIBS themselves, den Hertog (2000) concentrated more on the changes that KIBS provoke (Miles 2008). These differences in perspective are reflected by the fact that the *Co-Innovation Pattern* and the *Exploration Pattern* do not find an equivalent in den Hertog's (2000) innovation typology. In this context, it should be noted that changes in engineering services usually require changes in the role or organizational setup of the customer. This was demonstrated in the current study by the fact that, in order to develop new value propositions (e.g., those that are based on a new combination of competencies), ESPs typically require OEM departments and individuals to coordinate their outsourcing demands and to repackage them. This underscores the importance of studying service innovation processes from multiple perspectives.

Correlation to Toivonen and Tuominen's (2009) patterns

The patterns described by Toivonen and Tuominen (2009) (*Internal processes without a specific project*, *internal innovation projects*, *innovation projects with a pilot customer*, *innovation projects tailored for a customer, externally funded innovation projects*) are well reflected in the findings of the current study (cf. Fig. 7-1). This is due to the fact that the patterns described by Toivonen and Tuominen (2009) are based on qualitative empirical evidence from various KIBS industries, including engineering consulting services, so that the empirical domain overlaps considerably with the present study.

- *Internal processes without a specific project:* In line with the findings of Toivonen and Tuominen, this study shows that service innovation in the AES industry is often not the outcome of an intended internal innovation project, but instead emerges from interactions and collaborative efforts between ESPs and OEMs during day-to-day business. This link is well reflected in the *Lifecycle Pattern*, which highlights that competence development activities are triggered by cyclical forces at a market level and conveyed through daily interactions and information exchange between ESPs and other actors from their network. Similarly, the *Association Pattern* and the *Exploration Pattern* emphasize the close connection between service innovation and service provision. It becomes apparent that the interactions during service provision are essential, in order for ESPs to obtain information on customer requirements and to detect innovation opportunities.
- *Innovation projects with a pilot customer*: The findings of this study underline the essential role of projects with pilot customers in the development of new competencies and service offerings. Pilot projects were, however, not described as a separate pattern, because interviewees mentioned them in various contexts without revealing a significant influence on the course of service innovation processes. Instead, findings show that pilot projects may play a role in different types of service innovation processes. Specifically, pilot projects are reflected in the *Lifecycle Pattern* (in order to develop new competencies that are requested by the market), in the *Exploration Pattern* (to make the transition from an initial idea to a new service offering or value proposition), in the *Copycat Pattern* (to enable the ESP to offer a new combination of competencies), and in the *Co-Innovation Pattern* (to enable and implement a service offering that was jointly developed between the ESP and the OEM).
- The findings of this study show that *internal innovation projects* play only a minor role in the innovation of engineering services. One reason is that technical problems and customer requirements are subject to constant change, which makes it difficult to organize and plan innovation activities as projects. Instead of innovating within - and taking the results outside - the organizations, ESPs are more successful in their innovation activities

when the customer is directly on board from the outset and can integrate vital resources into the process first hand, e.g., knowledge of problems, needs, and requirements. An exception is the *Copycat Pattern*, in which the ESP innovation activities serve the purpose of developing a competence that addresses an established and known market demand.

- *Innovation projects tailored for a customer* refers to ad-hoc innovation processes and a close collaboration between service provider and customer. Such characteristics are well reflected in the *Co-Innovation Pattern* in which joint innovation activities and service provision are often intertwined or represent subsequent phases. The *Co-Innovation Pattern* suggests that the collaboration can be characterized by genuine partnerships in which ESPs and OEMs meet equally and on the basis of a high degree of trust.
- Consistent with the results of Toivonen and Tuominen (2009), the results of this work show that *externally funded innovation projects* play a vital part in the AES industry. However, in contrast to the findings of Toivonen and Tuominen (2009), the role of such projects in service innovation processes did not become discernible as a distinct pattern. Instead, the findings of the current study highlight the importance for ESPs to interact and exchange information with diverse actors in networks, in order to continually detect and facilitate the emergence of innovation opportunities. The essential activities include collaboration with universities and research institutes. Among the presented patterns, the *Exploration Pattern*, in particular, demonstrates explicitly how ESPs generate and distribute knowledge through interactions and joint activities with other actors in their own or other networks; in this way initiating and driving forward innovation processes, which enable multiple actors to co-evolve their roles and resource integration practices. However, externally funded innovation projects are only one specific method among several other activities in networks.

In summary, the innovation patterns presented in this study correlate better with the patterns outlined by Toivonen and Tuominen (2009) than those presented by den Hertog (2000). Differences between the typologies can be particularly observed in relation to the conceptual scope of the patterns (i.e., which actors are considered in the study of service innovation processes), as well as regarding the direction of the patterns (i.e., whether patterns focus on the changes in KIBS themselves or on the changes that KIBS providers provoke, which concern their customers).

7.2.2 Relation to Innovation Taxonomies

Most of the innovation patterns described in the established literature on innovation management are taxonomies (Hipp 2000). In section 2.5.1, some of the more frequently cited taxonomies were briefly introduced (e.g., Miozzo and Soete 2001). The typology presented in the current study complements the previous taxonomy research in several aspects.

First, the typology presented in this study differentiates from prior studies that have proposed taxonomies in that the specific types are, on the one hand, defined with a set of dimensions and characteristics but, on the other hand, are linked to more detailed conceptual models, which provide in-depth insights on the innovation process itself. Previous research on innovation taxonomies has typically used firm- or industry-level data to identify groups of organizations with similar innovation behavior. Many of the existing studies use quantitative data and mainly focus on the inputs and outputs of innovation processes (e.g., Miozzo and Soete 2001; Pavitt 1984). These studies have significantly contributed to a better understanding of the differences and commonalities in the innovation behavior between specific groups of firms and entire industries; however, they offer little insight on the process of innovation itself, which is certainly a result of the quantitative research methods taken. The present study combines the advantages of classification schemes (e.g., simplicity, applicability) and qualitative research (e.g., in-depth analysis). The presented findings complement previous quantitative research on service innovation, in that they extend beyond differences and commonalities in the innovation behavior of actors and instead offer detailed insights on the interplay between roles, process steps, institutions and interactions in specific service innovation processes.

Second, the five different patterns underscore the heterogeneity in service innovation processes within specific KIBS industries. They exemplify several specific ways in which ESPs engage in service innovation and differ significantly regarding roles, activities, and the level of abstraction, which emphasizes the need for more differentiated conceptualizations. Furthermore, the comparison between XTEC and SIMULI (chapter 5) shows that the innovation behavior of firms does not only vary between industries, but also within firms that operate in a similar environment but are different as a result of their market position, management attitude and/or strategical orientation. These findings are consistent with more recent taxonomies that define various innovation patterns of KIBS firms from the same industry, based on firm-level data (e.g., Camacho and Rodriguez 2008). Such works vary from the pioneer taxonomies that used a one-size-fits-all approach to capture innovation within and across service sectors (e.g., Pavitt 1984).

Third, the outlined service innovation processes describe interdependencies between changes on different systemic levels (i.e., macro-, meso-, and micro-levels). In this way, this research answers recent calls in the literature for studies to develop a more comprehensive and realistic understanding of service innovation by differentiating between different systemic levels

(Ostrom et al. 2015; Vargo et al. 2015; Wieland, Vargo, et al. 2016). The multi-level analysis complements previous taxonomy research which has typically concentrated on a specific firm-level or industry-level, whereby each level has its own limitations. Industry-level data considers the industry-specific characteristics as determinants of the innovation behavior. However, such studies have often neglected the individual situation of the organization (Camacho and Rodriguez, 2008). By contrast, studies that use firm-level data assume that the firm-specific characteristics, such as business capabilities or organizational specifics are decisive to understand the innovation behavior of organizations (Hipp and Grupp 2005; de Jong and Marsili 2006). However, these studies have been criticized for not considering the interrelations between service innovation and the business environment.

Fourth, the concepts *(Modes of Interactions, Recombinant Practices, and Roles in the Renewal of Institutions)* that are used to define and distinguish specific innovation patterns in this study are different from the typical variables of taxonomy research, which has focused on innovation inputs and outputs. For example, innovation taxonomies have seldom tried to explain the innovation behavior of actors from an institutional perspective. This is also because the concepts of institutional rules and institutionalization (i.e., institutional change) are difficult to measure with quantitative methods and are predestined for research that uses qualitative methods. The findings of this study show that institutions have a significant influence on how certain groups of actors can participate in service innovation processes and are therefore an important variable when attempting to understand the differences in the innovation behavior between actors, industries, and markets.

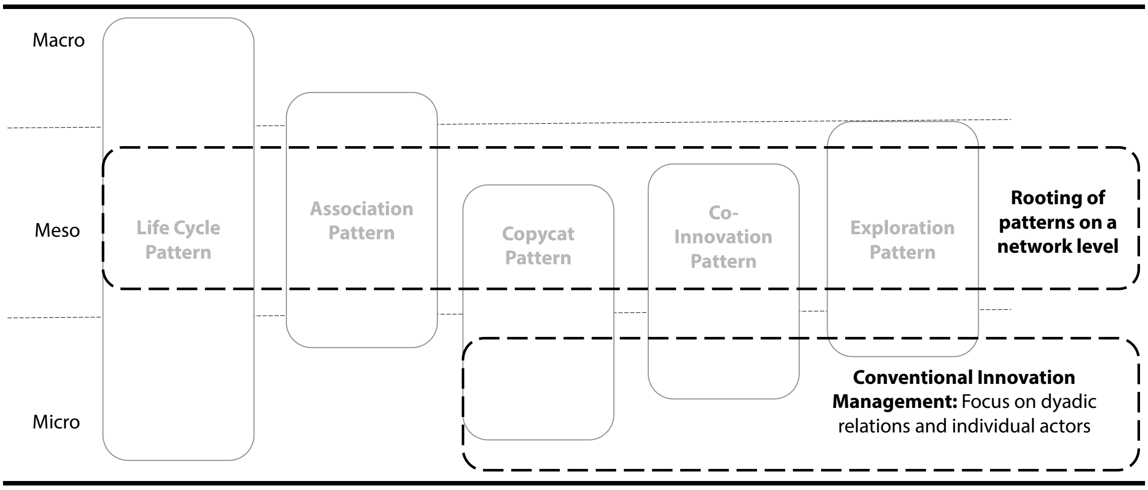
In summary, the typology proposed in this study complements findings from previous taxonomy research in several respects. While the presented typology is consistent with the finding that service innovation processes in KIBS industries are subject to a considerable heterogeneity, differences became apparent regarding a more distinct focus on the identified types of engineering services, the network-centric and systemic understanding of service innovation, as well as regarding the employed conceptual perspective.

7.2.3 Systemic Positioning of Service Innovation Patterns Compared to Classic Innovation Management

The findings of this study show that service innovation processes in the AES industry rely on interactions between ESPs and different actors from their network. The networked and interactive nature of service innovation is illustrated by the fact that the five patterns are all rooted in the systemic meso-level (cf. Fig. 7-2). The *Lifecycle Pattern* shows that ESPs also innovate within specific market trajectories that are determined and driven by forces and developments at an even higher systemic level of the service ecosystem. Such forces often relate to technological advances or broader changes in market practices and norms.

The findings of the current study contrast with the analytical focus and conceptual interpretation of service innovation, to be found in the established literature on innovation management, which is still narrow and often focused on linear innovation processes in individual firms or dyadic relationships (Kindström et al. 2013; Ordanini and Parasuraman 2011). Fig. 7-2 illustrates that most of the innovation management literature is still located on a systemic micro-level. The narrow conceptual understanding also leads to a narrow analytical scope that seldom considers the interdependencies between the innovation behavior of individual actors and changes in their business environment (cf. Carlborg et al. 2014). Obviously, a significant discrepancy exists between how service innovation processes occur in real-world contexts and how they are examined in the literature. As digitalization leads to a growing significance of networks in social and economic contexts (Nambisan and Sawhney 2007), this discrepancy appears to be further increasing.

Fig. 7-2 Systemic Positioning of Service Innovation Patterns Compared to Traditional Innovation Management



As a result of the analysis of the interview data, it became apparent that one limitation of the current literature on innovation management is related to the assumption that an innovation outcome is the result of purposeful and controlled innovation activities. However, the findings of this study show that ESPs have only limited control over service innovation processes. In fact, in the AES industry, it becomes especially obvious that the control and influence over service innovation processes are shared among different actors, who innovate collectively, based on a high level of mutual trust and a certain degree of common interest. Such a decentralized innovation setting is more complex and dynamic than a production-centric understanding of unidirectional innovation processes in which firms can plan and implement the steps leading to a new product or service and then finally launch it on the market.

As the innovation management literature currently lacks adequate concepts and theories to explain and describe service innovation processes in a networked, decentralized and complex innovation setting, the interest among scholars in an S-D logic perspective grows. Given the recent movement of S-D logic towards generic actor-to-actor networks and a systemic view of service innovation in service ecosystems, the S-D logic seems to be currently evolving in a direction that is more compatible with the innovation landscape of the digital age than previous literature in innovation management.

7.3 Relations to the Literature on S-D Logic

This section reflects on the findings of the current study in the context of recent publications that have extended S-D logic by adding a service ecosystem perspective on innovation. The service ecosystem perspective invokes a broader conceptual interpretation of service innovation beyond outputs, linear processes, and even beyond networks (Lusch and Nambisan 2015; Vargo et al. 2015). It emphasizes innovation as a process of reconfiguring institutional structures and resource integration practices in service ecosystems. The roles of interactions and institutions in service ecosystems are interlinked: interactions enable actors to engage in the renewal and disruption of institutions, and institutions determine the interactions among actors in networks and thus also how the different actors in a service ecosystem can engage in service innovation (Vargo et al. 2015). This thesis extends the existing understanding of a service ecosystem perspective on innovation by conceptualizing five specific service innovation processes in the AES industry that identify the interdependent nature and dynamics of interactions, institutional change, and resource integration.

7.3.1 Networked Processes of Innovation in Service Ecosystems

An essential idea underpinning the service ecosystem perspective is to break away from the prescribed roles of a production-oriented economy (i.e., producer/consumer and innovator-/innovation-adopter) and to develop an unbiased and network-centric understanding of how multiple actors interact, integrate resources and engage in service innovation (Vargo et al. 2015; Vargo and Lusch 2011). The findings of this study extend recent conceptual thinking on a network-centric view along the following three themes.

Varying Activity Levels in Service Innovation Processes

The S-D logic argues that the traditional divide between firms, as innovators, and customers, as innovation-adopters, is oversimplified and that new role concepts are necessary to better understand how different actors in service ecosystems contribute to service innovation (Lusch and Nambisan 2015; Vargo et al. 2015). The present study provides insights on roles and actor constellations in the AES industry by revealing varying levels of activity at which

ESPs engage in service innovation. For example, the *Copycat Pattern* illustrates how ESPs retain control over most activities in the development of a new competence and actively promote change towards a specific customer. The underlying service innovation process reflects dyadic and unidirectional interactions (i.e., the innovation activities of the ESP are directed towards the customer). By contrast, the *Lifecycle Pattern* and the *Association Pattern* emphasize a primarily reactive role of the ESP. In these patterns, the innovation activities of ESPs are mainly a response to a broader reconfiguration of resource integration practices and actor constellations in service ecosystems. In the *Co-Innovation Pattern* and the *Exploration Pattern,* the active part of the process is not limited to a single actor. Instead, ESPs share the driving role with several other actors, who jointly decide on innovation activities and make different contributions.

In most of the identified patterns, the control over the service innovation process is shared by ESPs with several other actors (including the OEMs), which means that ESPs are not free to decide how to proceed in the innovation process, but need to coordinate their activities with the OEMs and other actors. Interactions are thus essential for the coordination of roles and innovation activities in service innovation processes in which various parties are involved. The lack of control, however, also shows that ESPs must deal with considerable uncertainties regarding the course and outcome of their innovation activities. A frequent argument in S-D logic literature (cf. Lusch and Nambisan 2015; Vargo et al. 2015) is that the conceptual divide between innovator and innovation-adopter is overly simplified and cannot adequately cover this networked nature of service innovation processes, in which a larger variety of actors make various contributions. Four of the five presented patterns offer substantive support for the network-centric understanding of service innovation of S-D logic, in that they show that both the actor constellations and the roles of different actors are more complicated and diverse than innovator and innovation-adopter. Only in the *Copycat Pattern* does the traditional divide seem to reflect the observed role constellation. In this pattern the innovation process is mostly driven and controlled by a single firm (an ESP), and the customer is mostly supporting and adapting. While, this specific pattern shows that the traditional divide between innovator and innovation-adopter may still be an adequate illustration of roles and interactions in specific service innovation processes, service innovation processes in the AES industry typically involve constellations of actors and roles that are more complex.

Decentral Service Innovation and Shared Control

The generic concept of A2A networks suggests that service innovation processes are not managed by individual actors (Barile et al. 2016; Vargo and Lusch 2011), but that the control over critical resources and activities is shared among a network of actors, all of whom contribute to service innovation in varying roles. The findings of this study confirm this decentralized interpretation of service innovation processes, as they underline the need for ESPs to coordinate their innovation activities with other actors from their network. The role of shared control in service innovation processes becomes strongly visible in the *Co-Innovation Pattern* and the *Exploration Pattern.* Both patterns show the innovation activities of ESPs are dependent on resources of customers and other actors from their network, so that they have to cope with a high degree of uncertainty regarding the course and outcome of the innovation process. For example, the *Co-Innovation Pattern* emphasizes that ESPs depend on the knowledge of OEMs about their requirements and service needs to develop individual solutions and service offerings. However, at the outset of the innovation process, these needs are often not well understood and first need to be explored, which requires close collaboration between ESPs and their customers. Furthermore, customers often suggest new requirements or ideas that cause innovation activities to alter. Shared control also becomes apparent regarding the fact that the interactions between ESPs and OEMs are not dyadic. They take place among constellations of multiple actors from different organizations with different aims and needs. For example, institutions and normative structures separate the technical department (as the primary service beneficiary) from the purchasing department, who decides whether value propositions are accepted or rejected. In such a setting, not only the innovation activities are under the shared control of different actors, but also the assessment and evaluation of innovation outcomes takes place in networked constellations.

Systemic View of Service Innovation

The service ecosystem perspective emphasizes service innovation as a process of reconfiguring service systems, service networks, and service ecosystems (Barile et al. 2016; Vargo et al. 2015). Actors, systems and entire networks of actors are thereby interacting with one another and with their environment to coordinate changes in institutional rules and resource integration practices as they co-evolve (Barile et al. 2016; Metcalfe 2010; Vargo et al. 2015). The five patterns presented in this thesis illustrate this systemic view of service innovation by conceptualizing interrelations between changes on different systemic levels (i.e., micro-, meso-, macro-level). The patterns show that actor constellations and resource integration practices in the provision of engineering services are subject to continual (incremental) changes that are enabled and propelled by interactions. These changes are the result of smaller improvements and adaptations in specific engineering projects that, over time, combine, and retrospectively become evident as substantial deviations from previous resource integration practices and as new behavioral patterns among actors. The *Lifecycle Pattern* and the *Association Pattern* show that ESPs typically evolve their competencies and service offerings in innovation trajectories that are determined by the general development of the market and guide and constrain the innovation activities of the ESPs. Changes in market demands are thereby often driven by changes in the OEM's sales markets. In fact, changes in the consumer preferences in the OEMs' own sales markets alter the contextual determinants by which OEMs assess engineering services in the market, which underlines market interdependencies that exist through interconnections between actors on different levels of institutional context (Wieland, Vargo, et al. 2016). For example, the value of traditional mechanical engineering services has declined while new service offerings in the field of electronics and IT are now more in demand. In this way, changes in the beliefs, values, and preferences of customers in the OEMs sales markets create trajectories for service innovation in the AES market. Innovation activities of ESPs thus typically address market demands that are predicted to grow in importance. In this regard, ESPs increasingly recognize that in order to anticipate market change, it is vital for them to look at the sales markets and the business environment in the same way their customers do, although ESPs point out that they often struggle when trying to do this.

7.3.2 Institutions and Institutional Change in Service Ecosystems

The S-D logic emphasizes the need for empirical research to better understand how innovation in service ecosystems unfolds as a process of reconfiguring the institutionalized rules of resource integration (Vargo et al. 2015). The presented patterns respond to this call by contributing to a better understanding of how actors engage in the disruption and renewal of institutions (specifically for the AES industry) by illustrating the roles of ESPs in processes of institutional change. Findings highlight the need to consider more carefully asymmetries in the distribution of institutional power in service ecosystems that have a significant influence on how actors engage in institutional work and service innovation.

Institutions as Constraints and Enablers of Service Innovation

S-D logic emphasizes the coordinating function of institutions in service ecosystems (Vargo and Lusch 2011, 2016). For example, Koskela-Huotari et al. (2016) point out that service innovation processes not only mean institutional rules are broken and replaced, but also that some existing rules are maintained. The coordinating function of institutions in service ecosystems has become especially apparent in the AES industry, where the resource integration practices of ESPs and OEMs, as well as their mutual interactions, are enabled, guided, and constrained by a tight set of institutional rules and practices. ESPs and OEMs have a shared understanding of these institutional arrangements, which is emphasized by interviewees, who highlighted a typical automotive attitude among managers in the AES industry. From the perspective of the ESPs, institutional rules are often seen as obstacles to their innovation activities, e.g., because governance mechanisms in procurement processes demand (for comparability of service offerings) least three different competing providers. Some of these rules and norms may be designed explicitly by OEMs to suppress the capabilities of ESPs to distinguish themselves from competitors (in other ways, apart from on price) and, thus, to avoid dependencies from the service offerings of single service providers. When ESPs develop new service offerings or try to evolve their resource integration practices and roles in the interaction with their customers, they need to adhere to these institutional rules, which makes them crucial to understand their innovation behavior.

On the other hand, the findings of this study show that institutions are also enabling service innovations, in that they create the foundation for joint innovation activities between ESPs and OEMs. For example, interviewees indicated that the shared institutional logic of service ecosystems makes the behavior of actors in service innovation processes, to some extent, predictable and allows them to anticipate and target the future needs of their customers (cf. Vargo and Lusch 2016). By recognizing and understanding the patterns in the behavior of other actors from their service ecosystem, ESPs can develop procedures and strategies to circumvent certain innovation constraints. This is, for example, shown in the case of XTEC, who use a specific approach to overcome the typical Not-Invented-Here phenomenon. Furthermore, findings suggest that in some cases institutional rules need to be broken and renewed on a broader scale before specific groups of actors can attain a position in their service ecosystem, which allows them to assume a more active role in service innovation processes. For example, the specific case of SIMULI (cf. section 2.3.4) shows that recent changes in the legal regulation of engineering contracts and collaboration modes have created new opportunities to build up knowledge and operational capabilities that are useful in developing more compelling value propositions. These changes also allow SIMULI to transfer service offerings and competencies to new customers and markets.

Asymmetries of Institutional Influence in Service Ecosystems

The findings of this thesis illustrate service innovation to be a process of institutional change (Vargo et al. 2015), by conceptualizing the different roles in which ESPs contribute to the disruption and renewal of institutions in specific types of service innovation processes. The existing literature on S-D logic has mostly focused on actors that are in a dominant position in service ecosystems and whose innovation activities direct the resource integration practices of other actors (cf. Koskela-Huotari et al. 2016). Such a focus implies that actors innovate by purposefully breaking, making, and maintaining institutional rules (cf. Koskela-Huotari et al. 2016; Vargo et al. 2015). For example, Koskela-Huotari et al. (2016) describe how a large food retailer changes the market structure by breaking and enacting rules on the design and management of a supermarket. In the AES industry, ESPs state that they are not capable of changing the market structure. Instead, changes in markets primarily occur through technological developments and changes in the preferences of the OEMs, who frequently enact new rules and norms that then require ESPs to adapt their resource integration practices and value propositions. These findings emphasize the need to consider asymmetries in the institutional influence of actors in service ecosystems in order to understand the innovation behavior of different groups of actors. In fact, ESPs belong to a group of actors whose institutional influence is in several respects limited by the existing institutional logic. Three dominant *roles in the renewal of institutions* were conceptualized in this thesis (cf. the analytical framework in section 5.4). These roles show that, unlike the OEMs, ESPs cannot directly dictate the resource integration activities and the behavior of their customers. Instead, the institutional influence of ESPs is primarily indirect, such that they typically assume a role in service innovation processes, in which they mainly adapt their behavior to broader institutional change (*Synchronizer*); incentivize customers to deviate from familiar practices and rules (*Stimulator*); or exert a subtler influence by consulting their customers on how to design specific practices and rules (*Co-Designer*). These roles demonstrate that ESPs are typically not driving substantial changes in the institutional logic of their service ecosystem. However, ESPs can facilitate innovation in service ecosystems by supporting, stimulating, and sometimes triggering the innovation activities of the OEMs. From an institutional perspective, the institutional influence of ESPs is thus rather indirect. The findings are consistent with previous studies that indicate that KIBS firms often lack institutional influence and control (Agarwal et al. 2003) and that they are thus particularly reliant on collaboration with partners, who are often more powerful and better positioned (Romero and Molina 2011). The findings highlight the importance of considering the role of institutional power in networked actor constellations. However, more research attention should be given in future studies to this variable in order to gain a more differentiated understanding as to how differences in the distribution of power and control among the population of service ecosystems can lead to different service innovation patterns.

7.4 Chapter Conclusion

In this chapter, the findings of this research were compared and contrasted with the existing body of knowledge on service innovation. The discussion differentiated between the established literature on innovation management and the literature on S-D logic. The five presented patterns were compared with innovation taxonomies and typologies from the KIBS-specific literature on innovation. In doing so, it was shown that the five patterns incorporate and validate several concepts and patterns that were described in previous studies. However, they complement the previous findings with a more detailed conceptual process description that illuminates the links between interactions, institutions, roles, and activities. Moreover, the chapter showed how the findings of this study underpin the recent discussion on an S-D logic perspective on service innovation. They provide insights on asymmetries in institutional influence and shared control in service ecosystems. These topics have been discussed separately from innovation in other research domains (e.g., Choi et al. 2001; Lawrence 2008), but are not yet integrated into the service ecosystem interpretation of S-D logic. With the increasing network focus of S-D logic, such an integration becomes increasingly important.

8 CONCLUSION

8.1 Chapter Introduction

This chapter concludes the study by revisiting the research questions and discussing theoretical implications. Furthermore, it describes managerial implications, which are useful to practitioners in the AES industry to gain a better understanding of the varying roles in which ESPs engage in service innovation. Moreover, this chapter discusses the limitations of this study and points out fruitful avenues for future research.

8.2 Revisiting the Research Questions

This research set out with the objective of applying the S-D logic to the investigation of service innovation processes in the networked and collaborative business environment of the German AES industry. Three research questions were derived from this overarching objective. The first research question (RQ1) asked *"How can service innovation processes in the AES industry be categorized?"* This question was addressed by this research with the development of a typology of service innovation processes. The typology comprises five innovation patterns as reflected in the empirical data *(Lifecycle Pattern, Association Pattern, Copycat Pattern, Co-Innovation Pattern, and Exploration Pattern)*. The typology is rooted in the dimensions and characteristics of an analytical framework. Patterns are characterized by a specific combination of dimensions and characteristics and can be distinguished from other types by this combination. The typology provides a common structure for the description and discussion of service innovation processes in the AES industry, which also illustrates differences in the innovation behavior of ESPs.

In addressing the second research question (RQ2), *"How do ESPs interact with other actors from their network in the course of service innovation processes?"*, the study proposes four essential modes of interactions (cf. Tab. 5-2): *Adapting along Evolutionary Pathways, O-utlining Value Co-Creation Possibilities, Moderating Co-Creation Processes* and *Brokering Kn-owledge.* The different modes conceptualize specific patterns identified with respect to how ESPs interact with actors in networks during service innovation processes. The modes highlight differences regarding the direction of the interactions, the activity level of the ESPs, and the specific groups of actors involved. The differences in the way how ESPs interact with other actors from their network became evident as a differentiating variable in service innovation processes. Therefore, interaction modes were incorporated into the analytical framework as a separate dimension.

The third research question (RQ3) asked: *"How are service innovation processes interlinked with changes in institutions and institutional arrangements?"*. Regarding this research question, this study offers a more complex set of answers. In general, the findings of this study have shown that service innovation processes in the AES industry are triggered and propelled by institutional changes that emerge on a systemic macro-level. Such changes are beyond the direct influence of the ESPs (e.g., as described by the *Lifecycle Pattern*), whose role is primarily to continually synchronize their behavior to the institutional logic of the service ecosystem. ESPs thus need to ensure that they develop their value propositions, resource integration practices, and competencies in ways that allow them to fulfill the requirements and expectations of their customers. Their innovation activities focus on stimulating institutional changes or co-designing institutional rules in close collaboration with the OEMs (e.g., described by the *Co-Innovation Pattern*). However, these changes are typically incremental and do not exert much influence on the general institutional logic of the organizations' service ecosystem. Furthermore, the impact of recent changes in the regulation of contracts on the AES industry also shows that even the renewal of a limited area of institutional rules may trigger a substantial reconfiguration of the roles of multiple actors in service ecosystem and influence the capacity of actors to engage in service innovation.

8.3 Theoretical Implications

This thesis has used the service ecosystem perspective from S-D logic to examine processes of service innovation in the German AES industry. The findings are substantive in that they are grounded in extensive empirical data – primarily in-depth interviews with ESPs and OEMs. As opposed to theory testing, this study followed the exploratory aim of developing new theoretical concepts. The two central concepts developed within this study are: first, an analytical framework with dimensions and characteristics, and second, a service innovation process typology (i.e., the patterns) that is linked to detailed conceptual process descriptions. The patterns complement the existing literature, which has often considered service innovation as a series of systematically implemented activities in the development of new service offerings (Carlborg et al. 2014; Droege et al. 2009). Moreover, the findings integrate various concepts and themes from a broader and more dynamic perspective of innovation in service ecosystems that extends beyond linear, firm-centric R&D processes and which embraces interactions in multi-actor constellations and networks (Lusch and Nambisan 2015; Ostrom et al. 2015; Vargo et al. 2015). Such a systemic view of innovation becomes increasingly essential in the digital age, as firms no longer innovate within the confines of their organization, but instead need to interact and collaborate with other actors from their network (Lusch 2011; Lusch and Nambisan 2015; Ostrom et al. 2015). The results of this thesis contribute to a better understanding of service innovation processes in the specific AES domain, but additionally they expand and complement the recent theoretical discussions of a service ecosystem perspective on innovation (Carlborg et al. 2014; Lusch and Nambisan 2015; Vargo et al. 2015), providing new concepts and opinions, and, most importantly, new empirical insights.

The study extends recent conceptualizations of innovation as a collaborative process in service ecosystems (Vargo et al. 2015), by demonstrating that the innovation behavior of ESPs in the German AES industry relies fundamentally on interactions and collaborative activities with other actors from their network. The roles of ESPs and their interactions with other actors that were conceptualized in this study underline the need for a more decentralized understanding of service innovation. In fact, the processes that lead to innovation in the AES industry are not entirely controlled by individual parties. Instead, control and influence over critical innovation activities are often distributed amongst several actors and may change in the course of the service innovation process. The five patterns that were presented in this study offer a more detailed description of actor constellations and innovation processes and a conceptualization of the role of ESPs. They show that the role of ESPs in these processes varies, with respect to the activity level and the extent of control. Furthermore, the five service innovation patterns reflect actor constellations and role configurations of varying complexity, ranging from dyadic relationships (i.e., ESP-OEM) to more complex formations in which entire networks of actors are involved. The research showed that the setting of an innovator and an innovation-adopter is only one specific constellation (i.e., the role of the firm is active, the customer is passive) among several other possibilities. Hence, scholars should approach service innovation processes with an open mind that neither overemphasizes nor neglects specific actor constellations.

Recent conceptualizations of innovation processes in service ecosystems emphasize that the interactions between actors are essential because they allow actors to engage in processes of institutional change and renewal, which enable service innovation (Vargo et al. 2015). The five patterns that were presented in this study confirm this link by showing that differences in the way ESPs interact with other actors in service innovation processes also influences the role of ESPs in the renewal and change of institutions. ESPs interact with various actors, such as universities, start-ups, but most critical for their innovation activities are the interactions between the ESPs and the OEMs. These interactions often take place during the provision of engineering services. In this respect, the selection of customers and the engagement with other actors during service provision are important variables that influence the innovation capabilities of ESPs. This is, for example, shown by the fact that some customers tend to be more open to ideas from external service providers than others do. Changing the mode of collaboration during service provision or the constellation of actors involved can therefore exert a significant influence on their innovation capabilities. In this regard, recent changes in the reconfiguration of work modes in engineering projects have, on the one hand, reduced the intensity of interactions, but, on the other, they have expanded the capacity of ESPs to recombine resources and competencies. These findings extend recent academic thoughts on innovation in service ecosystems as a process of changing and renewing institutions and institutional arrangements (Vargo et al. 2015; Vargo and Lusch 2014), by offering insights into the different roles of actors in such processes.

The principle tenet of S-D logic is that for innovations to occur, at least some actors need to work towards the disruption and renewal of institutions and institutional arrangements (e.g., Koskela-Huotari et al. 2016; Vargo et al. 2015), by enacting and enforcing rules that encourage other actors to change their behavior. So far, the literature on service ecosystems has paid little attention to asymmetries in institutional power and control. Recent studies that employ S-D logic and an institutional view of service innovation have focused solely on actors in dominant positions, who can orchestrate the roles and resource integration activities of other actors by enacting new rules or switching to a new role in the interaction (e.g., Aal et al. 2016). By contrast, this study has analyzed how ESPs can innovate and influence institutional rules as a group of actors who are in a less dominant position than their customers. Findings show that ESPs additionally contribute to the disruption and renewal of institutions, but more subtly and indirectly than described by previous studies (e.g., Koskela-Huotari et al. 2016). They rely on a close collaboration with their customer, who is much more influential. Changes in resource integration practices and value propositions can thus only be made with consent between the ESP and the OEM. In contrast, the findings indicate that actors might be able to extend their institutional influence when they establish and maintain relationships of trust with other actors (who are more powerful) from their service ecosystem. The restricted direct institutional influence of ESPs suggests the importance of embracing the individual roles of actors in service ecosystems and acknowledging the existence of asymmetries in institutional power and control.

8.4 Managerial Implications

The results of this study show that the development networks of the German automotive industry are frequently exposed to interactions with networks of other industries. ESPs must adapt more rapidly to new market changes and technological trends. In this dynamic environment, they do not only pursue different development paths, but increasingly act in a more autonomous role in the market, which additionally fuels the dynamics of the network. However, many changes in automotive technology are still ongoing. Radical technological progress in the areas of mobility services, autonomous driving, and electric mobility are far from being fully implemented and will continue to transform the automotive industry in the coming decades. This means that several further changes to the business environment of the ESPs are ahead. At the same time, OEMs become more reliant on the innovation impulses of the ESPs, as they reduce their own involvement in several of the traditional engineering activities, which they have previously carried out. For the ESPs, it becomes more significant to assume a more active role in the market, in which they not only adapt to their environment but make active contributions to the development of more compelling value propositions. In this regard, the results of this research entail practical implications for managers and decision makers – both from ESPs and OEMs – as described in the following paragraph.

ESP managers need to remember that service innovation processes are not entirely under their personal control, but are dependent on the interactions with other actors in networks. This implies the necessity for managers to develop a more comprehensive view of innovation activities within the organization, beyond those designed to meet existing market demands. However, ESPs are under tremendous pressure to adapt to the constantly changing competence requirements and service demands of their customers. The five presented conceptual elaborations of roles, interactions, and activities in service innovation processes offer managers a basic orientation regarding possible suggestions, as to how to engage in service innovation and how to cope with a high degree of uncertainty, regarding the course and outcome of service innovation processes. The conceptual models of the patterns can guide managers and employees through their innovation activities and help them to overcome problem phases and challenges in service innovation processes. Furthermore, the compilation of patterns in the typology offers an overview of the various roles that ESPs can assume in service innovation processes. In this regard, the comparison between XTEC and SIMULI has also shown that some ESPs favor specific roles and innovation activities, without mentioning others, which suggests that practitioners are not fully aware of the spectrum of possible roles and opportunities in service innovation. In this regard, the outlined link between specific roles in service innovation processes and the modes of interaction can guide managers to take more deliberate and conscious actions, with respect to their collaboration with other actors.

The findings of this study offer suggestions for ESPs how to engage in a more active role in service innovation processes. First, by creating ideas jointly with customers in an early phase before requirements are fixed, ESPs can increase the chances that the outcome of service innovation processes will be supported by the customer. This is particularly essential in order to avoid OEMs taking an overly critical stance against ideas whose origin lies outside their organization. ESPs can integrate customers in an early phase of idea development and thereby allow them to identify with the ideas and outcomes of joint innovation activities. Second, ESPs need to align their innovation activities with the general market trajectories that are often linked to the development paths of technological changes. ESPs will find greater support and interest of customers when they address and integrate topics which become more significant in the market. ESPs need to be able to recognize and become familiar with topics of growing relevance before they become everyday market demands; this may require interactions with actors from outside the automotive industry.

Combining and recombining various resources and competencies in service innovation processes is vital and requires ESPs to create an environment within the organization that facilitates interactions among employees in atypical constellations in which the density and heterogeneity of resources are high. ESPs also need to establish internal guidelines and rules in the organization that help managers and employees to assess innovation opportunities quickly and to encourage them to pursue their own pathways. However, the case of SIMULI shows that in times of large-scale and rapid transformations of the business environment, a more centralistic approach with top-down coordination is another option to guide the organization through significant changes.

The findings highlight the link between interactions and the capacity of ESPs to actively endorse service innovation processes. The recent trend in the AES industry towards a model of service provision, in which OEMs are less involved, gives ESPs more freedom in the organization and management of engineering activities during service provision. However, it also limits the exchange of information and knowledge between the two sides, thus potentially preventing ESPs from engaging in service innovation. Given this trend, it becomes crucial for ESPs to create additional interaction possibilities and to open up new lines of communication that allow them to exchange information and knowledge with customers beyond the daily project business. In this regard, recent attempts by ESPs to facilitate dynamic interactions with various actors via community meetings already reflect such an approach. Furthermore, the specific case of XTEC's Innovation Studio illustrates how ESPs can succeed in this regard. This also shows that actors can innovate their innovation procedures by changing the way they interact with other actors in service ecosystems. For ESPs it may, therefore, be an option to first stimulate novel forms of interactions and communication, before performing more specific activities aimed at innovation. In order words, changing interactions may be seen as a critical step of the service innovation process itself.

Finally, the findings of this study have implications for OEM managers and policymakers. They should be aware that changing the institutionalized mode of collaboration in service ecosystems has an extensive impact on the innovation capabilities of the different groups of actors. For example, the case of SIMULI shows that the legally enforced changes in collaboration between OEMs and ESPs in engineering projects has expanded their capacity to engage in service innovation. At the same time, OEMs have made it more difficult for ESPs to be distinguishable, when compared to their competitors (apart from in price), by tightening the rules of their procurement processes, which counteracts the ESPs' attempts to assume an active role in service innovation processes. While the S-D logic emphasizes that service innovation means that organizations strive for better ways to serve their customers, such OEM behavior makes it extremely difficult for their ESPs to actually find better ways to serve them. Given the fact that OEMs seem increasingly dependent on external innovation impulses, it would be advisable for them to design the rules and practices in their service ecosystems in ways that not only lead to a high cost pressure on their suppliers, but also encourages competition among ESPs and suppliers, based on the value and innovativeness of their service offerings.

8.5 Limitations

Service innovation is a complex phenomenon that has been studied in a broad range of empirical contexts and from different conceptual perspectives. This research is one of the first to apply the service ecosystem perspective to innovation in KIBS. Especially in exploratory research, the researcher is always an external observer, who attempts to make sense of the world by connecting certain elements and findings (Yin 2014). However, the choice of concepts and the method of interpretation are made, these are always in some way dependent upon the researcher's personal interest and understanding of the research subject. Not only may other researchers have focused on different concepts and findings, but they may have also come to different interpretations and conclusions. Therefore, this research is automatically restricted to a certain extent by some limitations regarding the research approach and the generalizability of its findings.

A first limitation concerns the conceptual interpretation of service innovation. In the established literature of innovation management, innovation outcome is typically assessed by the degree of novelty. For example, researchers have differentiated between radical and incremental innovations (e.g., Gallouj and Weinstein 1997; Sundbo and Gallouj 2000). In service ecosystems, innovation is instead defined by changes in the institutionalized practices of resource integration and the way actors co-create value (Lusch and Nambisan 2015; Vargo et al. 2015). This systemic perspective focuses on the process of innovation rather than the outcome (Capra and Luisi 2014; Vargo et al. 2017). Instead of assessing the degree of novelty of the outcome, the focus of this study was therefore on the analysis of activities, process steps, roles, institutions and interactions that lead to sustainable changes in the way ESPs and other actors integrate resources and co-create value in the provision of engineering services. The higher level of abstraction of S-D logic has enabled a more holistic conceptualization of service innovation processes, but has also revealed some lack of operational clarity about what innovation in engineering services is and how it differs from organizational change in general. If organizations are changing internal institutional rules and practices, can these activities be understood as part of service innovation processes in service systems and service ecosystems? Since the S-D logic literature promotes such a broader and process-oriented conceptual perspective (cf. Pohlmann and Kaartemo 2017), this limitation generally concerns the application of the S-D logic to empirical research on service innovation.

A second limitation concerns the research methodology, specifically the approach taken to the collection and analysis of the empirical data. In this study, data was mainly collected in the form of in-depth interviews with ESPs and OEMs. The understanding of service innovation processes was gained by analyzing the data with a focus on two specific individual organizations (XTEC and SIMULI), and complemented with a broader range of organizations, including multiple OEMs and ESPs. The network-centric understanding of service innovation processes was thereby developed by discussions with the interview participants about the interactions and collaborative activities between ESPs and other actors. However, some of the actors that are involved in such constellations were not explicitly considered in the data collection and only derived from the statements of the ESPs and OEMs. It cannot thus be excluded that more extensive data collection may lead to different results, especially with respect to the roles of actors in service innovation processes apart from ESPs and OEMs. Furthermore, the findings presented in this study were mostly obtained by analyzing and comparing the statements of different participants, who reported retrospectively on their personal observations, behaviors, and experiences. These statements referred to varying innovation contexts and timeframes. The findings of this study are thus a general representation of service innovation processes in the AES industry, but cannot claim to reflect the activities or interactions of actors in more specific innovation settings (e.g., a project).

A third limitation concerns the analysis and interpretation of the data. Given the large number of topics identified during the research process and the comprehensiveness of the S-D logic perspective on service innovation, it was not possible to integrate all themes and concepts that were identified in the interviews in this research. Instead, the presented types of service innovation processes reflect those patterns that recurred during the analysis of the interviews and appeared most significant based on the statements made by the interviewees. Nevertheless, the typology of service innovation processes is not to be considered fully comprehensive and may only illuminate a fraction of the diverse ways in which ESPs engage in service innovation. In addition, more fine-grained models of the service innovation processes could have been developed. In the end, the number of patterns that was considered in the typology is a tradeoff between manageability and preciseness (Bailey 1994, pp. 14–16). It may further be noted that the analysis of the data was carried out by a single researcher. Thus, much of the interpretation of the data depends on the author's knowledge of the research subject. However, this is a general shortcoming which applies to all interpretative case study research (cf. Klein and Myers 1999).

The outlined limitations should be viewed against the background of the exploratory nature of this study. By employing S-D logic in the study of service innovation in the specific KIBS domain, this research has entered new territory, so that few guidelines were available in the research process, e.g., regarding the application of the service ecosystem concept or the detection of service innovation patterns. As will be discussed in the next section, the outlined limitations represent fruitful avenues for future research.

8.6 Research Outlook

In recent years, the growing popularity of the S-D logic and its service ecosystem perspective have inspired significant changes in the theoretical understanding of service innovation (Carlborg et al. 2014; Lusch and Nambisan 2015). However, despite the increasing number of scientific contributions, there is broad agreement that research into innovation processes in service ecosystems is still in its infancy and thus requires further academic efforts (Ostrom et al. 2015; Vargo et al. 2015). With the conceptualization of innovation patterns in the AES industry, this study takes a first step towards an empirically grounded and S-D logic-based understanding of service innovation processes in KIBS. Given the complexity of the subject, however, it cannot be claimed that this phenomenon is now fully understood. For this reason, this thesis concludes by presenting seven research areas on the study of innovation in service ecosystems that have become evident from the results of this study (Tab. 8-1).

Tab. 8-1 Overview of Possible Research Avenues

Research Avenues
1) Theory development regarding roles and contributions of actors in institutionalization processes
2) Incorporation of institutional thought into S-D logic
3) Theory development regarding the outcome of service innovation patterns
4) Longitudinal studies of service innovation strategies
5) Conceptualization of typologies and service innovation patterns across industries
6) Follow-up research on possible linkages between service innovation patterns
7) Elaboration of methodological guidelines for employing S-D logic to study innovation

First, this study has drawn attention to the fact, that actors, who operate in different roles, vary regarding their institutional influence. Hence, the assumption that all actors can instigate new institutional rules would be oversimplified. In this regard, this research has outlined some general differences in the ways ESPs interact with OEMs to stimulate institutional change. Future research can examine the influence of asymmetries in power and control on the innovation behavior of different actors in service ecosystems. Service innovation in the AES industry typically takes place in multi-actor constellations, in which changes in the role of ESPs require consent and close coordination with assorted other parties, e.g., with the purchasing and the specialist department of the OEM. Future studies should focus even more specifically on the interactions and the evolution of roles in such multi actor constellations and consider the differences in the institutional power of different actors. In the AES industry, for example, future work could study the interactions between ESPs and OEMs on the level of departments and project teams, and, in this way, complement the findings of the present study. Modelling interactions and role changes among specific constellations of actors could be a fruitful approach to better understand how actors participate in institutionalization processes and how their institutional influence evolves.

Second, the integration of institutional thought into S-D logic should also advance on a theoretical level. However, the literature on institutional theory is extensive and divided into different research streams. Vargo and Lusch (2016) have made an initial effort to integrate institutional thought into S-D logic by outlining different institutional streams of thought across academic disciplines. The different streams provide scholars with various possibilities to further develop and expand the service ecosystem perspective and improve our understanding of service innovation. For example, the literature on institutional theory in politics and economics (e.g., Giesler 2008; Scott 2008) may be useful in identifying and differentiating institutional logics that correlate with specific behavioral patterns in the innovation behavior of actors and networks. Another fruitful pathway is provided by the literature on institutional work (e.g., Battilana et al., 2009; Lawrence and Suddaby, 2006). Notions and concepts from this stream, such as "institutional entrepreneurship" (DiMaggio 1988), may help scholars to understand how organizations and individuals proceed to broaden their institutional influence and establish new rule systems (Vargo and Lusch 2016).

Third, building on the previous remarks, the theoretical foundation of the outcome of service innovation processes also represents a fruitful field for future research efforts. The conceptualization of innovation patterns in this study has set a distinct focus on the process of service innovation. Future research can study more specifically the outcomes of different innovation patterns, for example, to improve the understanding of specific patterns on the configuration of institutional rules and resource integration practices, but also on the success and firm performance of individual actors in service ecosystems. The comparison between XTEC and SIMULI shows that significant differences exist regarding the focus of ESPs on specific service innovation processes. Future research can thus contribute to advancing the existing understanding of the impact of a distinct focus on specific roles in service innovation processes on corporate success. Studying the relation with innovation outcomes would also address the fundamental question to what extent traditional conceptualizations of innovation outcomes (e.g., incremental and radical innovation) in the innovation management literature are compatible with the service ecosystem perspective. In fact, recent conceptualizations from the S-D logic literature indicate that new approaches may be needed to capture and conceptualize different innovation outcomes in service ecosystems based on changes in institutional rule systems and the recombination of resources (cf. Lusch and Nambisan 2015).

Fourth, equipped with a better understanding of how ESPs engage in service innovation, scholars can now conduct empirical research to develop a more holistic understanding of the strategies that ESPs employ to expand their institutional influence in service ecosystems. In particular, there is a need to understand the communication and interaction strategies of ESPs with which they can innovate their services, despite the restrictions of stringent institutional rules. In this regard, the multi-actor relations and interactions between ESPs, technical departments, and purchasing departments in service innovation processes also deserve more research attention. Advanced communication and interaction strategies should not only aim to demonstrate added value to the OEM's specialist departments, but must also consider the requirements of the purchasing department. Observing the activities, roles, interactions among specific constellations of actors over a longer period could be an approach to validate and supplement the service innovation patterns described in this study.

Fifth, given that the service ecosystems perspective should be broadly applicable and not limited to individual industries or specific types of actors, more exploratory research is required to detect innovation patterns and develop innovation typologies in other industries. As yet, empirical studies that employ the service ecosystem perspective have focused on large enterprises and a small number of industries, e.g., manufacturing industries. Given the claim of S-D logic to provide a meta-theoretical framework that is not limited in its usefulness and applicability to specific areas or types of actors (cf. Vargo et al. 2008; Vargo and Lusch 2011), future research should aim for more diversity and study service innovation in industries that are so far underrepresented in the literature (such as e.g., KIBS). Additionally, extending the service ecosystem understanding of innovation to additional KIBS domains seems vital, since previous research has noted significant differences in the innovation behavior amongst KIBS industries (Miles 2008; Miles et al. 1995).

Sixth, a further possible research avenue relates to the validation and further development of the presented typology of service innovation processes. While the service innovation patterns were conceptualized as distinct types, the findings also indicate the existence of interrelations between the patterns. For example, when ESPs collaborate with universities, or expand their networks, these activities are not only aiding specific innovation patterns, but also unfold their positive influence more broadly on the innovation capacity of the organization. On the other hand, there may also be interrelations between patterns with a negative influence. For example, cyclical forces on higher systemic levels may pose constraints to ESPs in completing other service innovation patterns. The full range of interdependencies between service innovation patterns is currently not well understood and would be deserved of further research attention. In addition, the results indicate some commonalities between service innovation processes, which offer starting points for splitting patterns into smaller sequences of steps and activities and to shed more light on their interdependencies.

Seventh, further efforts should be made to operationalize the S-D logic and to develop guidelines on its application in empirical studies. In its existing state, the axioms and premises of S-D logic provide scholars with a coherent meta-theoretical framework for the analysis of socioeconomic exchanges. The high degree of abstraction of the S-D logic is both a strength and a weakness at the same time. On the one hand, it ensures the applicability of the S-D logic in various contexts and in the study of various socioeconomic phenomena, including innovation. On the other hand, scholars find little orientation regarding the application and employment of the concepts in empirical research. Recent publications, which describe more explicitly the shift in perspective through S-D logic, have made the first step towards operationalizing the S-D logic (Vargo et al. 2017). However, further research efforts are required to develop guidelines on how scholars can incorporate the S-D logic in empirical research.

In summary, service innovation processes in service ecosystems are a research subject that is of growing significance in the digital age and at the same time – due to its complex nature – offers a variety of possible research avenues. In this research, a first step was taken to validate and complement the conceptual understanding of service innovation (which was grounded in the S-D logic), with empirical insights. However, further research is necessary, given that a more differentiated understanding of the innovation opportunities and the roles of actors is still lacking. In particular, the different positions of actors should be taken into account in future studies, as their institutional influence in service ecosystems varies widely. Such an improved understanding would be crucial for managers, in order for them to take more purposeful and targeted actions towards service innovation.

REFERENCES

Aal, K., Di Pietro, L., Edvardsson, B., Renzi, M. F., and Mugion, R. G. 2016. "Innovation in Service Ecosystems: An Empirical Study of the Integration of Values, Brands, Service Systems and Experience Rooms," *Journal of Service Management* (27:4), pp. 619–651.

Agarwal, R., and Selen, W. 2007. "Drivers of Elevated Service Offerings in Collaborative Service Networks," in *Proceedings of the 3rd Conference on Production and Operations Management Society*, London, July 12.

Agarwal, S., M. Krishna Erramilli, and Chekitan S. Dev. 2003. "Market Orientation and Performance in Service Firms: Role of Innovation," *Journal of Services Marketing* (17:1), pp. 68–82.

Akaka, M. A., and Vargo, S. L. 2013. "Technology as an Operant Resource in Service (Eco)Systems," *Information Systems and E-Business Management*, pp. 1–18.

Akaka, M. A., Vargo, S. L., and Schau, H. J. 2015. "The Context of Experience," *Journal of Service Management* (26:2), pp. 206–223.

Arthur, W. B. 2009. *The Nature of Technology: What It Is and How It Evolves*, New York: Simon and Schuster.

Audi. 2017. "Audi Technology Portal," *Electric/Electronics*. (http://www.audi-technology-portal.de/en/electrics-electronics, accessed October 19, 2017).

Bailey, K. D. 1994. *Typologies and Taxonomies: An Introduction to Classification Techniques*, Thousand Oaks: SAGE.

Baines, T. S., Lightfoot, H., Benedettini, O., Whitney, D., and Kay, J. M. 2010. "The Adoption of Servitization Strategies by UK-Based Manufacturers," *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture* (224:5), pp. 815–829.

Baines, T. S., Lightfoot, H. W., Evans, S., Neely, A., Greenough, R., Peppard, J., Roy, R., Shehab, E., Braganza, A., Tiwari, A., Alcock, J. R., Angus, J. P., Bastl, M., Cousens, A., Irving, P., Johnson, M., Kingston, J., Lockett, H., Martinez, V., Michele, P., Tranfield, D., Walton, I. M., and Wilson, H. 2007. "State-of-The-Art in Product-Service Systems," *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture* (221:10), pp. 1543–1552.

Balser, M. 2016. "Das Ziel Muss Heißen: Weniger Autos," *Sueddeutsche*, February 6. (http://www.sz.de/1.2850442, accessed October 19, 2017).

Barile, S., Lusch, R., Reynoso, J., Saviano, M., and Spohrer, J. 2016. "Systems, Networks, and Ecosystems in Service Research," *Journal of Service Management* (27:4), pp. 652–674.

Barile, S., Pels, J., Polese, F., and Saviano, M. 2012. "An Introduction to the Viable Systems Approach and Its Contribution to Marketing," *Journal of Business Market Management* (5:2), pp. 54–78.

Barnes, S. J. 2005. "Assessing the Value of IS Journals," *Communications of the Association for Computing Machinery (ACM)* (48:1), pp. 110–112.

Barrett, M., Davidson, E., Prabhu, J., and Vargo, S. L. 2015. "Service Innovation in the Digital Age: Key Contributions and Future Directions," *MIS Quarterly* (39:1), pp. 135–154.

Bask, A., Lipponen, M., Rajahonka, M., and Tinnilä, M. 2011. "Framework for Modularity and Customization: Service Perspective," *Journal of Business & Industrial Marketing* (26:5), pp. 306–319.

Battilana, J., Leca, B., and Boxenbaum, E. 2009. "How Actors Change Institutions: Towards a Theory of Institutional Entrepreneurship," *Academy of Management (ACM) Annals* (3:1), pp. 65–107.

Bauchmüller, M., Finke, B., and Markus, M. 2017. "Großbritannien Verbietet Autos mit Verbrennungsmotoren," *sueddeutsche*, July 26. (http://www.sz.de/1.3604849, accessed May 24, 2018).

Baynes, C. 2017. "Paris to Ban All Petrol and Diesel Cars by 2030," *Evening Standard*, October 12. (www.standard.co.uk, accessed October 19, 2017).

Bellos, I., Ferguson, M., and Toktay, L. B. 2017. "The Car Sharing Economy: Interaction of Business Model Choice and Product Line Design," *Manufacturing & Service Operations Management*, pp. 185–201.

Bernhart, W., Winterhoff, M., Hasenberg, J.-P., and Fazel, L. 2016. "Automotive Transition," Think Act, Munich: Roland Berger, March.

Beverungen, D., Lüttenberg, H., and Wolf, V. 2017. "Recombinant Service System Engineering," in *Proceedings of the 13th Conference of Information Systems*, St. Gallen: AISeL.

BGA. 1985. *Urt. v. 14.08.1985, Az.: 5 AZR 225/84*.

BGA. 2014. *Urt. v. 15.04.2014, Az.: 3 AZR 395/11*.

BGBI. 2017. *Gesetz Zur Änderung Des Arbeitnehmerüberlassungsgesetzes Und Anderer Gesetze Vom 1. April 2017, in: Bundesgesetzblatt. I, Nr. 8, S. 258*, p. 258.

Blöcker, A. 2016. "Branchenanalyse Entwicklungsdienstleister," Working Paper No. 17, Working Paper, Duesseldorf: Hans-Böckler-Stiftung, July.

Brown, J., and Wyatt, T. 2010. "Design Thinking for Social Innovation," *Development Outreach* (12:1), pp. 29–43.

Busse, C., Fromm, T., and Martin-Jung, H. 2017. "Route Geändert," *Sueddeutsche*, March 13. (http://www.sz.de/1.3417204, accessed May 2, 2017).

Cabigiosu, A., Zirpoli, F., and Camuffo, A. 2013. "Modularity, Interfaces Definition and the Integration of External Sources of Innovation in the Automotive Industry," *Research Policy* (42:3), pp. 662–675.

Camacho, J. A., and Rodriguez, M. 2008. "Patterns of Innovation in the Service Sector: Some Insights from the Spanish Innovation Survey," *Economics of Innovation and New Technology* (17:5), pp. 459–471.

Campbell, P. 2017. "UK to Allow Road Tests of Fully Driverless Cars by 2019," *Financial Times*, November 19. (https://www.ft.com/content/c6296054-cc82-11e7-b781-794ce08b24dc, accessed May 20, 2018).

Capra, F., and Luisi, P. L. 2014. *The Systems View of Life: A Unifying Vision*, New York: Cambridge University Press.

Carlborg, P., Kindström, D., and Kowalkowski, C. 2014. “The Evolution of Service Innovation Research: A Critical Review and Synthesis,” *The Service Industries Journal* (34:5), pp. 373–398.

Cassell, C., and Symon, G. 2004. *Essential Guide to Qualitative Methods in Organizational Research*, London: SAGE.

Chandler, J. D., and Vargo, S. L. 2011. “Contextualization and Value-in-Context: How Context Frames Exchange,” *Marketing Theory* (11:1), pp. 35–49.

Chesbrough, H. 2003. “The Logic of Open Innovation: Managing Intellectual Property,” *California Management Review* (45:3), pp. 33–58.

Choi, T. Y., Dooley, K. J., and Rungtusanatham, M. 2001. “Supply Networks and Complex Adaptive Systems: Control Versus Emergence,” *Journal of Operations Management* (19:3), pp. 351–366.

Clagett, R. P. 1967. “Receptivity to Innovation - Overcoming N.I.H.,” Thesis, Thesis, Boston: Massachusetts Institute of Technology.

Colfer, L. J., and Baldwin, C. Y. 2016. “The Mirroring Hypothesis: Theory, Evidence, and Exceptions,” *Industrial and Corporate Change* (25:5), pp. 709–738.

Constantin, J. A., and Lusch, R. F. 1994. *Understanding Resource Management: How to Deploy Your People, Products, and Processes for Maximum Productivity*, Oxford: Irwin Professional Pub.

Coombs, R., and Miles, I. 2000. “Innovation, Measurement and Services: The New Problematique,” in *Innovation Systems in the Service Economy*, Economics of Science, Technology and Innovation, Boston: Springer, pp. 85–103.

Creswell, J. W. 2003. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, (2nd ed.), Thousand Oaks: SAGE.

Czarnitzki, D., and Spielkamp, A. 2003. “Business Services in Germany: Bridges for Innovation,” *The Service Industries Journal* (23:2), pp. 1–30.

Day, G. S. 2004. “Achieving Advantage with a New Dominant Logic,” in “Invited Commentaries on ‘Evolving to a New Dominant Logic for Marketing,” *Journal of Marketing*.

DiMaggio, P. J. 1988. “Interest and Agency in Institutional Theory,” in *Institutional Patterns and Organizations: Culture and Environment*, Cambridge: Ballinger, pp. 3–21.

Droege, H., Hildebrand, D., and Forcada, M. 2009. “Innovation in Services: Present Findings, and Future Pathways,” *Journal of Service Management* (20:2), pp. 131–155.

Dubois, A., and Gadde, L.-E. 2002. “Systematic Combining: An Abductive Approach to Case Research,” *Journal of Business Research* (55:7), pp. 553–560.

Dubois, A., and Gadde, L.-E. 2014. “‘Systematic Combining’ - A Decade Later,” *Journal of Business Research* (67:6), pp. 1277–1284.

Dubois, A., and Gibbert, M. 2010. “From Complexity to Transparency: Managing the Interplay between Theory, Method and Empirical Phenomena in IMM Case Studies,” *Industrial Marketing Management* (39:1), Case Study Research in Industrial Marketing, pp. 129–136.

Dudenhöffer, F. 2015. "Altersprozess Beschleunigt," *Marke 41 Marketingjournal*, Marke 41, pp. 62–66.

Eisenhardt, K. M. 1989. "Building Theories from Case Study Research," *The Academy of Management Review* (14:4), pp. 532–550.

ElMaraghy, H., Schuh, G., ElMaraghy, W., Piller, F., Schönsleben, P., Tseng, M., and Bernard, A. 2013. "Product Variety Management," *CIRP Annals - Manufacturing Technology* (62:2), pp. 629–652.

Enkel, E., Gassmann, O., and Chesbrough, H. 2009. "Open R&D and Open Innovation: Exploring the Phenomenon," *R&D Management* (39:4), pp. 311–316.

Eurostat, N. 2008. "Rev. 2–Statistical Classification of Economic Activities in the European Community," *Office for Official Publications of the European Communities, Luxemburg.*

Evangelista, R. 2000. "Sectoral Patterns Of Technological Change In Services," *Economics of Innovation and New Technology* (9:3), pp. 183–222.

Evangelista, R. 2006. "Innovation in the European Service Industries," *Science and Public Policy* (33:9), pp. 653–668.

Freeman, C. 1995. "The 'National System of Innovation' in Historical Perspective," *Cambridge Journal of Economics* (19:1), pp. 5–24.

Friedland, R., and Alford, R. 1991. "Bringing Society Back In: Symbols, Practices and Institutional Contradictions," in *The New Institutionalism in Organizational Analysis*, Chicago: University Of Chicago Press, pp. 232–263.

Fromm, T. 2017. "BMW sucht seinen 'Tesla-Killer,'" *sueddeutsche*, September 7. (http://www.sz.de/1.3657270, accessed October 20, 2017).

Fromm, T., and Bernau, V. 2014. "Telekom Drängt Ins Vernetzte Auto," *sueddeutsche*, October 10. (http://www.sz.de/1.2166458-2, accessed October 22, 2017).

Frow, P., Nenonen, S., Payne, A., and Storbacka, K. 2015. "Managing Co-Creation Design: A Strategic Approach to Innovation," *British Journal of Management* (26:3), pp. 463–483.

Gallouj, F. 2002. "Innovation in Services and the Attendant Old and New Myths," *The Journal of Socio-Economics* (31:2), pp. 137–154.

Gallouj, F., and Savona, M. 2009. "Innovation in Services: A Review of the Debate and a Research Agenda," *Journal of Evolutionary Economics* (19:2), pp. 149–172.

Gallouj, F., and Weinstein, O. 1997. "Innovation in Services," *Research Policy* (26:4–5), pp. 537–556.

Gibbs, G. R. 2014. "Using Software in Qualitative Data Analysis," in *The SAGE Handbook of Qualitative Data Analysis*, Los Angeles: SAGE, pp. 277–294.

Giesler, M. 2008. "Conflict and Compromise: Drama in Marketplace Evolution," *Journal of Consumer Research* (34:6), pp. 739–753.

Giusto, P., Ramesh, S., and Sudhakaran, M. 2016. "Modeling and Analysis of Automotive Systems: Current Approaches and Future Trends," in *Proceedings of the 4th International Conference on Model-Driven Engineering and Software Development*, Rome: Scitepress, February, pp. 704–710.

Glazer, R. 1991. "Marketing in an Information-Intensive Environment: Strategic Implications of Knowledge as an Asset," *Journal of Marketing* (55:4), pp. 1–19.

Godin, B. 2006. "The Linear Model of Innovation: The Historical Construction of an Analytical Framework," *Science, Technology, & Human Values* (31:6), pp. 639–667.

Gropp, M., and Jung, M. 2018. "Urteilsbegründung: Fahrverbote sind Sofort Möglich," *FAZ*, May 18. (http://www.faz.net/1.5597177, accessed May 20, 2018).

Grunewald, M. 2015. "Beschaffungslogistik in der Automobilindustrie," in *Planung von Milkruns in der Beschaffungslogistik der Automobilindustrie*, Wiesbaden: Springer, pp. 9–32.

den Hertog, P. 2000. "Knowledge-Intensive Business Services as Co-Producers of Innovation," *International Journal of Innovation Management* (04:04), pp. 491–528.

Hipp, C. 2000. *Innovationsprozesse Im Dienstleistungssektor: Eine Theoretisch Und Empirisch Basierte Innovationstypologie*, (Vol. 40), Technik, Wirtschaft Und Politik, Heidelberg: Physica-Verlag.

Hipp, C., and Grupp, H. 2005. "Innovation in the Service Sector: The Demand for Service-Specific Innovation Measurement Concepts and Typologies," *Research Policy* (34:4), pp. 517–535.

Johnson-Laird, P. N. 2006. *How We Reason*, Oxford: Oxford University Press.

de Jong, J. P. J., and Marsili, O. 2006. "The Fruit Flies of Innovations: A Taxonomy of Innovative Small Firms," *Research Policy* (35:2), pp. 213–229.

Kaas, H.-W., Mohr, D., Gao, P., Müller, N., and Wee, D. 2016. "Automotive Revolution - Perspective Towards 2030," *Auto Tech Review* (5:4), pp. 22–25.

Kindström, D., Kowalkowski, C., and Sandberg, E. 2013. "Enabling Service Innovation: A Dynamic Capabilities Approach," *Journal of Business Research* (66:8), pp. 1063–1073.

King, N. 2004a. "Using Interviews in Qualitative Research," in *Essential Guide to Qualitative Methods in Organizational Research*, London: SAGE, pp. 11–22.

King, N. 2004b. "Using Templates in the Thematic Analysis of Text," in *Essential Guide to Qualitative Methods in Organizational Research*, London: SAGE, pp. 256–270.

Kjellberg, H., and Helgesson, C.-F. 2006. "Multiple Versions of Markets: Multiplicity and Performativity in Market Practice," *Industrial Marketing Management* (35:7), pp. 839–855.

Kjellberg, H., and Helgesson, C.-F. 2007. "On the Nature of Markets and Their Practices," *Marketing Theory* (7:2), pp. 137–162.

Klein, H. K., and Myers, M. D. 1999. "A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems," *MIS Quarterly* (23:1), pp. 67–93.

Kleinhans, C. 2015. "Digitalisierungsstrategien in Der Automobilindustrie," Frankfurt am Main: VDA/Berylls Consulting.

Kleinhans, C. 2016. "Zukunftsmarkt 'Digitale Entwicklung,'" Munich: Berylls Consulting.

Kleinhans, C., Neidl, T., and Radics, A. 2015. “Automotive Entwicklungsdienstleistung - Zukunftsstandort Deutschland,” Studie No. 48, Materialien Zur Automobilindustrie, Studie, Berlin: Verband der Automobilindustrie e.V. (VDA), March. (www.vda.de).

Korosec, K. 2016. “Autonomous Car Sales Will Hit 21 Million by 2035,” *Fortune*, June 7. (http://fortune.com/2016/06/07/autonomous-car-sales-ihs/, accessed May 20, 2018).

Korosec, K. 2017. “Audi And Nvidia Team Up to Bring Self-Driving Cars to Market by 2020,” *Fortune*, January 4. (www.fortune.com, accessed October 22, 2017).

Koschatzky, K., and Stahlecker, T. 2010. “The Emergence of New Modes of R&D Services in Germany,” *The Service Industries Journal* (30:5), pp. 685–700.

Koskela-Huotari, K., Edvardsson, B., Jonas, J. M., Sörhammar, D., and Witell, L. 2016. “Innovation in Service Ecosystems - Breaking, Making, and Maintaining Institutionalized Rules of Resource Integration,” *Journal of Business Research* (8:69), pp. 2964–2971.

Kröger, M. 2018. “Fraunhofer-Studie: Umstellung Auf Elektroantriebe Könnte Zehntausende Jobs Kosten,” *Spiegel Online*, June 5. (http://www.spiegel.de/1211293.html, accessed June 5, 2018).

Krüger, W., and Homp, C. 1997. *Kernkompetenz-Management: Steigerung von Flexibilität und Schlagkraft im Wettbewerb*, Springer-Verlag.

Kruse, P. 2009. “Wertewandel: Ein Kultobjekt Wird Abgewrackt,” *GDI Impuls* (79:1/2009), Ein Neues Zeitalter Der Mobilität, pp. 12–19.

Länsisalmi, H., Peiro, J. M., and Kivimäki, M. 2004. “Grounded Theory in Organizational Research,” in *Essential Guide to Qualitative Methods in Organizational Research*, London: SAGE, pp. 243–255.

Larsen, J. N. 2000. “Supplier–User Interaction in Knowledge-Intensive Business Services: Types of Expertise and Modes of Organization,” in *Services and the Knowledge-Based Economy*, London: Cotinuum, pp. 146–154.

Lawrence, T. B. 2008. “Power, Institutions and Organizations,” in *The SAGE Handbook Of Organizational Institutionalism*, London: SAGE, pp. 170–197.

Lawrence, T. B., and Suddaby, R. 2006. “Institutions and Institutional Work,” *The Sage Handbook of Organization Studies* (2), pp. 215–254.

Lounsbury, M., and Crumley, E. T. 2007. “New Practice Creation: An Institutional Perspective on Innovation,” *Organization Studies* (28:7), pp. 993–1012.

Lüerßen, H. 2013. “Sonderanalyse - Engineering Services in Deutschland,” Kaufbeuren: Lünendonk.

Lüerßen, H. 2014. “Sonderanalyse 2014 - Führende Anbieter von Technologie-Beratung Und Engineering Services in Deutschland,” Kaufbeuren: Lünendonk.

Lusch, R. F. 2011. “Reframing Supply Chain Management: A Service-Dominant Logic Perspective,” *Journal of Supply Chain Management* (47:1), pp. 14–18.

Lusch, R. F., and Nambisan, S. 2015. “Service Innovation: A Service-Dominant Logic Perspective,” *MIS Quarterly* (39:1), pp. 155–175.

Lusch, R. F., and Vargo, S. L. 2006a. "Service-Dominant Logic: Reactions, Reflections and Refinements," *Marketing Theory* (6:3), pp. 281–288.

Lusch, R. F., and Vargo, S. L. 2006b. "Service Dominant Logic as a Foundation for a General Theory," in *The Service-Dominant Logic of Marketing: Dialog, Debate, and Directions*, London: Routledge, pp. 32–420.

Lusch, R. F., and Vargo, S. L. 2006c. *The Service-Dominant Logic of Marketing: Dialog, Debate, and Directions*, M.E. Sharpe.

Lusch, R. F., and Vargo, S. L. 2014. *Service-Dominant Logic: Premises, Perspectives, Possibilities*, Cambridge: Cambridge University Press.

Lusch, R. F., Vargo, S. L., and Tanniru, M. 2010. "Service, Value Networks and Learning," *Journal of the Academy of Marketing Science* (38:1), pp. 19–31.

Maglio, P. P., Vargo, S. L., Caswell, N., and Spohrer, J. 2009. "The Service System Is the Basic Abstraction of Service Science," *Information Systems and E-Business Management* (7:4), pp. 395–406.

Maxton, G. P., and Wormald, J. 2004. *Time for a Model Change: Re-Engineering the Global Automotive Industry*, Cambridge: Cambridge University Press.

Maxwell, J. A. 2012. *Qualitative Research Design: An Interactive Approach*, (3rd ed., Vol. 41), London: SAGE.

May, T., and Perry, B. 2014. "Reflexivity and the Practice of Qualitative Research," in *The SAGE Handbook of Qualitative Data Analysis*, Los Angeles: SAGE, pp. 109–122.

Metcalfe, J. S. 2010. "Technology and Economic Theory," *Cambridge Journal of Economics* (34:1), pp. 153–171.

Metcalfe, J. S., and Miles, I. 2000. *Innovation Systems in the Service Economy*, (Vol. 18), Economics of Science, Technology and Innovation, Boston: Springer.

Miles, I. 2005. "Knowledge Intensive Business Services: Prospects and Policies," *Foresight* (7:6), pp. 39–63.

Miles, I. 2008. "Patterns of Innovation in Service Industries," *IBM Systems Journal* (47:1), pp. 115–128.

Miles, I., Kastrinos, N., Flanagan, K., Bilderbeek, R., Den Hertog, P., Huntink, W., and Bouman, M. 1995. "Knowledge-Intensive Business Services," Users, Carriers and Sources of Innovation, Manchester: The University of Manchester PREST.

Miozzo, M., and Soete, L. 2001. "Internationalization of Services: A Technological Perspective," *Technological Forecasting and Social Change* (67:2), pp. 159–185.

Mokyr, J. 2011. *The Gifts of Athena: Historical Origins of the Knowledge Economy.*, Princeton: Princeton University Press.

Muller, E., and Doloreux, D. 2007. *The Key Dimensions of Knowledge-Intensive Business Services (KIBS) Analysis: A Decade of Evolution*, Karlsruhe: Fraunhofer ISI.

Muller, E., and Doloreux, D. 2009. "What We Should Know about Knowledge-Intensive Business Services," *Technology in Society* (31:1), pp. 64–72.

Muller, E., and Zenker, A. 2001. "Business Services as Actors of Knowledge Transformation: The Role of KIBS in Regional and National Innovation Systems," *Research Policy* (30:9), pp. 1501–1516.

Muller, E., Zenker, A., Héraud, J.-A., and Muller, E. 2012. "Knowledge Angels: Fostering Innovation in Knowledge-Intensive Business Services through Creative Individuals," *Autonomous University of Madrid*.

Nalebuff, B. J., and Brandenburger, A. 1996. *Co-Opetition*, New York: Profile Books.

Nambisan, S. 2013. "Information Technology and Product/Service Innovation: A Brief Assessment and Some Suggestions for Future Research," *Journal of the Association for Information Systems* (14:4), pp. 215–226.

Nambisan, S., and Sawhney, M. 2007. "A Buyer's Guide to the Innovation Bazaar," *Harvard Business Review* (85:6), pp. 109–118.

Nordenflycht, A. von. 2010. "What Is a Professional Service Firm? Toward a Theory and Taxonomy of Knowledge-Intensive Firms," *Academy of Management Review* (35:1), pp. 155–174.

Normann, R. 2001. *Reframing Business: When the Map Changes the Landscape*, New York: Wiley & Sons.

North, D. C. 1990. *Institutions, Institutional Change and Economic Performance*, Cambridge University Press.

OliverWyman/VDA. 2012. "FAST 2025 - Massiver Wandel in Der Automobilen Wertschöpfungsstruktur," Berlin/Munich: OliverWyman/VDA, November.

Ordanini, A., and Parasuraman, A. 2011. "Service Innovation Viewed Through a Service-Dominant Logic Lens: A Conceptual Framework and Empirical Analysis," *Journal of Service Research* (14:1), pp. 3–23.

Orlikowski, W. J. 1992. "The Duality of Technology: Rethinking the Concept of Technology in Organizations," *Organization Science* (3:3), pp. 398–427.

Ostrom, A. L., Parasuraman, A., Bowen, D. E., Patrício, L., Voss, C. A., and Lemon, K. 2015. "Service Research Priorities in a Rapidly Changing Context," *Journal of Service Research* (18:2), pp. 127–159.

Pavitt, K. 1984. "Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory," *Research Policy* (13:6), pp. 343–373.

Pavitt, K., Robson, M., and Townsend, J. 1989. "Technological Accumulation, Diversification and Organisation in UK Companies, 1945–1983," *Management Science* (35:1), pp. 81–99.

Peirce, C. S. 1974. *Collected Papers of Charles Sanders Peirce*, Cambridge: Harvard University Press.

Pepperson, R. 1991. "Institutions, Institutional Effects, and Institutionalism," in *The New Institutionalism in Organizational Analysis*, Chicago: University of Chicago Press, pp. 143–163.

Peters, S., Chun, J.-H., and Lanza, G. 2016. "Digitalization of Automotive Industry – Scenarios for Future Manufacturing," *Manufacturing Review* (3), p. 1.

Piccinini, E., Hanelt, A., Gregory, R., and Kolbe, L. 2015. "Transforming Industrial Business: The Impact of Digital Transformation on Automotive Organizations," in *Proceedings of the 36th International Conference of Information Systems (ICIS)*, Texas, December 13.

Pil, F. K., and Holweg, M. 2004. "Linking Product Variety to Order-Fulfillment Strategies," *Interfaces* (34:5), pp. 394–403.

Plattner, H., Meinel, C., and Leifer, L. 2010. *Design Thinking: Understand – Improve – Apply*, Heidelberg: Springer Science & Business Media.

Pohlmann, A., and Kaartemo, V. 2017. "Research Trajectories of Service-Dominant Logic: Emergent Themes of a Unifying Paradigm in Business and Management," *Industrial Marketing Management* (63:C), pp. 53–68.

Prahalad, C. K., and Hamel, G. 2006. "The Core Competence of the Corporation," in *Strategische Unternehmungsplanung — Strategische Unternehmungsführung* (9th ed.), Berlin: Springer, pp. 275–292.

Prahalad, C. K., and Ramaswamy, V. 2004. "Co-Creation Experiences: The Next Practice in Value Creation," *Journal of Interactive Marketing* (18:3), pp. 5–14.

Proff, H., Schönharting, J., Schramm, D., and Ziegler, J. 2012. *Zukünftige Entwicklungen in der Mobilität: Betriebswirtschaftliche und technische Aspekte*, Wiesbaden: Springer.

Reichertz, J. 2014. "Abduction, Deduction and Induction in Qualitative Research," in *The SAGE Handbook of Qualitative Data Analysis*, Los Angeles: SAGE, pp. 299–310.

Rodriguez, M., Doloreux, D., and Shearmur, R. 2017. "Variety in External Knowledge Sourcing and Innovation Novelty: Evidence From the KIBS Sector in Spain," *Technovation* (68), pp. 35–43.

Romero, D., and Molina, A. 2011. "Collaborative Networked Organisations and Customer Communities: Value Co-Creation and Co-Innovation in the Networking Era," *Production Planning & Control* (22:5–6), pp. 447–472.

Sampson, S. E., and Froehle, C. M. 2006. "Foundations and Implications of a Proposed Unified Services Theory," *Production and Operations Management* (15:2), pp. 329–343.

Sanchez, R., and Mahoney, J. T. 1996. "Modularity, Flexibility, and Knowledge Management in Product and Organization Design," *Strategic Management Journal* (17:2), pp. 63–76.

Schneider, K. 2011. *Modernes Sourcing in der Automobilindustrie*, (1st ed.), Gabler Research Informationsmanagement und Computer Aided Team, Wiesbaden: Gabler Verlag.

Schumpeter, J. A. 1934. *The Theory of Economic Development*, Cambridge: Harvard University Press.

Schumpeter, J. A. 1943. *Capitalism, Socialism and Democracy*, (1st ed.), London: Allen & Unwin Ltd.

Scott, W. R. 2001. *Institutions and Organizations*, (2nd ed.), Foundations for Organizational Science, Thousand Oaks: SAGE.

Scott, W. R. 2008. "Approaching Adulthood: The Maturing of Institutional Theory," *Theory and Society* (37:5), pp. 427–442.

Singh, A. S. 2014. "Conducting Case Study Research in Non-Profit Organisations," *Qualitative Market Research: An International Journal* (17:1), pp. 77–84.

Smith, A. 1776. *The Wealth of Nations*, London: Reprint: Printed for W. Strahan and T, Cadell.

Smith, L., Maull, R., and Ng, I. C. L. 2014. "Servitization and Operations Management: A Service Dominant-Logic Approach," *International Journal of Operations & Production Management* (34:2), pp. 242–269.

Spohrer, J., Maglio, P. P., Bailey, J., and Gruhl, D. 2007. "Steps Toward a Science of Service Systems," *IEEE* (40:1), pp. 71–77.

Sundbo, J., and Gallouj, F. 2000. "Innovation as a Loosely Coupled System in Services," *International Journal of Services Technology and Management* (1:1), pp. 15–36.

Thorngate, W. 1986. "The Production, Detection, and Explanation of Behavioral Patterns," in *The Individual Subject and Scientific Psychology*, Perspectives on Individual Differences, Boston: Springer, pp. 71–93.

Tidd, J., Bessant, J. R., and Pavitt, K. 2005. *Managing Innovation: Integrating Technological, Market and Organizational Change*, (3rd ed.), Chichester: Wiley & Sons.

Tidd, J., and Hull, F. M. 2003. "Managing Service Innovation: Variations of Best Practice," in *Service Innovation*, Series on Technology Management, London: Imperial College Press, pp. 3–34.

Toivonen, M., and Tuominen, T. 2009. "Emergence of Innovations in Services," *The Service Industries Journal* (29:7), pp. 887–902.

Toivonen, M., Tuominen, T., and Brax, S. 2007. "Innovation Process Interlinked with the Process of Service Delivery : A Management Challenge in KIBS," *Economies et Sociétés* (41:3), pp. 355–384.

Vargo, S. L., and Akaka, M. A. 2009. "Service-Dominant Logic as a Foundation for Service Science: Clarifications," *Service Science* (1:1), pp. 32–41.

Vargo, S. L., Koskela-Huotari, K., Baron, S., Edvardsson, B., Reynoso, J., and Colurcio, M. 2017. "A Systems Perspective on Markets – Toward a Research Agenda," *Journal of Business Research*.

Vargo, S. L., and Lusch, R. F. 2004. "Evolving to a New Dominant Logic for Marketing," *Journal of Marketing* (68:1), pp. 1–17.

Vargo, S. L., and Lusch, R. F. 2008. "Service-Dominant Logic: Continuing the Evolution," *Journal of the Academy of Marketing Science* (36:1), pp. 1–10.

Vargo, S. L., and Lusch, R. F. 2011. "It's All B2B…and Beyond: Toward a Systems Perspective of the Market," *Industrial Marketing Management* (40:2), pp. 181–187.

Vargo, S. L., and Lusch, R. F. 2014. "Inversions of Service-Dominant Logic," *Marketing Theory* (14:3), pp. 239–248.

Vargo, S. L., and Lusch, R. F. 2016. "Institutions and Axioms: An Extension and Update of Service-Dominant Logic," *Journal of the Academy of Marketing Science* (44:1), pp. 5–23.

Vargo, S. L., Maglio, P. P., and Akaka, M. A. 2008. "On Value and Value Co-Creation: A Service Systems and Service Logic Perspective," *European Management Journal* (26:3), pp. 145–152.

Vargo, S. L., and Morgan, F. W. 2005. "Services in Society and Academic Thought: An Historical Analysis," *Journal of Macromarketing* (25:1), pp. 42–53.

Vargo, S. L., Wieland, H., and Akaka, M. A. 2015. "Innovation through Institutionalization: A Service Ecosystems Perspective," *Industrial Marketing Management* (44), pp. 63–72.

VDA. 2017. "Mobilität Und Wachstum," Frankfurt am Main: Verband der Automobilindustrie (VDA), February. (http://vda.de).

VDI. 2006. "Engineering Services and Requirements to Engineering Service Providers," VDI-Guideline No. 4510, VDI-Guideline, Duesseldorf: Verein Deutscher Ingenieure (VDI), May.

Viereckl, R., Koster, A., Hirsh, E., and Ahlemann, D. 2016. "Connected Car Report 2016: Opportunities, Risk, and Turmoil on the Road to Autonomous Vehicles," strategy&, September.

Wachenfeld, W., Winner, H., Gerdes, J. C., Lenz, B., Maurer, M., Beiker, S., Fraedrich, E., and Winkle, T. 2016. "Use Cases for Autonomous Driving," in *Autonomous Driving - Technical, Legal and Social Aspects*, New York: Springer, pp. 9–40.

Weber, J. 2009. *Automotive Development Processes: Processes for Successful Customer Oriented Vehicle Development*, Heidelberg: Springer.

Wieland, H., Koskela-Huotari, K., and Vargo, S. L. 2016. "Extending Actor Participation in Value Creation: An Institutional View," *Journal of Strategic Marketing* (24:3–4), pp. 210–226.

Wieland, H., Polese, F., Vargo, S., and Lusch, R. 2012. "Toward a Service (Eco) Systems Perspective on Value Creation," *Wieland, H., Polese, F., Vargo, S., Lusch*, pp. 12–24.

Wieland, H., Vargo, S. L., and Akaka, M. A. 2016. "Zooming Out and Zooming In: Service Ecosystems as Venues for Collaborative Innovation," in *Service Innovation: Novel Ways of Creating Value in Actor Systems* (Vol. 6), Tokyo: Springer, pp. 35–50.

Wilden, R., Akaka, M. A., Karpen, I. O., and Hohberger, J. 2017. "The Evolution and Prospects of Service-Dominant Logic: An Investigation of Past, Present, and Future Research," *Journal of Service Research* (20:4), pp. 345–361.

Winterhagen, J. 2016. "Elektroautos: Weniger Teile, Weniger Arbeit, Weniger Jobs?," *FAZ*, December 5. (http://www.faz.net/1.4547766, accessed January 21, 2018).

Wirth, M., Friesike, S., Flath, C., and Thiesse, F. 2015. "Patterns of Remixes or Where Do Innovations Come from: Evidence from 3D Printing," in *Proceedings of the 23rd European Conference on Information System (ECIS)*, Muenster: AISeL.

Witell, L., Snyder, H., Gustafsson, A., Fombelle, P., and Kristensson, P. 2015. "Defining Service Innovation: A Review and Synthesis," *Journal of Business Research*.

Wood, P. 2002. "Knowledge-Intensive Services and Urban Innovativeness," *Journal of Urban Studies* (39), 5-6, pp. 993–1002.

Yin, R. K. 2014. *Case Study Research: Design and Methods*, (5th ed.), Los Angeles: SAGE.

Yin, R. K., and Davis, D. 2007. "Adding New Dimensions to Case Study Evaluations: The Case of Evaluating Comprehensive Reforms," *New Directions for Evaluation* (113), pp. 75–93.

APPENDIX

A Interview Guidelines

Tab. A-1 Sample of the Interview Guidelines (Phase II)

Questions and Follow-up Questions
Part A: Projects and service provision
1. What is your position and role in the organization?
2. Which phases of the automotive value chain do you contribute to with your service offerings?
3. What are typical steps and challenges during project acquisition?
4. What are the most critical customer requirements during service provision?
a. Technical
b. Process-related
c. In terms of outcome
5. How do you ensure the quality of the services provided?
6. What are stressful situations that you have recently encountered during service provision?
7. What are currently important topics in the area of competence?
Part B: Clients and interactions with clients
8. How do you communicate with the customer?
9. How is the customer involved in service provision?
10. What are important project interfaces?
a. To internal employees
b. To other actors outside the organization
Part C: Innovation activities
11. How has the organization changed in recent years?
12. What are the specific objectives of your specific department and area of competence?
13. Can you give examples of new services that have recently emerged?
14. How would you describe your own capacity to innovate?
15. What efforts have you made recently to improve existing services or develop new service offerings?
Part D: Contextual factors
16. What were the most significant changes in recent years in the market?
17. What distinguishes *your services* from *those of your* competitors?
18. What are the advantages of the competitors?
Part E: Trends and strategy
19. What trends do they see in the market?
a. How do they react to these trends?

Tab. A-2 Sample of the Interview Questions (Phase III)

Questions and Follow-up Questions

Part A: Development of competencies and service offerings

1. How has the service portfolio of your organization evolved in recent years?
2. To what extent do your competencies change and the role of your organization in cooperation with other actors in the market, e.g., with the OEMs?
3. What changes and challenges do you observe with respect to the implementation of engineering projects?

Part B: Influence of technologies and digitization

4. How do you assess the influence of the digitalization on automotive engineering in general and, in particular, on the situation of your organization in the market?
5. To what extent do you already deal with digital trends?
6. To what extent do you see changes in networks as a result of technological developments?

Part C: Networking and information exchange

7. What are recent changes in your relationships with other actors in the market?
8. How do you organize the communication with other actors in the network?
    a. What is the role of information systems for the exchange of information?
9. How do you support the internal knowledge management and the exchange of information among internal employees?

Part D: Sensing innovation opportunities

10. Where do the impulses for (further) development of the service offer come from?
11. Where do the ideas come from that lead to the further development of your services?

Part E: Seizing innovation opportunities

12. If ideas for the development of services are identified, which further activities follow?
13. How do you succeed in inspiring customers with new services?
14. How do you succeed in establishing services in the market?

Part F: Innovation in networks

15. What structural changes do you observe in the market for ESPs?
16. Do you interact with other actors in order to develop competencies and service offering?
17. Which factors enable fruitful cooperation? Which factors make them more difficult?
18. How satisfied are you with your own role in the market?
    a. Do you pursue another role?

B Background of the Interviewees

Tab. B-1 Background of the Interviewees of XTEC and SIMULI

Firm	Interviewees	Position and Background
XTEC	Person 1	The interviewee is *the CEO of one of XTEC's sites in southern* Germany. He holds a diploma and a P.hD in construction engineering and has more than 15 years of experience in automotive engineering.
	Person 2	The interviewee is the *CEO of one of XTEC's largest sites*. He also has a significant share in the firm and a leading role among the other Branch Manager (CEO)'s. He holds a diploma in automotive engineering and has more than 20 years of professional experience in this domain.
	Person 3	The interviewee is the *CEO of one of XTEC's smaller sites* in central Germany and also the manager of another site that is located in close proximity. He holds a diploma in mechanical engineering and works for XTEC for more than 15 years.
	Person 4	The interviewee is the *CEO of one of XTEC's larger sites* in southern Germany. He has been trained as a mechanical engineer and has in-depth knowledge in the field of carbon composite.
	Person 5	The interviewee is the *CEO of one of XTEC's smaller sites* in northern Germany. He has more than 20 years of professional experience in automotive engineering with a particular focus on chassis construction.
	Person 6	The interviewee is the *CEO of one of XTEC's larger sites* in central Germany. He has a strong mechanical engineering background with a focus on exterior development. He has more than 25 years of professional experience in the field of automotive engineering.
	Person 7	The interviewee is an *internal technical consultant*. In this role, he supports other projects with his interdisciplinary experience and facilitates networking. He has more than 20 years of professional experience in the field of automotive engineering and is furthermore involved in innovation and training activities.
	Person 8	The interviewee is an *innovation manager* in the organization with additional responsibility for service offerings related to project management and consulting services. He holds a diploma in engineering and business administration and has more than 5 years of experience in automotive engineering.
	Person 9	The interviewee is an *innovation manager* in the organization with an academic engineering background. He has in-depth knowledge in the field of material science and is involved in business development as well as innovation activities in different interdisciplinary functions.
SIMULI	Person 1	The interviewee is the *manager of the division for simulation and technical calculation*. He has responsibility for more than 300 employees. He furthermore is involved in the development of the corporate strategy.
	Person 2	The interviewee is the *manager of the division of electronics, assurance and project management*. He has been working at SIMULI for more than 10 years.
	Person 3	The interviewee is a *commercial manager with responsibility for topics related to IT, legal and finance*. He is also a division manager for quality

Firm	Interviewees	Position and Background
		management services and has a vital role in the process of strategy development.
	Person 4	The interviewee is the *manager of the division for technical construction*. He holds a diploma in engineering and has been working in the automotive industry for more than 10 years.
	Person 5	The interviewee is the *manager of the division for acoustics and material tests*. His responsibility is cross-site, and he has more than 10 years of professional experience in the field of automotive engineering.

C List of Interviewees

Tab. C-1 List of Interviewees

Code	Type	Organization	Role	Date	Length [min]	Record
1.1	ESP	XTEC	Branch Manager (CEO)	06-02-2016	77	Audio
1.2	ESP	XTEC	Branch Manager (CEO)	01-23-2017	30	Notes
1.3	ESP	XTEC	Branch Manager (CEO)	04-13-2017	40	Notes
2	ESP	XTEC	Branch Manager (CEO)	06-06-2016	66	Audio
3	ESP	XTEC	Branch Manager (CEO)	06-09-2016	45	Audio
4	ESP	XTEC	Branch Manager (CEO)	05-18-2016	55	Audio
5	ESP	XTEC	Branch Manager (CEO)	05-18-2016	82	Audio
6	ESP	XTEC	Branch Manager (CEO)	06-02-2016	57	Audio
7	ESP	XTEC	Technology Consultant	05-17-2016	45	Notes
8	ESP	XTEC	Innovation Manager	05-13-2016	41	Audio
9	ESP	XTEC	Innovation Manager	05-17-2016	50	Audio
1.1	ESP	SIMULI	Division Manager	04-01-2015	53	Audio
1.2	ESP	SIMULI	Division Manager	05-27-2016	52	Audio
2.1	ESP	SIMULI	Division Manager	02-16-2015	45	Audio
2.2	ESP	SIMULI	Division Manager	05-10-2016	45	Audio
3	ESP	SIMULI	Commercial Manager	06-03-2016	33	Audio
4.1	ESP	SIMULI	Division Manager	06-03-2016	58	Audio
4.2	ESP	SIMULI	Division Manager	06-08-2016	60	Audio
5	ESP	SIMULI	Department Manager	10-27-2016	54	Audio
1	ESP	XTR	Division Manager	10-13-2016	34	Audio
2	ESP	XTR	Division Manager	10-13-2016	38	Audio
1	ESP	MCRAFT	CEO	02-18-2015	32	Audio
2	ESP	MCRAFT	Head of Strategy	06-01-2016	45	Audio
1	ESP	IDESIGN	CEO	01-28-2015	63	Audio
1	ESP	YEDGE	Head of Consulting	02-18-2015	47	Audio
2	ESP	YEDGE	Head of Engineering	02-18-2015	47	Audio
1	ESP	ZMETAL	Branch Manager (CEO)	03-02-2015	30	Notes
1	ESP	TAGOW	Branch Manager (CEO)	06-01-2016	35	Audio

Code	Type	Organization	Role	Date	Length [min]	Record
1	OEM	DRIVE AG	Purchasing Executive	02-18-2015	36	Audio
2	OEM	DRIVE AG	Engineering Executive	02-06-2015	94	Audio
3	OEM	DRIVE AG	Engineering Executive	02-18-2015	29	Audio
4	OEM	DRIVE AG	Purchasing Executive	02-18-2015	34	Audio
5	OEM	DRIVE AG	Purchasing Executive	02-18-2015	34	Audio
6	OEM	DRIVE AG	Engineering Executive	03-03-2015	25	Audio
1	OEM	BRUM AG	Engineering Executive	03-19-2015	54	Audio
2	OEM	BRUM AG	Engineering Executive	06-08-2016	45	Audio
3	OEM	BRUM AG	Engineering Executive	02-16-2015	36	Audio
1	OEM	AUTO AG	Purchasing Executive	02-18-2015	45	Audio
2	OEM	AUTO AG	Engineering Executive	02-23-2015	40	Audio
3	OEM	AUTO AG	Engineering Executive	06-01-2016	35	Audio
1	OEM	XRAD AG	Engineering Executive	06-20-2016	38	Audio

D Interview Transcripts

For a list of the interview transcripts see the separate document on the data storage device: *"Appendix D – Interview Transcripts.pdf"*

E List of Translations

For a list of the translations of the interview citations see the separate document on the data storage device: *“Appendix E – List of Translations.pdf”*

F Declaration

Ich versichere hiermit, dass ich meine Dissertation mit dem Titel *Patterns of Service Innovation: An Empirical Investigation of Automotive Engineering Services in Germany* ohne unerlaubte Hilfe angefertigt habe, keine als die von mir angegebenen Quellen und Hilfsmittel benutzt habe, und alle benutzten Werken wörtlich oder inhaltlich entnommenen Stellen als solche kenntlich gemacht habe.

Einer Überprüfung der Dissertation mit qualifizierter Software im Rahmen der Untersuchung von Plagiatsvorwürfen gestatte ich hiermit.

Florian Müller

Zürich, den 14. Dezember 2018