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Increasing Customer Acceptance in Planning Product-Service Systems

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FOREWORD OF THE EDITOR

Problem

The success of the Product-Service System (PSS) "Power-by-the-Hour", offered by Rolls-Royce to airlines, shows that customers appreciate a problem-oriented solution instead of a product fulfilling just the requirements. The service "Power-by-the-Hour" covers all maintenance processes of aircraft turbines and relieves the airlines of the responsibility of caring for the turbines – for a fixed price per flight time. This increases customer acceptance by reducing financial risks for airlines and by reducing the complexity perceived by airlines in managing their fleets. The approach PSS describes this way of integrating a product into a service to gain benefits for customers: PSS integrates both product and service elements into one integrated market offer.

The example "Power-by-the-Hour" demonstrates that PSS are capable of increasing customer acceptance. Besides financial risks and perceived complexity, there are other aspects influencing customer acceptance. Using the potential of PSS to increase customer acceptance is a challenge for companies: they might not know the relevant aspects of customer acceptance and they might not know how to influence those aspects of customer acceptance in the PSS planning phase.

Objectives

The overall objective of this work is to provide supporting tools, methods, and models that enable companies to plan a PSS for increasing customer acceptance. Companies need to know the reasons, drivers, and barriers of customer purchase decisions. Modeling those aspects of customer acceptance can help firms to better understand customers and their behavior. Knowing the relevant aspects of customer acceptance is a premise for customer centricity in PSS design.

The PSS planning phase is essential for the success of the PSS for customer acceptance, because the planning phase determines main elements of the PSS, i.e. the business model and major product and service elements. Intertwined processes of service and product design characterize this planning phase. In this context, companies need to know the decisions and activities that are necessary for creating a PSS concept.

To enable companies to focus the PSS planning on customer acceptance, this work defines a measure that connects PSS planning with the aspects of customer acceptance. This measure should support PSS planners in defining PSS elements to influence customer acceptance.

Results

The main results of this work are the decision-making process of PSS planning that integrates the model of customer acceptance and the service catalogue. Those tools support project managers, product managers, sales managers, or marketers in planning PSS to increase customer acceptance.

The decision-making process for planning PSS structures the process from the first idea to the final PSS concept into three stages: requirements definition, concepts generation, and concepts evaluation. After each stage, a design review serves as a decision point that describes the decision objects and the information required at this stage. This process model helps companies to manage the processes in the PSS planning phase.

The model of customer acceptance is divided into eight categories: values and beliefs, unawareness of needs, trust, psychological phenomena, perceived complexity, costs and prices, interoperability, and reliability and availability. Every category includes detailed aspects of customer acceptance. A detailed description of all those aspects, as well as a catalogue of questions for an interview or a survey, supports users of this model in identifying and quantifying the aspects of customer acceptance.

The service catalogue is a collection of services structured into four levels. This catalogue supports PSS planners in identifying relevant services for their products or finding fields of potential service innovations. The four levels of the service catalogue provide a comprehensive overview and make the catalogue easy to understand for practitioners.

Conclusions for Industrial Applications

The transition from a product seller to a PSS provider, the so-called PSS transition or PSS shift, is a long-term process for companies involving many opportunities and risks. One opportunity is to increase customer acceptance, e.g. by better fulfilling customer wishes. This work's results support companies, especially SMEs that just have started the process of PSS transition, in planning PSS to increase customer acceptance. Companies using the model of customer acceptance can identify and quantify relevant and unknown aspects of customer acceptance to understand the purchase decisions of their customers. The decision-making process for PSS planning provides transparency in the decisions of the planning phase and helps companies implement processes to create integrated PSS. The service catalogue supports companies in identifying fields for new services to increase customer acceptance.

Conclusions for Scientific Researchers

This work contributes to the research field PSS by connecting PSS planning with customer acceptance. The underlying approach of increasing customer acceptance is a novelty for PSS research: based on the customer target group, relevant aspects of customer acceptance are identified and quantified, while the PSS planning follows those aspects. The model of customer acceptance provides a comprehensive collection of aspects that are relevant for purchase decisions. The decision-making process for PSS planning adapts the existing approaches of PSS planning to a process model that organizes decisions and information required for the planning phase. The service catalogue is a service classification scheme that structures a broad range of existing services into four categories. Matching the model of customer acceptance with the service catalogue provides a direct linkage between customer acceptance and the service elements of a PSS.

Garching, July 2017

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The following publications are part of the work presented in this thesis:

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Schmidt, D. M.; Schenkl, S. A.; Mörtl, M.: Matrix-based Decision-making for Compatible Systems in Product Planning Concerning Technologies for the Reduction of CO2-Emissions, in: Marle, F.; Jankovic, M.; Maurer, M.; Schmidt, D. M.; Lindemann, U. (Eds.), Dependency and Structure Modeling (DSM) Conference. Hanser Verlag, Paris, France, July 2-4, 2014, pp. 107-116.

Mörtl, M.; Schmidt, D. M.; Kammerl, D.; Schweigert, S.; Schenkl, S.A.; Orawski, R.; Hepperle, C.: PSS-Planung – Methodenunterstützung zur Kompatibilitätsanalyse von Lösungselementen, in: Vogel-Heuser, B., Lindemann, U., Reinhart, G. (Eds.), Innovationsprozesse zyklenorientiert managen: verzahnte Entwicklung von Produkt-Service Systemen. Springer Vieweg, Berlin Heidelberg, 2014, pp. 91-105.

Schmidt, D. M.; Bauer, P.; Mörtl, M.: Product-Service Systems for influencing customer barriers and customer acceptance, International Conference on Business, Marketing and Management (ICBMM), Hong Kong, November 8-10, 2014.

Schmidt, D. M.; Schenkl, S. A.; Munkhart, E.; Nilsson, S.; Mörtl, M.; Interview study: Decisions and decision criteria for development in industry, IEEE International Conference on Industrial Engineering and Engineering Management, Bandar Sunway, Malaysia, December 9-12, 2014, pp. 297-301.

Schmidt, D. M.; Urquidi Guerrero, J.; Michailidou, I.; Lindemann, U.: Differentiated Customer Needs' Analysis for User Experience, in: Ahmed, P.K., Jiao, R., Teh, P.-L., Xie, M. (Eds.), IEEE - International Conference on Industrial Engineering and Engineering Management. Institute of Electrical and Electronics Engineers, Kuala Lumpur, Malaysia, December 9-12, 2014, pp. 1305 - 1309.

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Schmidt, D. M.; Mörtl, M.; Product-Service Systems for Increasing Customer Acceptance Concerning Perceived Complexity, Asian Design Engineering Workshop (A-DEWS), Hong Kong, 2015, October 29-30, 2015, pp. 77-82.

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Schmidt, D. M.; Brüderle, P.; Mörtl, M.: Focusing Aspects of Customer Acceptance for Planning Product-Service Systems - A Case Study from Construction Machines Industry, in: Wang, L.; Kjellberg, T. (Eds.), 26th CIRP Design Conference. Elsevier B.V., Stockholm, Sweden, June 15-17, 2016, pp. 372-377.

Schmidt, D. M.; Hübner, D.; Mörtl, M.: Product-Service Systems for Increasing Customer Acceptance in Terms of Interoperability, 4th International Conference on Serviceology, Tokyo, Japan, September 6-8, 2016, pp. 350-356.

CONTENTS

1. Introduction

This chapter provides an introduction into the thesis. It starts with the initial situation and the problem definition on which this work relies. Based on this problem description main objectives are declared. The thematic classification distinguishes this work from other approaches and research areas and defines the main objects considered by this thesis. The research procedure of this work relies on the Design Research Methodology (DRM) and specific research methods (e.g. literature review, modeling) are described. The chapter concludes with a description of the thesis structure and the links between the chapters.

1.1 Initial Situation and Problem Description

During the last decades a plethora of product design approaches have been developed which focus on more than only fulfilling requirements. The globalization and increasing complexity of markets require companies to create innovative solutions and business models, meaning it is not sufficient to meet already-known customer requirements only. The most successful innovations introduced during the last years, e.g. internet or smart phones, did not focus on customer requirements. They went one step further and satisfied customers' wishes that were not explicitly expressed. To be successful in any market long-term, companies have to provide solutions that are accepted by customers. This requires a transition from product focus to customer orientation. (Lindemann, 2009)

One approach that facilitates companies' focus on customers is the research field of Product-Service Systems (PSS) (Goedkoop et al., 1999). PSS integrate both product and service elements. The nature of PSS implies that the integrated product parts and service parts cannot exist without each other, and the combination of both makes the PSS into a beneficial market offer (Baines et al., 2007). PSS enable the switch from developing and producing products to providing benefits for customers by means of integrated solutions (Mont, 2002a; Tukker, 2004). However, as Mont (2004) argues in her dissertation, the approach of PSS is not a magic bullet for having market success at a low price, quite the opposite; PSS requires more complexity in design processes (Hepperle, 2013; Kim et al., 2011b), handling of stakeholders (Meier et al., 2010a), knowledge (Schenkl, 2014), and information (Isaksson et al., 2009). The strong interconnections of product and service elements lead to varying conditions for companies in their planning and designing; companies have to consider interactions and interfaces between product and service elements from the very beginning of the design process and other innovation processes. Unlike the conventional design process of tangible products, companies' service departments cannot start to develop services after designing the tangible product. PSS design requires the integration of service departments into the early stages of PSS development. Since developing PSS differs from developing stand-alone physical products or services, the PSS planning process has to be adjusted to the PSS-specific requirements. A PSS planning process has to consider tangible components, service components, the merging infrastructure, the company's knowledge and competencies, and external factors (Schenkl et al., 2013c). For planning and developing PSS, they have to be orientated towards the customers and their needs.

The level of customer integration in the early phases of PSS development needs to be increased. While this customer integration might be challenging for PSS design, PSS promise to be beneficial for customer acceptance (Mont & Plepys, 2003). While several authors mention the advantages of PSS for customers (Baines & Lightfoot, 2013; Beuren et al., 2013; Mont, 2002c; Schenkl, 2014), e.g. greater flexibility in fulfilling changing customer requirements (Mont, 2002c), there are still many companies that have not implemented the PSS approach in their businesses (Neely, 2013) (see subsection 2.3.1). While literature provides many generic procedures for designing PSS (Vasantha et al., 2015), there is still a lack of methods and models that are easy to understand and easy to use for practitioners. To facilitate companies' planning of PSS focusing on customer acceptance, those methods and models have to integrate customer acceptance into the planning phase.

The following example explains this problem in more detail. Hewlett Packard (HP) has revolutionized the B2C market in printers by making the transition from selling products to providing PSS. While the main revenue stream of traditional business models is included in the asset costs (selling the printer, i.e. product part), the main revenue stream of HP's business model was included in the equipment costs (costs for ink, i.e. service part). This switch suited the preferences of private customers who overvalue the asset costs compared to the running costs. In doing so, HP has focused on this aspect of customer acceptance using the PSS approach. However, to orientate the PSS design towards customer acceptance, companies need to know the relevant aspects of customer acceptance and they need to know how PSS can address those aspects; there is a need for models, methods, and measures that support companies in PSS conceptual design.

1.2 Objectives and Thematic Classification

This work is based on the assumption that PSS are capable of increasing customer acceptance. The main objective is to create models and methods to support companies in the PSS planning phase. This objective deals with two main topics: customer acceptance and methods of PSS planning. In the field of customer acceptance, this work supports companies in identifying customer acceptance aspects relevant for their customers or customer segments. The following methods of PSS conceptual design enable companies to provide PSS to increase customer acceptance.

To support companies in PSS planning, this work first creates a decision-making process for PSS planning. This process model provides activities and milestones that are needed to plan PSS. It has to consider both PSS-specific process requirements and organizational aspects. To ensure a benefit for companies, the process model must be easy to understand and easy to apply. This requires a reasonable representation of the process model. This process model should include decisions that have to be made during the planning phase to support companies in accurate decision-making in PSS conceptual design.

Second, this work deals with customer acceptance and declares the terms of customer acceptance to distinguish from related terms, like customer satisfaction or adoption. To create a model of customer acceptance, relevant aspects of customer acceptance will be identified that are relevant for customer purchase decisions. Those aspects will be categorized and summarized, resulting in a model that supports companies in finding customer aspects they

were not aware of. This model of customer acceptance can serve as a checklist for identifying relevant aspects of customer acceptance.

The third measure for supporting companies in planning PSS is a method to help PSS planners find new services. This method is the service catalogue. This catalogue is a collection of services that can be added to tangible product elements. The catalogue is comparable to a construction catalogue (e.g. (Roth, 2000)) for design engineers. The service catalogue can serve as a checklist for determining the service parts of the current PSS offer. This helps product managers identify all services the company is currently offering as a basis for a structured PSS portfolio. The structure of this service catalogue has to be easy to understand and use for practitioners. To integrate customer acceptance into the usage of this service catalogue, this work creates a measure to link the service catalogue with the model of customer acceptance. This linkage supports PSS planners in developing services based on relevant aspects of customer acceptance.

To improve those three design supports (the decision-making process for PSS planning, the model of customer acceptance, and the service catalogue), several studies have to evaluate those design supports concerning several criteria. This also requires industrial case studies to check if practitioners from industry can use those methods and models and if they gain benefits from using them.

Figure 1-1 shows an overview of issues and areas which this thesis focuses on and related topics. Most related topics were identified in the research field Product-Service Systems based on Baines et al. (2009); Beuren et al. (2013); Kim (2016); Schenkl (2014); Vasantha et al. (2015). The literature review discusses various issues of PSS from different perspectives. This work only deals with crucial topics to support companies in planning PSS for increasing customer acceptance. Extracting those themes defines this work's system boundaries. The topics this thesis is focused on are shown in black and in underlined font, while the topics that are relevant but not focused are shown in light grey in Figure 1-1.

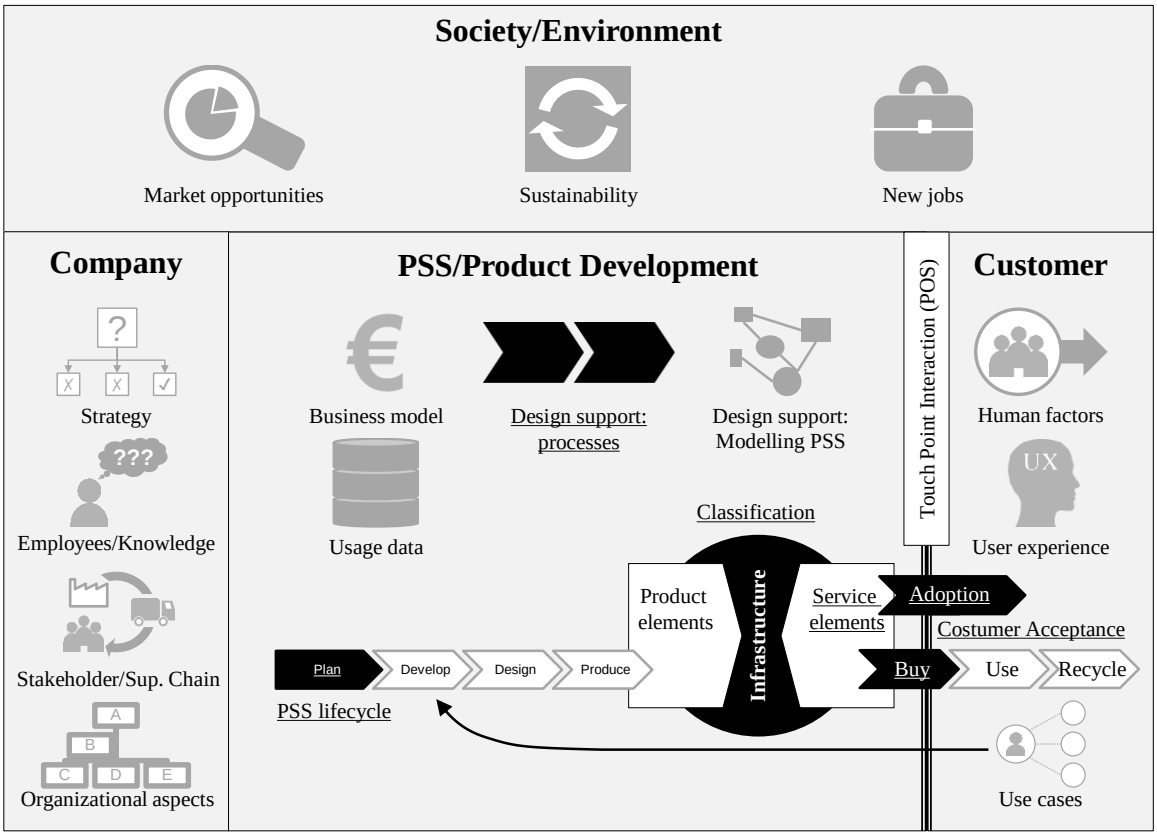

Figure 1-1 Topics of PSS research focused by this work and related research topics

The PSS research field can be divided into four main areas: society/environment, company, PSS/product development, and customer. This work is mainly focused on PSS development and the customer. There are comprehensive issues that describe the effects of PSS on the **environment or the society**. Tukker (2004) discusses whether PSS influence sustainability in a positive way, PSS might create new jobs because of a greater requirement for labor for services compared to tangible products (Gao et al., 2009). PSS enable providers to distinguish themselves from their competitors or break into new markets (Baines & Lightfoot, 2013). This work does not deal with issues of society or environment. Issues emerging from the **companies** are broadly discussed in literature: strategic implications of servitization discussed by (Manzini & Vezzoli, 2003). Kim et al. (2015b) propose a double-deck servitization process that shows the interactions between the level of the company's strategies and the level of the PSS development. The literature also provides support for developing PSS business models (Barquet et al., 2015; Lee et al., 2011). Other researchers in the PSS field deal with supply chain management (Meier & Völker, 2008) or with stakeholder analysis (Vezzoli et al., 2015). Schenkl (2014) investigates employees, their knowledge, and the prevention of product imitation. Calabretta et al. (2016) focuses on organizational aspects, e.g. the organizational challenges for servitization. The company itself is not a topic of this work. Another relevant field of PSS research is the **PSS design and development**; there are many approaches to dealing with design supports, e.g. modeling PSS (Bochnig et al., 2013; Morelli, 2006; Weber et al., 2004). This thesis deals with engineering processes (see chapter 4) and comprehensive methodologies (see chapter 3). The PSS transition requires changing the business model (Lee et al., 2011; Rese et al., 2013; Tukker, 2004). Other researchers focus on the PSS lifecycle that

is characterized as intertwined processes of tangible product and service elements (Aurich et al., 2007; Hepperle et al., 2010). The early phases of the PSS lifecycle are discussed in chapter 4. Furthermore, there are various categorizations, classifications, and typologies of PSS, products, or services for different purposes. For example Park et al. (2012) created a taxonomy of PSS offers in B2B markets based on the criteria ownership, level of product-service integration, and the role of technology. This categorization should support companies in planning their servitization strategy. This work provides a service catalogue that can be seen as a classification scheme of services (see chapter 6). The **point of sales (POS)** is one of the interfaces between providers and customers. Kim (2016) considers the touchpoints and interactions between customers and providers as relevant issues in PSS development. The buying process (Kotler & Keller, 2011) and the adaption process of innovations (Rogers, 2003) are essential issues of customer acceptance; even though they are not broadly discussed in the PSS field, they are relevant topics of this work. Since a improved involvement of **customers** is considered as a benefit of PSS, there are many approaches focusing on customer-related issues: Dewit (2015) and Kim et al. (2011a) deal with user experience issues, Mont and Plepys (2003) addresses customer satisfaction. Other topics are human factors (Mathieu, 2001; Verstrepen et al., 1999), use cases or scenarios (Dewit, 2014; Hollauer et al., 2015; Omer et al., 2016), or the integration of usage data in the PSS development process (Lützenberger et al., 2016).

This work deals with processes and methods in the PSS planning phase and combines findings from customer acceptance research with a service classification scheme.

1.3 Research Methods

The procedure of this thesis is based on the Design Research Methodology (DRM) according to Blessing and Chakrabarti (2009). The DRM provides a basic research procedure and focuses on research in the field of construction methodologies. It structures research into four main stages:

- The **research clarification** analyses relevant literature and results in the definition of a research goal. Research questions or hypotheses detail this research goal.
- The **descriptive study I** increases the understanding of the research field and the research problem based on empirical data or literature.
- The **prescriptive study** provides the solution for the research problem and results in the design support.
- The **descriptive study II** applies and evaluates the results of the prescriptive study, e.g. interviews or case studies.

The DRM has an iterative character and allows the user to return to previous stages. The main procedure of this work and its iterations are shown in Figure 1-2.

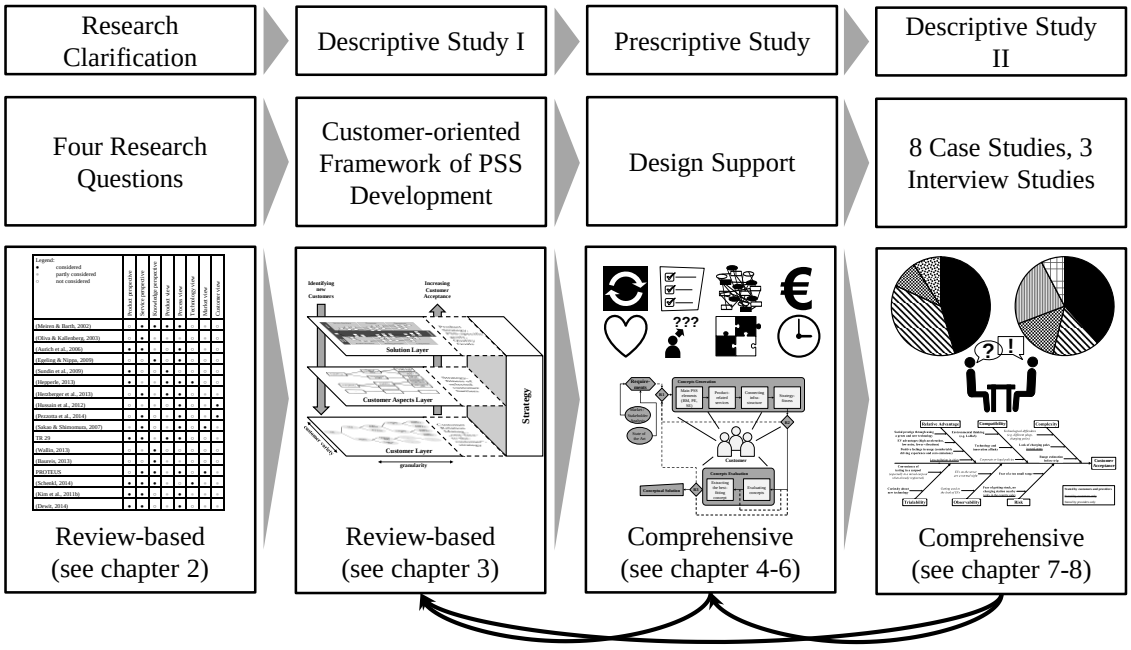

Figure 1-2 Stages of DRM in this work

The review-based research clarification of this work discusses PSS design approaches and how those approaches involve customers. This results in an identification of the research gap and the definition of four research questions. The review-based descriptive study I focuses on understanding the research questions and the domains touched by the research questions. The result of the descriptive study I is the customer-oriented framework that describes the mechanism of PSS used to increase customer acceptance. The comprehensive prescriptive study consists of three parts that focus particularly on the research questions defined in the research clarification. Those three parts include recursive applications of the DRM. The comprehensive descriptive study II evaluates the results of the prescriptive study. This evaluation is based on the requirements of the prescriptive study that have been defined in the descriptive study I. The descriptive study II consists of eight case studies and three interview studies.

Those four research stages used different kinds of research methods. Figure 1-3 shows the research methods and the links between them.

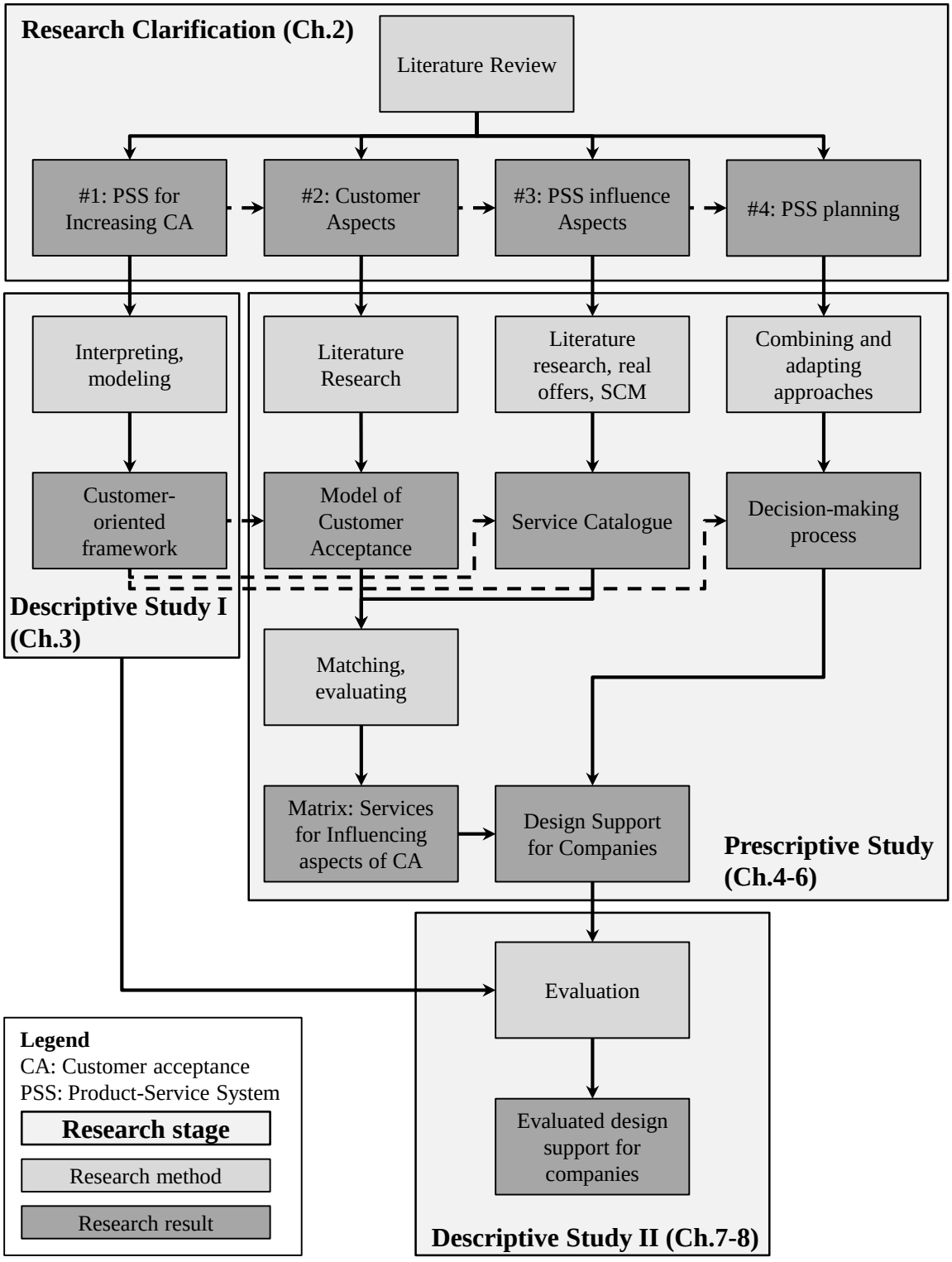

Figure 1-3 Research methods in this work

The research clarification is a literature review that results in four research questions. The first research question describes the underlying hypothesis of this work:

RQ #1: How can PSS planning increase customer acceptance?

RQ #1 is the basis for the descriptive study I that consists of interpreting the approaches analyzed from literature and modeling the customer-oriented framework. Furthermore, RQ #1 is split into three sub-questions:

RQ #2: Which aspects, drivers, and barriers of customer acceptance influence the customers and their perception of products, service, or PSS?

One part of the prescriptive study will answer this research question by creating the model of customer acceptance. This model is based on aspects of customer acceptance that are identified in literature.

RQ #3: How can PSS affect the aspects of customer acceptance to increase customer acceptance?

Another part of the prescriptive study aims for the service catalogue that is built by identifying services from literature and real industrial offers. To provide a service catalogue that is easy to use and easy to understand, the services are structured and clustered using a procedure called Structural Complexity Management (StCM).

RQ #4: How can a company design the PSS planning phase to increase customer acceptance?

The last research question focuses on supporting companies or PSS providers in PSS planning. The prescriptive study creates a decision-making process for PSS planning to enable companies to achieve reasonable PSS planning. This process is based on existing process models from literature and is created by combining and adapting existing approaches.

The model of customer acceptance (chapter 5), the service catalogue (chapter 6), and the decision-making process (chapter 4) are located in the customer-oriented framework (chapter 3). To provide decision support in using the service catalogue, the model of customer acceptance is matched with the service catalogue, resulting in a matrix describing the effects of services on aspects of customer acceptance. Those methods and models are the design support for companies in planning PSS to increase customer acceptance.

The descriptive study II includes the evaluation of this design support and the evaluation of the underlying hypothesis, that PSS are capable of increasing customer acceptance (RQ #1). The evaluation is based on the four requirements defined in the descriptive study I: applicability, added value, consistency, and adaptability. The design support is evaluated in eight case studies. An interview study focuses on RQ #1 and four expert interviews were conducted to evaluate all results of this work.

1.4 Structure of the Thesis

As this work's procedure relies on the DRM (section 1.3), the structure of this thesis is based on its application, shown in Figure 1-4. The first chapter includes the basic motivation and objectives of this thesis and roughly locates this work in the research landscape.

The theoretical background is described in chapter 2, focusing on the main research areas of customer acceptance and PSS. The term customer acceptance is defined and differentiated from similar terms and research fields. Furthermore, chapter 2 describes the state of research in PSS and provides a literature review about frameworks of PSS design/development. This review

results in research clarification by forming four research questions based on the research gaps identified. The research clarification includes the definition of system boundaries, i.e. determining markets, products, and companies.

Chapter 3 represents the descriptive study I and describes the customer-oriented framework for PSS development. Besides creating the framework and presenting the model's purpose, the requirements of the prescriptive study that will be used in the evaluation are defined.

The prescriptive study is documented in chapter 4-6. All those parts are an independent application of the DSM and chapters 4-6 start with a literature review to analyze existing approaches or to identify knowledge from literature that is included in the design support. Chapter 4 creates a process model of a decision-making process for PSS planning. As a basis for this process model, existing process models from literature are analyzed in a literature review. The final process model is composed of elements adapted from existing approaches. Chapter 5 starts with a literature review of approaches, describing aspects of customer acceptance for different products or markets. After that, the model of customer acceptance is presented and its more detailed aspects are explained. Chapter 6 shows first a literature review of approaches to structure services, e.g. ontologies, taxonomies, or categorizations. The service catalogue is created based on services identified in this literature review and based on services identified in industrial offers. At the end of chapter 6, the service catalogue and the model of customer acceptance are linked to each other.

Chapter 7 and chapter 8 are the descriptive study II. Chapter 7 starts with the concept of the evaluation. Selected case studies are presented in chapter 7 and two interview studies in chapter 8 show the evaluation of this work's results. The thesis ends with a reflection of this work in chapter 9 and a summary and outlook in chapter 10.

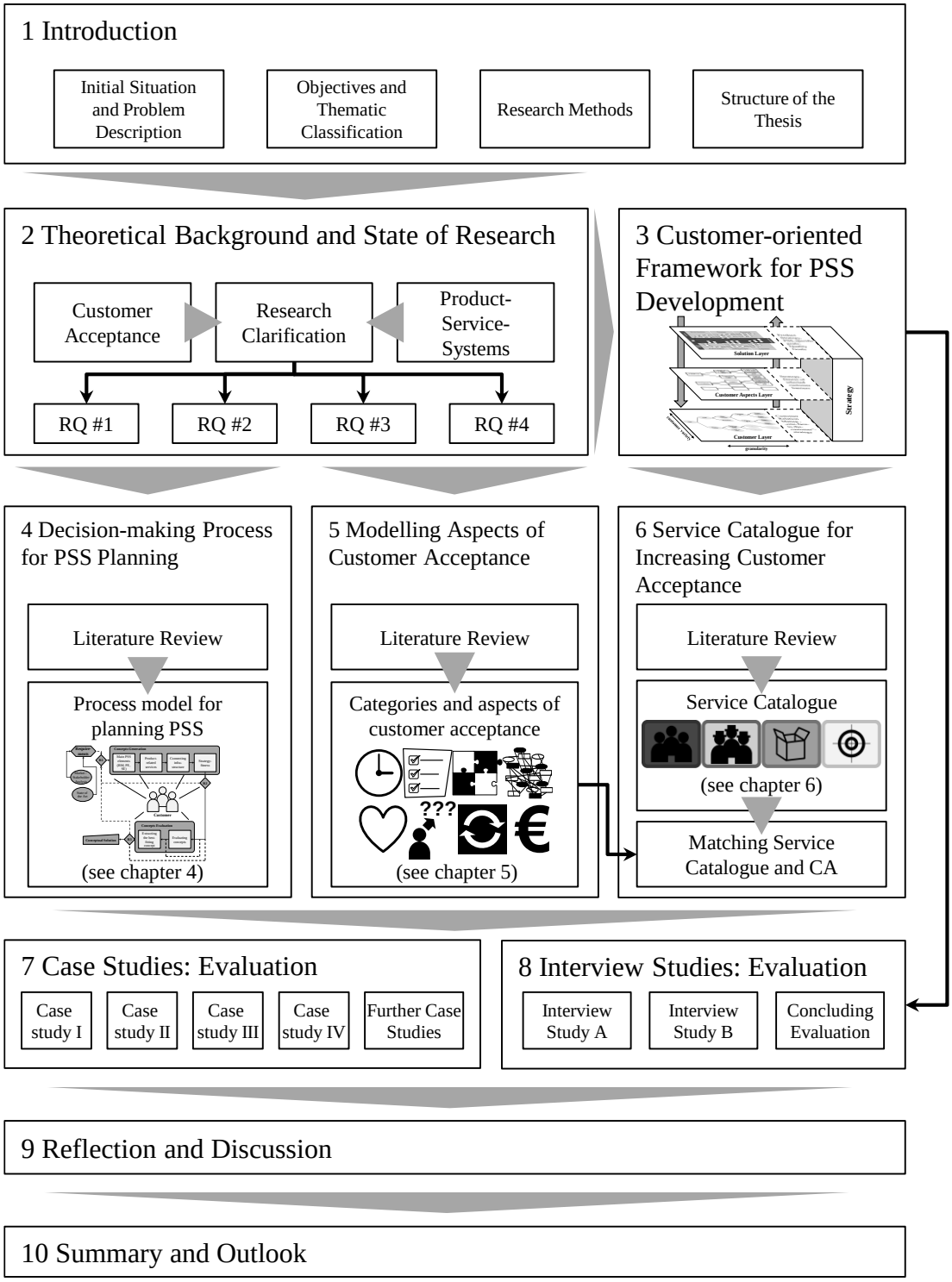

Figure 1-4 Structure of this thesis

2. Theoretical Background and State of Research

Based on the rough problem description (section 1.1), this chapter provides the theoretical basis and presents existing approaches in relevant research fields. Analyzing the state of research reveals weak points and deficits of existing approaches. Based on those weaknesses, the research gap will be identified. Research questions declare the research gap on which this work is focused. The research questions are the result of the research clarification. Since the following chapters are based on those research questions, a throughout definition is necessary.

This chapter elaborates the basis of customer acceptance and PSS as the theoretical foundation of this work. This thesis supports companies in providing PSS for increasing customer acceptance. This requires to define customer acceptance for setting the aim of this design support. It will be shown which approaches exist to increase customer acceptance. One approach of them is using PSS. Defining the term PSS reveals the differences to traditional products and product development. During the last decades, a lot of PSS approaches were created for supporting designers and for involving customers in the PSS conceptual design. A literature review results in the research clarification that answers the questions "why", "how", "what", and "where and who". The why-question asks why research is required on that field. Analyzing the deficits of existing PSS approaches uncovers research gaps. The how-question investigates the way this work intends to fill those research gaps. Formulating the research question details the what-question. Those research questions are the basis for the following work that finds answers for them. The questions "where and who" of the research clarification consider the stakeholders on which this work focuses. They describe who and where the results of this work will support and they define the system boundary of this work by laying the focus on suitable industries, companies, customers and products.

2.1 Customer Acceptance and Related Terms

This section deals with the theoretical foundation of customer acceptance. Since the aim of the thesis is to provide methods and models to increase customer acceptance using PSS, the term customer acceptance has to be taken into consideration. There are many different views and perspectives from various disciplines on acceptance in general and on customer acceptance in particular. The definitions of customer acceptance differ. To have a clear understanding of this term, this work provides an own definition. This definition is distinct from related terms. Based on this definition, the term aspects of customer acceptance is defined. To distinguish this work from other research, this section concludes with introducing and distinguishing from approaches of other research areas. This section serves as one part of the basis for clarifying the research questions in subsection 2.3.3.

Existing Definitions of Acceptance

Definitions of the terms acceptance, customer acceptance and equivalents exist in computer science and business (Amberg et al., 2005; Ba et al., 2003; Davis, 1989; Ho & Ko, 2008; Kittl, 2009; Kollmann, 1998), construction projects (Krips, 2011), marketing and service sciences

(Pai & Yeh, 2015; Wünderlich, 2009), psychology (Ajzen & Fishbein, 1980), education (Simon, 2001; Tinto, 1975), sociology (Lucke, 1995), and innovation science (Rogers, 2003). Publications from engineering research take up those definitions and do not provide an own, specified definition (Diwisch et al., 2016; Leutenecker et al., 2015; Moatari Kazerouni et al., 2011). Approaches from business, computer science, marketing, and service science provide similar definitions, because they focus similar objects; they investigate the acceptance mechanisms of users or customers for offline applications, websites or online services. Concerning the acceptance definition, those disciplines involve three main streams:

1. Innovation acceptance as a result of a diffusion or adoption process (Rogers, 2003)
2. Technology acceptance (Technology Acceptance Model, TAM) as a target value depending on acceptance factors (mainly use-related factors) (Davis, 1989)
3. Innovation acceptance as a layer model that consists of the attitude layer, the behavior layer and the usage layer (Ajzen & Fishbein, 1980; Kollmann, 1998)

Those main streams are not precisely distinguishable to each other, because they all are based on Rogers (2003) and they depend on each other. All of them focus on innovative products/services or new technologies and most of them consider the acceptance of users and not of customers. However, the focus of this work is not limited to innovative products but only on technical products. Furthermore, customer-related aspects referring to the purchase decision are also relevant for this work, while they are neglected in approaches focusing on the user only.

While the adoption process describes acceptance as a sequential progress (Rogers, 2003), Kollmann (1998) assumes a non-dichotomous character of acceptance depending on the phase in the acceptance process. This work does not see the acceptance as a target value or a target result of a process, however, it is seen as a more or less stable attribute that might change over time. While innovation research (Rogers, 2003) focuses on the adoption process until acceptance is reached, this work also considers the phase after the first acceptance of an innovation.

Definition Customer Acceptance

The disciplines considered do not provide a sufficient definition for the understanding of customer acceptance within this work, however, they include important findings that will be used and adapted to a definition suitable for this work. There are many publications in the research field of PSS dealing with customer acceptance (Mont & Plepys, 2003; Rexfelt & af Ornäs, 2009; Schenkl, 2014). However, they lack in providing a definition for customer acceptance. For creating a suitable definition, Lucke (1995) provides an important assumption for the term acceptance: it is based on the relations between acceptance subject, acceptance object and acceptance contest. The acceptance subject is a person or a group that provides acceptance for the acceptance object. For the term customer acceptance, the subject is the customer or a customer group that is not necessarily an individual human being: departments, organizations or societies are also potential customers. In this context, Picot and Reichwald (1984) differ between operators, users, organizations and societies. The acceptance object describes in this work a product, a service or a product-service system. The acceptance context contains the backgrounds of and between subject and object. In this work, the context covers

the conditions and requirements between customer and product, e.g. purchase situation or time. As acceptance depends on all three parts (subject, object and context), they influence the degree of acceptance: if one of them changes, the degree of acceptance changes as well. Customer acceptance is not a one-dimensional property that exists or not, it consists of several aspects (Rogers, 2003) and it can be quantified and measured (Anderson et al., 1994; Huber et al., 2001; Kahandawa & Wijayanayake, 2014).

This work defines the term customer acceptance as follows:

Customer acceptance describes the temporary persuasion of customers for purchasing, renting or using a product, service or a Product-Service System. The degree of acceptance is quantifiable on a continuous (non-binary) scale and depends on aspects increasing or reducing this degree of customer acceptance.

Based on this definition, the aspects of customer acceptance are crucial for increasing customer acceptance. The next paragraph defines the term aspect of customer acceptance that is different to the definition of attributes from innovation research (Rogers, 2003).

Adoption and Acceptance

Adoption can be seen as a pre-stage of acceptance (Albers, 2001; Hernandez et al., 2009; Karahanna et al., 1999). Some authors use the term acceptance synonymously to adoption (Kollmann, 1998; Rogers, 2003). Karahanna et al. (1999) differ between pre-adoption and post-adoption, while post-adoption is comparable to acceptance. To reach complete adoption, potential users or customers have gained information about the product and they have decided for testing or purchasing the product (Albers, 2001). To reach acceptance, users must have used the product and be convinced by the product usage (Hernandez et al., 2009). Adoption and acceptance might be based on each other, however, the influencing aspects are different (Albers, 2001; Hernandez et al., 2009; Karahanna et al., 1999). Referring to the buying decisions process (Kotler & Armstrong, 2014), the phases before and during the purchase decision are related to adoption, while only the post-purchase behavior can establish customer acceptance. As adoption is a pre-condition for acceptance, this work considers both adoption and acceptance. Even though they have different influencing aspects, this work does not distinguish between adoption aspects and acceptance aspects, because the concrete application case will define the relevant aspects: in some cases only adoption aspects or acceptance aspects are relevant, while other cases need the consideration of both kinds of aspects. In the context of PSS, the differentiation in adoption and acceptance is not clear, as the classic point of sales (POS) disappears: renting a car does not mean to buy a car but using it. For PSS, adoption and acceptance overlap and cannot be separated from each other.

Acceptance Subject: Customers and Users

Several terms describe potential acceptance subjects, most used words are customer, client, consumer, or user. While the term “customer” and “client” have similar meanings, the terms “user” and “customer” differ. However, the customer can also be the user depending on the market. The main difference between those terms is that customers and clients purchase (and do not necessarily use) the product, while users and consumers only use (and do not buy) the product. Terms might be also used synonymously, e.g. Vasantha et al. (2015) consider

consumer behavior as a sub-element of customer requirement. The difference between consumers and users is that consumers are users from B2C (Business to Consumer) markets, while users also appear in the B2B (Business to Business) market. Table 2-1 summarizes the terms and the markets and processes they are used for. Subsection 2.3.4 will define the system border concerning B2B and B2C markets, which makes the term user more suitable for this work. This work focuses primarily on customers and considers aspects of both, customers and users. The following chapters use the term customer (that also can be a user) in general, the term user will be taken for showing the varying consequences or aspects between customers or users, i.e. different aspects for purchasing or using a product.

Table 2-1 The terms customer, client, consumer, and user

Term	**Purchase**	**Usage**	**B2B market**	**B2C market**
Customer	Yes	Sometimes	Yes	Yes
Client	Yes	Sometimes	Yes	Yes
Consumer	Sometimes	Yes	No	Yes
User	No	Yes	Sometimes	Yes

Definition Customer Aspects

Aspects of customer acceptance, as described in the definition (see p. 13), influence the degree of acceptance and the rate of adoption (Rogers, 2003). The literature provides several names for those aspects: "perceived attributes of innovation" (Rogers, 2003), "variables determining the rate of adoption of innovations" (Rogers, 2003), "determinants" or "variables" (Davis, 1989), "perceptions" (Hernandez et al., 2009), "adoptions criteria" or "acceptance criteria" (Albers, 2001) (Lucke, 1995), "adoption factors" (Albers, 2001), "acceptance problems" or "barriers" (Kollmann, 1998), "factors" (Schenkl et al., 2014b; Rexfelt & af Ornäs, 2009). Except for (Kollmann, 1998), those aspects are considered to be neutral, they increase or reduce the degree of acceptance, depending on the acceptance subject, object and context. The relevance of those aspects depends on the perception by customers. For this work, customer aspects are factors, variables, criteria or attributes that influence the customer acceptance. This influence depends on the perception by the customer. Aspects can be drivers or barriers of customer acceptance. Perception is more than just processing information, it means to interpret information (Kotler & Armstrong, 2014). Therefore, the result of information interpretation depends on the person or the customer who is perceiving information. Dependent on the acceptance definition by Simon (2001) (acceptance is the opposite to refusal/rejection…), those aspects are only barriers of acceptance that must be reduced for increasing acceptance. However, for this work, those aspects might be drivers, barriers, or both for customer acceptance.

Distinction to Related Terms

Literature discusses many terms, which seem to be similar to the term customer acceptance, like customer satisfaction, customer value, customer loyalty, market acceptance, customer acceptance of brands, customer requirements, needs etc.

Customer satisfaction seems to be very close to the term customer acceptance. Satisfaction is described as the difference measured between customer expectations and subjective perceptions (Anderson et al., 1994; Huber et al., 2001; Oh, 1999). Customer satisfaction depends on experiences the customer made after the purchase (Oliver, 1977) that effects the future willingness of customers for using or purchasing products or services again (Anderson et al., 1994). Kim and Lee (2013) and Kahandawa and Wijayanayake (2014) use the terms acceptance and satisfaction synonymously. While Huber et al. (2001) detected satisfaction affecting acceptance, Kim and Lee (2013) and Kahandawa and Wijayanayake (2014) have integrated aspects of the Technology Acceptance Model (TAM) (Davis, 1989) as influencing aspects on the satisfaction into the American Customer Satisfaction Index (ACSI) (Fornell et al., 1996). Customer acceptance and customer satisfaction interact, satisfaction can increase customer acceptance for consequent purchases and the degree of acceptance has an effect on satisfaction. However, since customer satisfaction is only considered after using a product or a service, it does not include aspects of customer adoption. Researchers dealing with customer satisfaction focus on quantifying satisfaction to enable ongoing company success (Anderson et al., 1994; Ćoćkalo et al., 2011; Huber et al., 2001; Kahandawa & Wijayanayake, 2014). This work focuses on the conceptual design. The post-purchase findings from satisfaction investigations might be helpful for integrating them into a new PSS. However, only focusing customer satisfaction would neglect adoption aspects and aspects that are not relevant for customer satisfaction. Woodruff (1997) reasons that customer value and customer satisfaction are related to each other; the perception in the satisfaction concept depends on the **customer value** (Woodruff, 1997). Customer value can be defined as the benefit the customer receives or perceives from using a product, service or PSS (Ho & Ko, 2008; Woodruff, 1997; Zeithaml, 1988). Also Fornell et al. (1996) see perceived value as an antecedents of customer satisfaction (Fornell et al., 1996) and they define **customer loyalty** as a consequence of customer satisfaction. Similarly, Hallowell (1996) see customer loyalty related to customer satisfaction and company profitability, and Hallowell (1996) provides an empirical study for this hypothesis. Customer loyalty can be seen as a further development of satisfaction, meaning that people have a strong relation to a product, service, or brand (Dick & Basu, 1994; Hallowell, 1996). **Market acceptance** describes a similar term like customer acceptance, it is focusing the whole market, while the term customer acceptance is used for focusing on one or more customers. However, in most cases, the term market acceptance can be seen synonymously to the term customer acceptance, like in Schenkl et al. (2014b). The term customer acceptance refers to products, services, or PSS. Other researchers investigate the **customer acceptance of brands** or companies, i.e. the degree of acceptance that customers feel for brands (Brunk & Blümelhuber, 2011; Madrigal & Boush, 2008). The brand acceptance is also relevant for accepting a product or a service. Thus, brand acceptance (i.e. trust) is an aspect in this work's model of customer acceptance (see subsection 5.4.3). The concept of **customer preferences** seems to be similar to the concept of aspects of customer acceptance. According to Cao et al. (2011), customer preferences have a more subjective manner than **customer demand** has. They describe customer preferences as more vague elements (Cao et al., 2011; Slovic, 1995). Examples for preferences are "price, features, quality, safety" (Cao et al., 2011). Customer preferences are abstract categories of **customer requirements**, while aspects of customer acceptance more refer to the relation between the customer and the product. However, customer preferences and customer aspects might overlap for some elements. The terms **customer needs,**

customer wishes, customer wants, customer desires and **customer demand** are abstract element groups or concepts of customer requirements (Cao et al., 2011; Kimita et al., 2009; Ulrich & Eppinger, 2015).

2.1.1 Relevance of Customer Acceptance

The benefits of increasing customer acceptance should be obvious: customers are easier to persuade to buy a product and they are more satisfied with using the product. This leads to a more positive perception of products and the company that might raise the number of sales. Increasing customer acceptance is beneficial for both the customer and the company. Speaking about the trends in product design during past years, customer-oriented approaches became more and more important, e.g. individualization (Kosiol et al., 2015), user and customer integration (Füller et al., 2014; Reinicke, 2004), customization (Sakao et al., 2006), or user experience (von Saucken et al., 2012). These approaches aim to better fulfill customer (or user) requirements/preferences or to enthuse the customer. This also increases customer acceptance and it should guarantee a high level of customer acceptance.

In most today's markets, the initiative for new business ideas comes from the company that wants to sell services or products to the customer. In contrast, markets of 19th century were characterized by an excess demand and a shortage of supply (Jones & Richardson, 2007). Since today's markets usually include an excess supply, companies can differ from competitors by focusing on customer acceptance. Especially in saturated markets, companies' main activities are to improve customer connectivity, customer churn management, or customer acquisition from competitors. Focusing on customer acceptance can support those activities. Unsaturated markets might not have reached the saturation limit because customers cannot see the benefits and the advantages of using a product. This aspect "unawareness of needs" (see subsection 5.4.2) is more than just fulfilling requirements or satisfying needs, it is an aspect of customer acceptance.

The literature reasons that customer acceptance is beneficial for companies' performance from different perspectives. Hauser et al. (1994) see customer satisfaction as a basis for customers' purchasing potential: "more satisfied customers will buy more, buy more often, buy at a higher price" (Hauser et al., 1994). Huber et al. (2001) describe customer satisfaction as a premise for the long-term success of a company: "The challenge facing any company is thus to achieve the highest possible level of customer satisfaction" (Huber et al., 2001). Also Anderson et al. (1994) link customer satisfaction to the company's profitability. Besides the company's success, the product's success depends strongly on customer acceptance. As stated in (Dunphy & Herbig, 1995; Herbig & Day, 1992; Rogers, 2003), innovative products need to overcome customers' restrictions to reach customer acceptance and market success.

2.1.2 Approaches for Increasing Customer Acceptance

As shown in the previous subsection (2.1.1), there are more opportunities for increasing customer acceptance than using PSS. Many approaches in design research only focus on improving the tangible product itself. Some of them are summarized in the **Quality Function**

Deployment (QFD) (Akao, 2004) combining customer preferences with product elements. Another wide research field is **user-centered design** including approaches dealing with **usability** (Zhu et al., 2006), **user experience** (Schmidt et al., 2014d), **use cases** (Hollauer et al., 2015), **personas** (Nemoto et al., 2015), **scenarios** (Dewit, 2014), **story telling** (Michailidou et al., 2013), **prototyping** (Heck et al., 2015) and so on (Kaulio, 1998). In the context of users' perceptions of products, Kano et al. (1984) has to be mentioned who have developed a model for classifying needs into **basic needs, performance needs and delighters**. These works and related approaches more focus on the product part while they neglect the service part. Furthermore, those approaches investigate the customer and the customer behavior on a more concrete level. They provide procedures for improving a product concerning the usability or optimizing the product for relevant use cases. However, they might not consider all aspects of customer acceptance, because their focuses lie on the product use only. Those approaches cannot include the case of integrating a new service into a PSS to increase customer acceptance. There are other approaches dealing indirectly with issues that are relevant for customer acceptance, while their focuses are limited to a few aspects of customer acceptance only. **Customer Relationship Management** supports the customer connectivity (Baran et al., 2008). **Quality Management** (Garvin, 1987), **Value Engineering** (Park, 1999), **Integrated Value Engineering** (Behncke et al., 2014), or **Cost Management** (Ehrlenspiel et al., 2014) can improve the requirements fulfillment. **Open Innovation/Organization** approaches facilitate customer loyalty (Gürtler & Lindemann, 2013). These approaches only look on parts of customer acceptance. In addition, the research area marketing can be seen as a powerful lever to increase customer acceptance, e.g. by measures to improve the presentation method of products to customers. However, marketing can affect the pre-purchase stages, while it has limitations in compensating barriers of customer acceptance arising in the PSS use phase.

The literature provides many approaches that indirectly focus on one or more aspects of customer acceptance. However, those approaches are not useful for influencing particular aspects of customer acceptance. Furthermore, they are not competing with the PSS approach: they can be used additionally. PSS are capable of addressing particular aspects of customer acceptance, because there is a broad range of services that can be offered additional to a product. Kittl (2009) states that pre-sales, sales and after-sales processes (that result in services) are oriented towards the customer and influence the customer acceptance. The approach PSS includes a strong customer orientation and can provide benefits for the customer. The service part of a PSS can purposefully focus on particular aspects of customer acceptance. If the preconditions for customer acceptance change, the PSS can be easily adapted to changing requirements of customer acceptance, because the service part is easier adaptable than a product only (Kammerl et al., 2015).

PSS seem to be a promising approach to focus on particular aspects of customer acceptance. The next section explains the term PSS and its benefits and disadvantages.

2.2 Product-Service Systems

PSS or servitization is the lever this work uses to increase customer acceptance. This section first declares the term PSS and discusses specific characteristics, advantages and disadvantages of PSS. Since there are some approaches for PSS development and PSS planning focusing on

customers, a literature review evaluates those approaches. This evaluation is a basis for identifying research gaps and for defining research questions (see section 2.3).

2.2.1 Definition

Goedkoop et al. (1999) are considered to have first stated the term *product-services systems* (PSS). They also used the term *product service combination* to describe a system that consists of both product(s) and service(s). However, today's researchers see PSS as more than just the coexistence of a product and a service: it means a system containing product and service elements that are geared to each other (Tukker, 2004). To provide this strong connection between product and service elements, those elements needs to be planned and designed together: PSS have integrated lifecycle phases, e.g. planning, development, delivery, and use (Hepperle, 2013; Meier et al., 2010a). To enable interweaved lifecycle phases, the cooperation between different departments becomes essential. In contrast to conventional product development, PSS development needs the development department to work together with the service department from the beginning of the planning process. This shift in the lifecycle is shown in Figure 2-1.

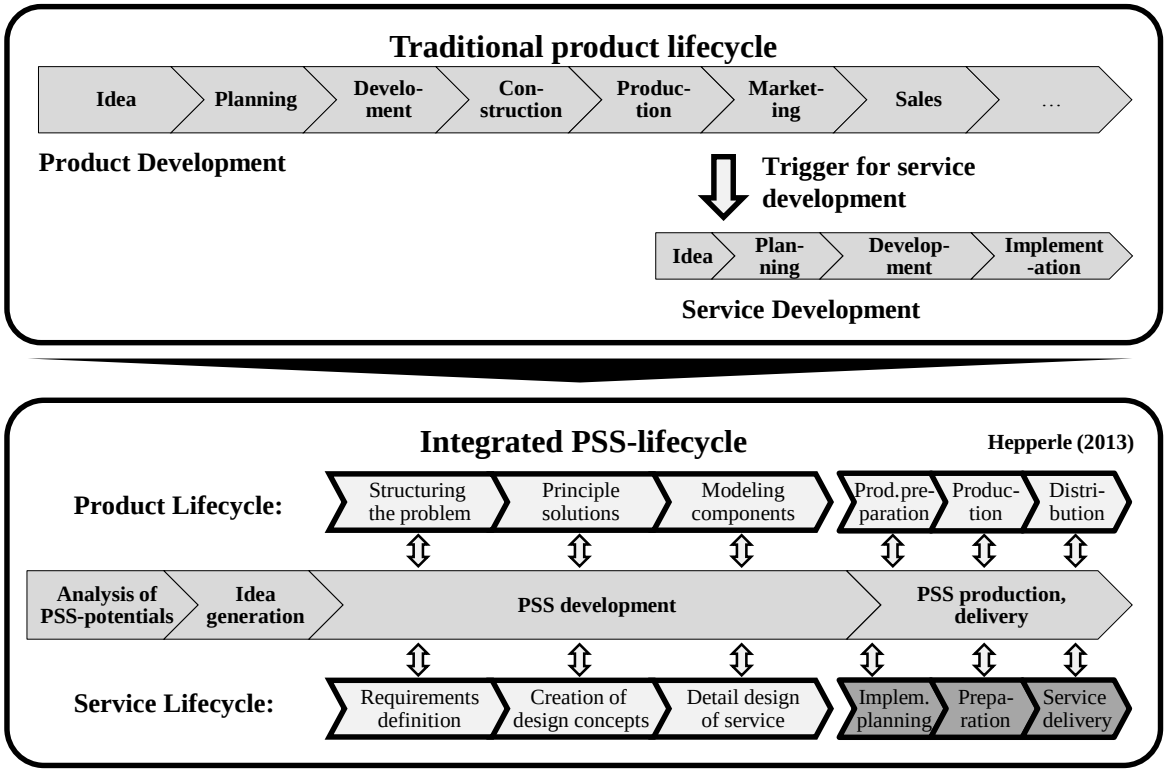

Figure 2-1: PSS lifecycle shift, adapted from Hepperle (2013)

The transition from selling products only to providing PSS is more than just changing the market offer, it also requires an organizational transition of the company (Baines et al., 2009). This organizational shift is also called servitization (Biege, 2011; Vandermerwe & Rada, 1988). Besides organizational aspects, Manzini and Vezzoli (2003) characterize PSS as an innovation strategy, Baines et al. (2007) and Tukker and Tischner (2006) define PSS as a value proposition. PSS imply a paradigm shift from selling technical products to fulfilling customer demands

(Baines et al., 2007). PSS have a wide range that Tukker (2004) classifies into three main types: (1) Product-oriented PSS are dominated by the product content and incorporate product-related services such as maintenance or consulting for product use. (2) Use-oriented PSS include renting, sharing and pooling of products. Car-sharing is an example of a use-oriented PSS. (3) Result-oriented PSS are dominated by the service content, e.g. passenger transportation without defining the means of transport is a functional result. Related terms for PSS are performance based contracting (Tukker, 2004), maintenance outsourcing (Tukker, 2004), functional sales, or functional (total care) products (Tan & McAloone, 2006). Those terms describe sub-categories of PSS, e.g. maintenance outsourcing is a special case of a product-oriented PSS. The overall concept of those approaches is called PSS.

Besides the service elements and the product elements, Schenkl et al. (2014c) came up with a third domain a PSS consists of: the connecting infrastructure. This infrastructure facilitates that service elements and products elements work together. Examples of elements belonging to the infrastructure are a communication system or an energy supply system. Those systems are necessary for product and service elements to fulfill their technical functions. Dewit (2015) suggest three pathways how service and product elements can be developed together. The *parallel pathway* (1) describes the pathway purposed by the PSS approach: it integrates product and service elements and includes interdependencies and strategic implications from the beginning. The *nested pathway* (2) develops product and service elements based on each other. The service and product elements synchronize within discrete intervals and synchronized on a continuous basis (like in the parallel pathway). The *sequential pathway* (3) starts with a product (or a service) and only adds service (or product) elements in later phases of the design process. These three pathways are shown in Figure 2-2.

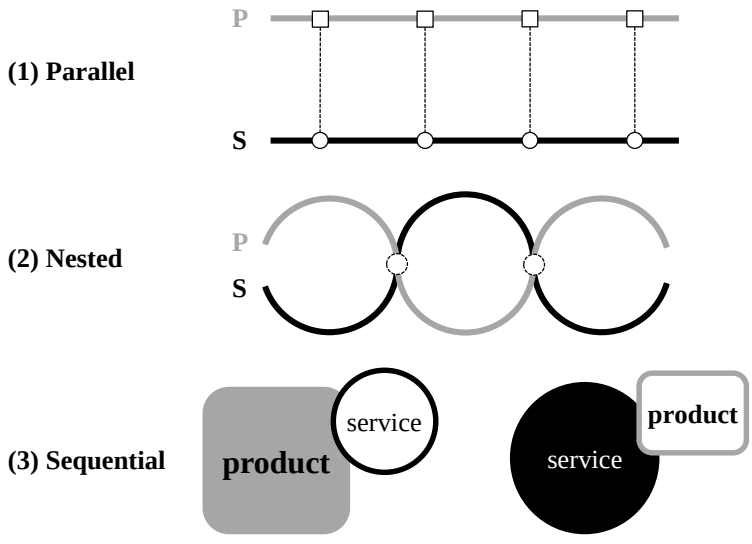

Figure 2-2: PSS pathways, adapted from Dewit (2015)

The two sequential pathways stem from the two research fields the PSS research is based on: First, the service science that sees the service as a core element of a PSS (Lusch et al., 2008; Vargo & Lusch, 2008). This service-dominant logic considers the product part of a PSS as the "service carrier". Second, the engineering fields that see the product as a core element of a PSS (Schenkl et al., 2013a). This product-dominant logic (i.e. goods-dominant logic) considers

services as capable of being beneficial for the value of using a product. Since PSS research has emerged from those two research areas, there are different perspectives on the PSS domains and elements. However, the PSS approach desists this strict differentiation of product and service elements (Bochnig et al., 2013). PSS elements (so-called PSS modules, PSS elements or PSS components) can include product elements, service elements, and elements focusing on fulfilling customer needs and increasing customer values (Bochnig et al., 2013).

Approaches from the service-dominant logic force a stronger service orientation, while the product-dominant logic still considers the technical product as the essential part of the PSS. Those two main streams also differ in the kinds of companies they focus on and they differ in the disciplines they belong to. While approaches from service science focuses on service-related industries, e.g. banks or web-services (Heinrich et al., 2011; Höfer & Karagiannis, 2011), approaches from engineering focus on traditional markets of technical complex products, e.g. machine tools or automotive industries (Meier et al., 2010a; Schenkl et al., 2013a). Linking the foundational premises of service-dominant logic with those two different types of industries results to the assumption that the service-dominant logic might be easier applicable for service-related industries. It might be more expensive and more difficult to apply approaches from service-dominant logic to companies, which have not yet completed the servitization process and which still have a strong focus on their tangible products: this usually includes a powerful product development department and an underrepresentation of service departments and service employees. Even though such a company had greater margins in its service business, the focus would still lie on developing and producing a high-quality product, instead of focusing on customer wishes. While those companies still lack acceptance of approaches of service-dominant logic, there is a need for tools and methods for engineering companies to increase this acceptance and to start the PSS transition process.

Based on these considerations and based on Schenkl (2014) and Schenkl et al. (2013a), this work defines PSS as follows:

PSS are an integrated market offer that combines product elements, service elements and a connecting infrastructure (=PSS elements). The aim of PSS is to increase customer value instead of selling a product or a service only. PSS are characterized by integrated lifecycle phases that facilitate a strong linkage between PSS elements. This requires a parallel planning and designing of PSS elements.

This definition includes the relevant implications from PSS research for this work. PSS must orientate towards customers and PSS require an integrated planning phase. This work focuses on increasing customer acceptance using PSS. To motivate further investigation of the relation between PSS and customer acceptance, the next subsection show the advantages and disadvantages of PSS for different stakeholders as they are described in literature.

2.2.2 Advantages and Disadvantages of PSS

The literature describes multiple advantages of PSS. The switch from owning products to using products leads to a dematerialization that decouples economic growth and sustainability (Baines et al., 2007; Goedkoop et al., 1999; Tukker & Tischner, 2006). The switch from selling technical products to fulfilling customer needs is beneficial for customer values (Manzini &

Vezzoli, 2003; Tukker, 2004). Providers can better distinct from the competition (Baines et al., 2007; Schenkl et al., 2014b). PSS facilitate long-term customer relationship (Vasantha et al., 2012) and higher customer loyalty, as well as higher revenues due to expanding business activities by services (Cavalieri & Pezzotta, 2012). PSS include a lower total cost of ownership than conventional products (White et al., 1999) and they are suitable for customizing (Cook et al., 2006). Researchers also stated disadvantages of the PSS approach (Mont, 2002b; Mont, 2004; Omann, 2003; Schenkl et al., 2014b), e.g. customers perceive the PSS lifecycle costs as too high. Schenkl (2014) analyzed the literature concerning the number of mentions of advantages. The analysis' result shows that literature mentions more advantages for providers than for customers and society. The main advantage for the society is the sustainability, while literature just names a few advantages for customers. This might be caused in the intention of PSS literature: there are many approaches that provide measures or methods for companies to deal with PSS. To increase the acceptance of companies for using those measures, companies have to know the advantages and literature mainly describes the advantages for the providers. PSS literature includes overall a more provider-based view on PSS, even though PSS are made to fulfill customers wishes and not to fulfill providers wishes. However, there are some approaches oriented towards customers in PSS research. These approaches are explained and analyzed in the next subsection 2.2.3.

2.2.3 Approaches for Customer-Orientation in PSS Design

To investigate approaches that enable a customer-oriented PSS design, a literature study was conducted based on the results from another literature analysis that was completed in a previous stage. This previous study according to Schenkl (2014) does not consider the customer view itself, it considers the customer view as a part of the market view. He considered the following criteria: the product or service perspective describes if the approaches consider both kinds of PSS elements (product perspective or service perspective). Approaches might focus on the PSS itself (product view) and/or on the (design) process of PSS (process view). Some approaches regard the company's knowledge or new technologies in the PSS innovation processes (knowledge perspective or technology view). Implications from external stakeholders are also relevant for PSS design (market view).

Since this dissertation focuses on customer acceptance, the literature review investigates if PSS approaches consider the customers and their requirements and preferences (customer view). The study of (Schenkl, 2014) was expanded by the customer view and by some sources that were considered as relevant for PSS design (Dewit, 2014; Hussain et al., 2012; Kim et al., 2011b; Pezzotta et al., 2014; Sakao & Shimomura, 2007). Table 2-2 shows the results of this literature review that presents if the approaches consider, partly consider, or do not consider the perspectives and views.

Table 2-2 Customer view of approaches from literature, based on (Schenkl, 2014)

Legend: ● considered ◌ partly considered ○ not considered	Product perspective	Service perspective	Knowledge perspective	Product view	Process view	Technology view	Market view	Customer view
(Meiren & Barth, 2002)	○	●	●	●	●	○	◌	○
(Oliva & Kallenberg, 2003)	○	●	◌	◌	◌	○	◌	○
(Aurich et al., 2006)	●	●	◌	○	●	○	◌	○
(Egeling & Nippa, 2009)	○	○	●	○	●	○	○	○
(Sundin et al., 2009)	●	○	○	●	○	○	○	○
(Hepperle, 2013)	●	◌	◌	●	●	●	○	○
(Herzberger et al., 2013)	○	●	◌	●	●	○	◌	◌
(Hussain et al., 2012)	○	◌	◌	○	●	○	◌	●
(Pezzotta et al., 2014)	○	●	○	◌	●	○	◌	●
(Sakao & Shimomura, 2007)	◌	●	○	◌	●	○	●	◌
TR 29	●	●	◌	●	●	○	○	◌
(Wallin, 2013)	○	◌	●	○	○	○	○	○
(Baureis, 2013)	○	○	●	◌	◌	○	○	○
PROTEUS	○	●	●	◌	●	○	●	◌
(Schenkl, 2014)	●	●	●	◌	○	●	◌	◌
(Kim et al., 2011b)	●	●	○	◌	●	◌	◌	◌
(Dewit, 2014)	●	●	○	◌	●	○	◌	◌

Approaches were evaluated at “considered” concerning the customer view if they include the customer view in the process and if they propose explicit methods to involve customers. The customer view is rated as “partly considered” if the customer view is just mentioned but not described in detail. “Not considered” means the lack of customer view in the approaches.

Meiren and Barth (2002) developed their approach for service engineering and not for PSS. The customer use value is determined in the product model and the customer interaction. Despite mentioning the importance of customer integration for providing successful PSS, they do not show how this should be done. Oliva and Kallenberg (2003) claim that changing the product-oriented relationship with the customer to a service-oriented relationship increases

customer acceptance. However, they do not mention any strategies or methods to increase customer acceptance. Aurich et al. (2006) describe a process-oriented way for developing PSS. They only mention the importance and relevance of involving customers and customers' needs and they indicate the process-phase in which customers should be included. Egeling and Nippa (2009) consider customers from the knowledge perspective. They state that customers have social-competences, method-competences, meta-competences, and subject-specific-competences. Providers have to possess the same knowledge and competences their customers have. However, no further considerations of the customers and their needs are made. Sundin et al. (2009) created a „Design for PSS"-approach that mentions the customer demands as drivers for PSS. However, it lacks a detailed consideration of customers and their needs. Hepperle (2013) considers the PSS lifecycle and the processes that ensure an integrated development of products and services. However, the customer-perspective is not considered at all. Herzberger et al. (2013) combine a business model canvas, a PSS lifecycle and a PSS configurator. All three parts consider the customers and their needs. Their service blueprinting mentions customer segments and the customers' pain or problems. That kind of customer integration is promising to connect service parts with customers' problems. This dissertation will consider the customer in a similar way (see chapter 3); however, the customer should be considered for both product and service components of a PSS. Herzberger et al. (2013) keep the description of customers' problems very generic and they do not mention customer barriers or aspects. The project TR 29 considers the customer as a relevant object in the PSS lifecycle and in the process model (Meier, 2013). The customers and their needs are the basis for the PSS development process. Meier (2013) suggests a PSS-layer model that involves the customer view via two layers: the customer needs layer and the customer value/benefit layer. While the customer needs layer describes what the customer needs, the customer value layer shows what the customer perceives as valuable (Müller & Stark, 2008). This approach focuses on the positive aspects of the PSS for the customer and how the PSS should be designed based on the perceived advantages. However, they do not take into account possible disadvantages of a product and how a PSS can reduce those disadvantages. Wallin (2013) points towards the importance of customer needs and customer relations in the PSS development. All phases of the development process have to consider customers and their needs. Even after the development stage, new customers can be identified. However, a detailed analysis of customer needs and their integration into the development process is not provided by Wallin (2013). Baureis (2013) does not consider the customer view, he only mentions the importance of integrating customers into PSS development. PROTEUS (Apitz et al., 2013; Avlonitis et al., 2013; Finken et al., 2013) focuses on user-oriented servitization and describes the transformation from selling products only to providing PSS. PROTEUS considers different perspectives, like the processes, and proposes PSS tools. Customers are involved in every step, however, only customers of the maritime industry are in the focus. As the relationship to the customers on the business model level is the core theme, PROTEUS does not mention customer barriers or problems. Schenkl (2014) proposes a framework dealing with consider the company's knowledge base and new technologies. For this, he also includes customer acceptance as a relevant factor for the success of technologies. Furthermore, he identifies barriers of customer acceptance of PSS. However, he does not investigate how those barriers can be reduced or eliminated. Hussain et al. (2012) built a framework to improve PSS design in the conceptual phase by integrating data and information of the use phase. They identify dissatisfaction of customers to enhance service

processes by optimizing service parameters and structure. Similar to Hussain et al. (2012), Pezzotta et al. (2014) developed a methodology for service engineering for adapting services to customers. They suggest different methods like the service requirements tree that supports designers in handling different kinds of requirements. They want to increase customer satisfaction by adjusting services. Sakao and Shimomura (2007) distinguish between the flow model (process orientation), the scope model (orientation towards service-stakeholder) and the view model (relations between customer satisfaction, services, and content parameters). They define the receiver state parameter (RSP), which is a measure for customer satisfaction. Adapting a PSS might increase (values for RSP) or decrease (costs for RSP) customer satisfaction (RSP). Dewit (2014) developed a framework consisting of the exploration level, the ideation level, and the definition level. His approach provides processes and methods for PSS planning and deals with user experience and a strategic transition. Even though he focuses on user experience, concrete measures of customer integration are missing. Kim et al. (2011b) built a design process for PSS and activities to support PSS design. They partly considered the customer by providing measures for customer integration, e.g. personas or stakeholder activity design. However, they do not describe in detail how the customer integration is to be accomplished.

2.3 Research Clarification

After defining relevant terms for this work and analyzing existing PSS approaches, this section defines the research questions and the system boundary of this work. First, the deficits of existing approaches and challenges in industry are identified. Based on this, the mechanism for increasing customer acceptance using PSS is presented. This results in formulating the four research questions. After that, the focus of this work is determined and potential appliers (companies, departments, markets) are described.

2.3.1 Why: Deficits of existing approaches and challenges in industry

The literature review (see subsection 2.2.3) shows seven approaches involving the customer view. Even though all authors mention the importance of integrating customers in the PSS development, only a few lay the focus on the customer. The research project TR 29 considers and investigates the customer on its own layer. This approach considers how a PSS influences customers: the PSS has to fulfill requirements and gain benefits for customers. Other approaches (Hussain et al., 2012; Pezzotta et al., 2014; Sakao & Shimomura, 2007) integrate the customer view only by adapting service parameters or optimizing service processes. Dewit (2014) considers user experience only and (Kim et al., 2011b) only presents existing methods to integrate customers. Some of them define terms, which are similar to customer barriers: customer dissatisfaction (Hussain et al., 2012) as the target of the PSS development, the gap between customer needs and PSS options (Pezzotta et al., 2014), or a decrease of the receiver state parameter (Sakao & Shimomura, 2007). Those approaches have included the customer view as a measure to quantify the desired state that is necessary for optimizing service parameters. However, they lack qualifying customer aspects of customer acceptance and they

only focus on adapting services. They do not consider offering new services or using another business model, e.g. offering a result-oriented PSS instead of a product-oriented PSS.

PSS literature provides many approaches to support companies or designers, while literature neglects the customer-orientation. As the introduction (see section 1.1) has shown, PSS are capable of increasing customer acceptance. However, literature does not provide suitable measures and methods that are easy to understand for practitioners. Based on the literature review in section 2.2.3 and based on literature reviews that were described in section 4.2, in section 5.2, and in section 6.1, the following deficits were identified:

- Model of customer acceptance that is easy to understand and that is valid for technical products (see section 5.1)
- Measures/methods that are easy to understand to support PSS planners (see section 6.1)
- Measures/methods that are easy to understand and that are connected to customer aspects for increasing customer acceptance
- Procedural framework of PSS planning that involves aspects of customer acceptance (see section 4.2)

Besides these gaps in literature, industry lacks methodical support to design PSS based on customer aspects. The PSS shift has not yet started and completed for several industries (Neely, 2008), there is a need for supporting companies in this PSS transition. A survey in German manufacturing industry revealed that only 25% of customers use a PSS (Schröter et al., 2010). Neely (2013) characterize 25% of German manufacturing firms as servitized which is a lower level than UK or the US. Other sectors like Energy and consumer goods have lower levels of servitization. Industrial branches like construction and engineering, aerospace and defense or industrial machinery have a greater level (around 50%). However, they are lower than the levels of servitization of firms from UK. Neely (2013) states that the high product quality German firms are known for could be reason for the lacking servitization. For this reason, the German companies that are product and quality oriented must handle the challenge of switching to customer-oriented services. Professor Hermann Simon underlined this missing capabilities of German companies to offer customer-oriented services and coined the term "Servicewüste Deutschland" (service desert Germany) (Gieskes, 1995). This term is still often used in today's German journalism (Danhong, 2015; Schmieder, 2015; Tödtmann, 2015). One of the critical success factors is the adoption of processes and methods to services Martinez et al. (2016), because service processes are different to traditional processes of products. Meuris et al. (2014) and Herzog et al. (2015) describe the lacking success of PSS in German manufacturing industry, based on the mindset needed for this extensive transition. To promote the servitization in those industries requires guidelines that are easy to understand by practitioners (Meuris et al., 2014). The planning phase, in particular, is responsible for the success of PSS (Meuris et al., 2014) and must be supported by tools and methods (McAloone, 2011). The PSS shift also requires a stronger customer-orientation in industry. While product innovations are based on both technology push and demand pull, service innovations are mainly generated by demand pull (Lay et al., 2011). Companies undergoing the PSS transition have to change their innovation mechanisms towards demand pull in order to be able to provide innovative PSS. From the industrial perspective, tools, methods, guidelines, and processes for the planning phase of PSS are needed that orient towards customer acceptance.

After concluding the deficits in literature and the needs in industry, the next sub-section present the basic approach of this work to fill these gaps. Chapter 3 and the descriptive study I provides a description in detail.

2.3.2 How: Approach for Increasing Customer Acceptance

The main hypothesis underlying this work is that PSS are capable of increasing customer acceptance. However, researchers pointed out that PSS also have deficits and barriers with regard to customer acceptance (Schenkl et al., 2014b). To reach the goal of this work, i.e. providing measures to increase customer acceptance, one option could be to find measures to reduce the deficits of PSS (= push strategy). This focuses on the PSS and this approach would only have smaller benefits for customers, because the customer is not in the center but the PSS. A more promising approach is to focus on the customer: based on aspects of customer acceptance, the PSS has to be designed and adapted (= pull strategy). This approach considers not only deficits of PSS but also concerns of customers. This approach enables a real customer-orientation to increase customer acceptance. The two principles of market push and market pull can describe the differences between these two approaches: while the approach dealing with reducing the deficits of PSS (push) tries to push a PSS into a market by reducing its deficits, the approach dealing with customer acceptance uses the market pull mechanism by referring to aspects of customer acceptance (pull). Those two approaches are shown in Figure 2-3.

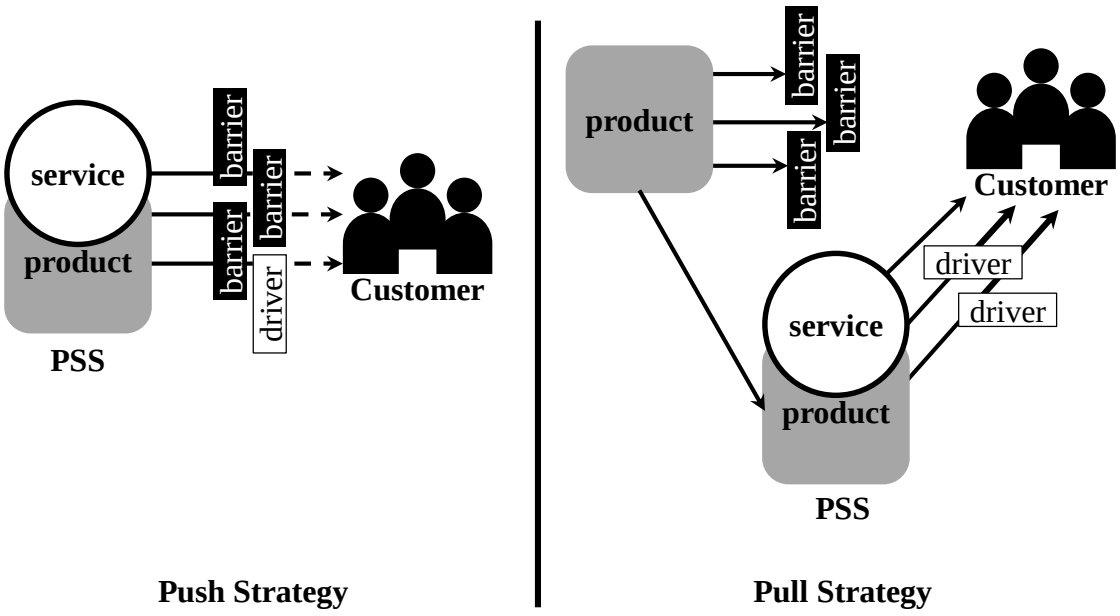

Figure 2-3 Pull strategy and push strategy for increasing customer acceptance

This work creates measures, methods, and processes to realize the second approach (pull strategy) and to support practitioners and companies in implementing PSS to increase customer acceptance. A further investigation of customer aspects is needed because the measures and methods to build are based on these aspects. Chapter 5 analyses the aspects of customer acceptance. Then, the service catalogue, a method to support PSS planners, is described in chapter 6. To enable companies to performing the PSS switch, they need a procedural model

for planning PSS. This process model also locates the measures into the planning process and is provided in chapter 4.

2.3.3 What: Research Questions

To define the aims of this work, this subsection asks the research questions. The thesis focuses on answers of those research questions and the reflection in chapter 9 discusses how those research questions were processed in this work. Thus, the work is based on the research questions and the questions define the system boundary. Four research questions were defined, while the first research question is the main question and three further research questions investigate partial aspects of this first question on a more detailed level: RQ #2-4 are sub-questions of RQ #1.

RQ #1: How can PSS planning increase customer acceptance?

The work focuses on supporting companies in the first step of the PSS transition. Models and methods should support companies concerning three areas mentioned in this first research question: PSS, planning, and customer acceptance. The next research question concerns the aspects of customer acceptance. Those aspects defined in section 2.1 describe factors and effects that influence the purchase decision and the customers' perceptions. This work investigates these aspects to provide a basis for measures and methods of PSS conceptual design.

RQ #2: Which aspects, drivers, and barriers of customer acceptance influence the customers and their perceptions of products, services, or PSS?

This work's approach uses PSS for influencing aspects of customer acceptance. This includes to figure out how to configure a PSS to influence particular aspects of customer acceptance. A perfect PSS does not exist, which is able to increase customer acceptance based on all aspects. To find a PSS configuration that increases customer acceptance, the PSS must be optimized for the aspects that are most relevant for a market or a customer group. This makes it necessary to investigate the mechanisms of PSS to influence aspects of customer acceptance.

RQ #3: How can PSS affect the aspects of customer acceptance to increase customer acceptance?

Besides providing tools and methods of planning PSS to increase customer acceptance, companies must be able to perform the PSS transition from the procedural perspective. This requires to know the activities that are necessary to plan PSS and define milestones to structure the planning process. There are many terms describing the planning phase, like fuzzy front-end, conceptual design, or early stages of PSS development or design. The planning phase this work is focused on starts with a rough PSS idea (input). This could be an idea for improving an existing product/PSS. The planning phase ends with a PSS concept (output) including product and service elements that is the starting point for embodied design. Organizational aspects that are relevant for the PSS transition are not discussed in this work (Calabretta et al., 2016). The fourth research question focuses on a process model for planning PSS.

RQ #4: How can a company design the PSS planning phase to increase customer acceptance?

Those research questions set the boundaries and define the orientation of this work; however, the questions neglect to define the focus on industry branches or on kinds of customers or products. The next subsection deals with the industry branches, kinds of companies, customers, and products on which this work is focused.

2.3.4 Who and Where: Relevant Products, Markets, Companies, and Users

This work focuses on typical companies of the PSS research field, i.e. companies offering technical complex products. Examples for those products are construction machines, cars, trucks, ships, trains, machine tools, manufacturing facilities, home appliances, mobile phones, laptops, or consumer electronics. Those products are focused that reach more benefits for customers by passing the PSS transition. This is the case for products that are difficult to use, because the user can be supported by services in the use phase. This might be not essential for simple products that are easy to use. However, also simple products can benefit from the PSS transition, e.g. clothes including a guarantee or a tailor service. Those markets are not considered, because the author of this work has mechanical engineering background and lacks knowledge of non-engineering markets. Besides complete solutions as products, this work also focuses on product components. If product components are important enough for the product functions, they also suit the PSS transition, e.g. turbines as important components of airplanes (Rolls Royce “Power by the Hour”).

The focus lies on both B2B and B2C markets. Since those two markets are differently organized and since they include varying implications for the PSS transition, this work considers different market’s requirements. There are products that are sold in both markets, e.g. cars for private use and for business clients. Those two cases require two different kinds of PSS offers. This work’s methods and tools can satisfy both markets’ requirements, because the approach itself is generic enough. Applying this work’s results to a market requires to consider all market-specific criteria. The aim of this work is to provide basic methods and tools basis that can be used for planning PSS oriented towards customers.

The methods and tools to be created in this work are beneficial for companies that have recently started the PSS transition process. Service-oriented companies that grew up with the service mindset, e.g. Apple or Google, might not see a benefit in using those methods. They need advanced methods provided by the approach of service-dominant logic. This work focuses on companies that grew up with developing, producing and offering a complex tangible product. Those companies usually have quite powerful development and production departments and weaker service departments due to historical reasons. They might have problems in using approaches from service-dominant logic, because their traditional mindset is oriented to the tangible product and not to customers’ benefits. Major corporations usually have started the PSS transition years ago and they have implemented standard processes and methods to plan and design PSS. However, many small and medium-sized enterprises (SME) need support in planning PSS. This work provides methods and tools to support SME in doing their first steps into PSS transition.

Potential users in companies might be from different departments and backgrounds. The models and methods mainly help product managers in understanding customers' behavior and in planning PSS. Other users might be sales managers or employees of the marketing department who need to better understand customers. Employees of strategy departments responsible for planning new PSS could also use some results of this work. Process managers could use the decision-making process of PSS planning. The models support service departments to improve existing services or to develop new services. The models provided by this work might be helpful for controlling: the model of customer acceptance and the service catalogue could be used as checklists to permanently ensure that the PSS fulfills the aspects of customer acceptance.

3. Customer-oriented Framework for PSS development

The DRM by Blessing and Chakrabarti (2009) defines the descriptive study I as the stage to provide a more detailed analysis of the current situation and the problem defined in section 2.3. The research clarification in the previous chapter 2 identified the research gaps on which this thesis focuses. However, there are the research gaps and the approach of PSS aims to fill those gaps, so a framework was developed to describe the problem and the way PSS can help users to solve it. This model is a customer-oriented framework for planning and developing PSS and shows the interrelations between PSS, customer acceptance and corporate strategy. It keeps this thesis' focus in an adequate range. Developing and analyzing this framework results in adjusting the focus of this thesis. Besides the applicability and benefit of this framework to situations described in section 3.1, this framework has helped the author get a clear understanding of the problem and helped to specify the focus of this thesis.

Developing and describing the model is orientated around the General Model Theory of Stachowiak (1973). His process for defining a model consists of four steps: planning, modeling, evaluating, and using the model. Section 3.1 deals with planning the model and presents the purpose, the basis, the original, and possible stakeholders of the model. The modeling itself describes the framework and the layers and relations involved in section 3.2. In section 3.3, the framework is evaluated and the implications for this work are underlined. Case study VIII (section 7.1) creates a new a sales concept based on this model.

3.1 Model's Basis and Purpose

The framework describes how PSS can increase customer acceptance by influencing diverse aspects of customer acceptance. It defines the relations between the domains that are considered within this dissertation. These domains are the perspectives or layers which are relevant for research clarification and which are necessary to consider for answering research questions. The framework can serve as a development model, like the technology-centered model according to Schenkl et al. (2014c). This model includes three levels representing the product-view of PSS and facilitates the target of PSS to solve performance gaps in innovations (Schenkl, 2014). The technology-centered framework visualizes the potential of PSS to overcome innovations performance gaps and enables a broader understanding of this issue (Schenkl, 2014). In a similar way, the customer-oriented framework demonstrates the capability of PSS to increase customer acceptance by influencing aspects of customer acceptance. Unlike the technology-oriented framework, this framework is not only applicable to improving communication in the development process (Schenkl, 2014). The customer-oriented framework might be also suitable for marketing or sales, for generating customer-oriented offers, or for identifying new customers. The framework supports an understanding of the hypotheses expressed in the research questions and explains to practitioners the benefits of PSS concerning customer acceptance.

The customer-oriented framework is based on the technology-centered framework according to Schenkl et al. (2014c). While the technology-centered framework focuses on the target-

means relationships between technologies and PSS, the customer-oriented framework focuses on the relations between customers and PSS. Furthermore, the relevant effects of the environment, like the strategy, are modeled as well. To build the customer-oriented framework, the technology-centered framework was adapted during the research clarification. The literature review revealed domains and perspectives which are essential for investigating the research questions.

3.2 Customer-oriented Framework

The research clarification (see section 2.3) has revealed the relevance of customers, aspects of customer acceptance, and the PSS as a solution concept for the research questions. The framework models those three fields as layers that depend on each other. However, there are other relevant criteria affecting decisions about planning PSS for increasing customer acceptance. The framework involves these criteria in the strategy space that covers all three layers, because strategic aspects affect working or decision-making within one of those layers. As this work focuses on company-related planning and developing processes, those external and environmental issues are covered by the corporate strategy. The customer-oriented framework is shown in Figure 3-1.

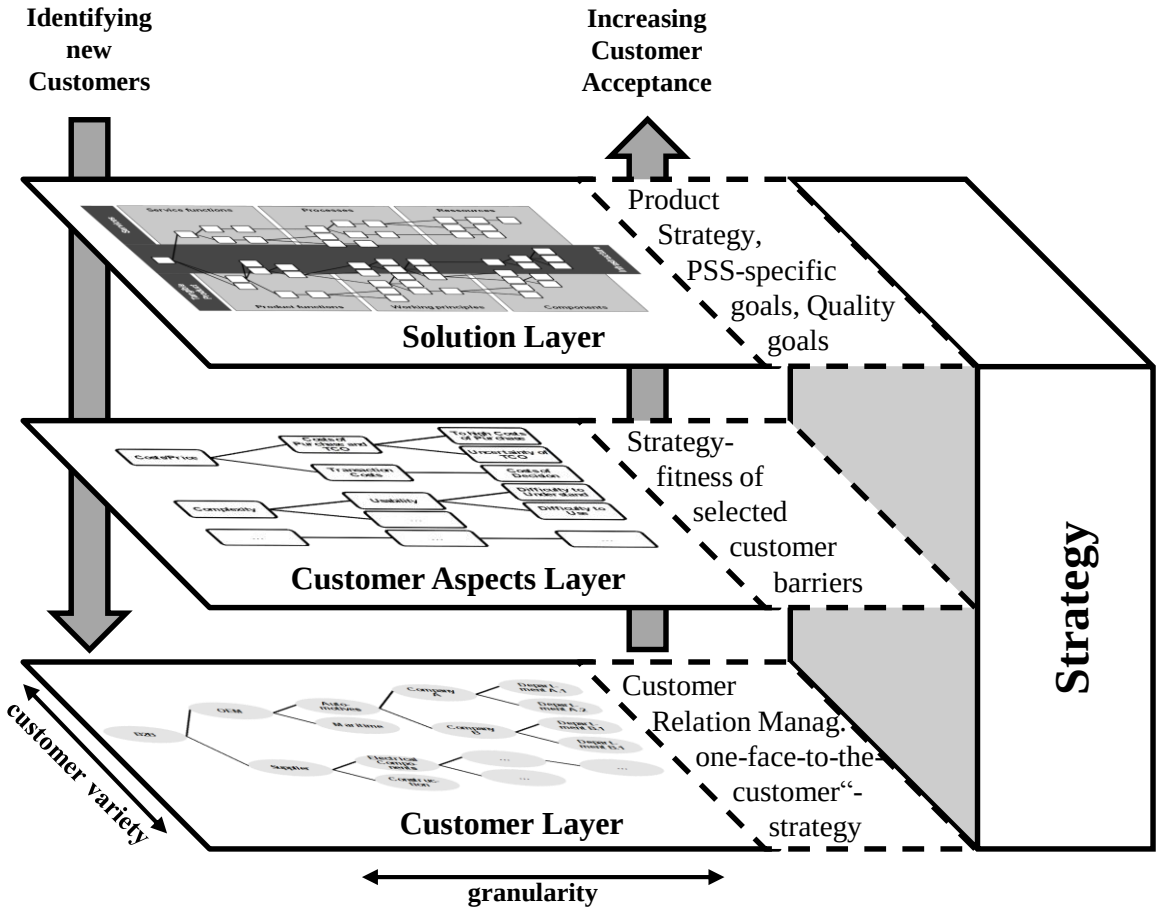

Figure 3-1 Customer-oriented framework

The lower level is the customer layer that describes the target groups of customers on which the PSS focuses. Above the customer layer, the layer for customer aspects is arranged. This layer involves aspects affecting customer acceptance. The relevance of those aspects depends on the target customers. The upper layer of the framework represents the solution. This layer includes the PSS as a solution for increasing customer acceptance. It aims to plan or compose the PSS to influence the customer aspects of increasing customer acceptance. It is closely related to the solution layer defined by Schenkl et al. (2014c). The work directions within this layer define the relations between the three layers; the model can serve as a framework to increase customer acceptance using PSS, or as a framework to identify new customer groups for existing PSS. The next subsections describe the framework from the work direction of increasing customer acceptance using PSS, because this direction suits the problem description and the research questions. The layers, the strategy space, and the work directions will be specified within the next subsections to provide a more detailed view of the customer-oriented framework.

Customer Layer

The customer layer deals with the customers and sees customers divided into groups and levels of detail. This layer enables PSS providers to select their target groups. To find in a suitable customer group, providers have to define an adequate customer variety and granularity. The variety distinguishes between categories of customers at the same level of detail. Variety in B2B markets results in the differentiation of industrial sectors, like the automotive industry, maritime industry, or manufacturing industry. The granularity defines the level of detail for the customer group. Changing the granularity means to specify or to summarize whether customers or customer groups are used on the graph. On a less precise level, entire markets or industry sectors are the focus. Individual customers or departments are considered at a more detailed level of granularity.

Figure 3-2 shows the customer layer and examples of customer groups. In this layer, the provider decides about the kinds of customers. Those customers are the subject of increasing customer acceptance within this work.

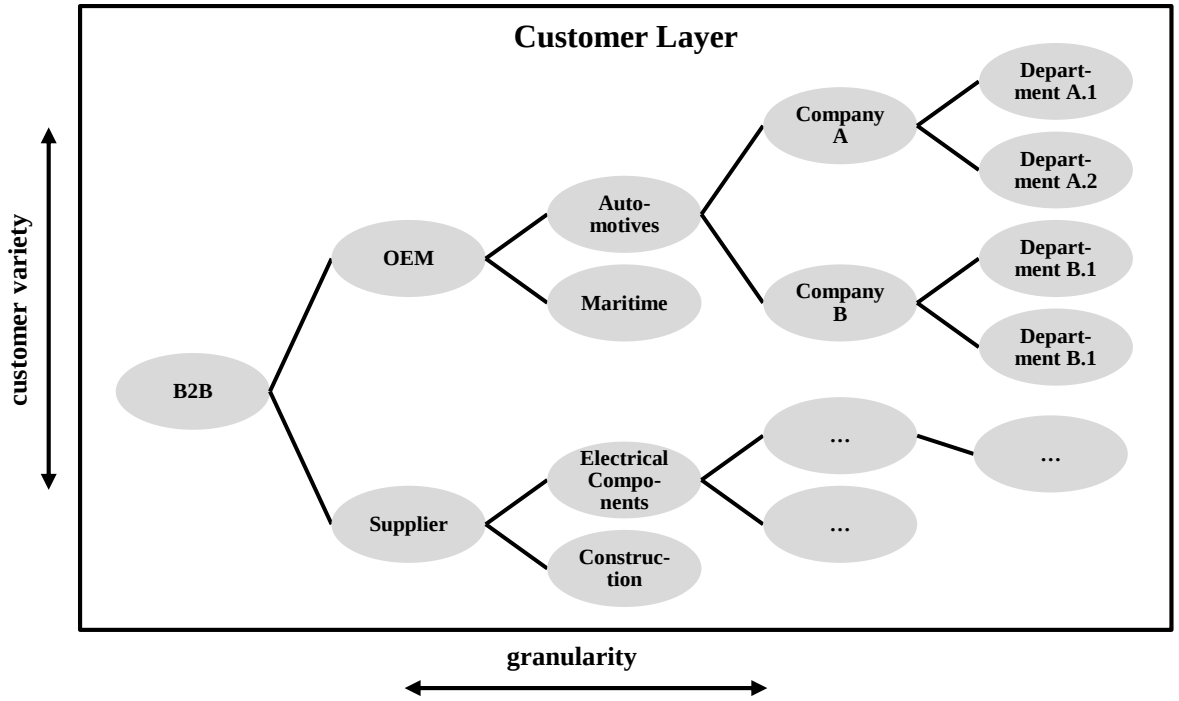

Figure 3-2 Customer Layer

Dependent on the customers selected, varying aspects of customer acceptance are relevant for the purchase decisions. E.g., while security of customer data is a relevant aspect for online businesses, it might be less important for the steel industry that does not handle much customer data. The customer layer determines the dimension of customer variety, which affects the customer aspects layer and the solution layer. For this, methods for customer selection and segmentation might be helpful (Hosono et al., 2009; Pirola et al., 2014). Besides the customers as individuals, their situations or use cases can be included in this layer. The relevance of aspects of customer acceptance is also based on customer situations, use cases, or user scenarios.

Customer Aspects Layer

Aspects of customer acceptance influence the purchase decisions (see definition in section 2.1). Those aspects are barriers to or drivers of customer acceptance and reasons for positive or negative purchase decisions. In this role of aspects, the customer aspects layer is located between the customer layer and the solution layer; the decision of a customer for or against a product in a defined situation (= customer layer). A service or a PSS (= solution layer) depends on those aspects of customer acceptance. Examples for those aspects are perceived complexity, psychological effects, or unawareness of need (see chapter 5).

The customer variety in this layer determines the relevance of aspects of customer acceptance. The solution layer describes a PSS for influencing the aspects. The customer aspects layer defines the relevant aspects the PSS should be designed for. As each customer group has its own aspects relevant for purchase decisions, this layer is for identifying and quantifying specialized aspects for the customer group being considered.

The granularity of this layer depicts the resolution of the customer aspects (see section 2.1). The aspects are structured based on a cause-effect-chain, consisting of four layers: characteristics/perception, cause, effect, and consequence (see section 5.4). The granularity describes on which level of detail the solution layer considers and uses the customer aspects.

Figure 3-3 shows the customer aspects layer and an excerpt of customer aspects and their sub-categories. For this layer, the user of the model decides what kind of customer aspect should be focused on to increase customer acceptance, based on the target customer group.

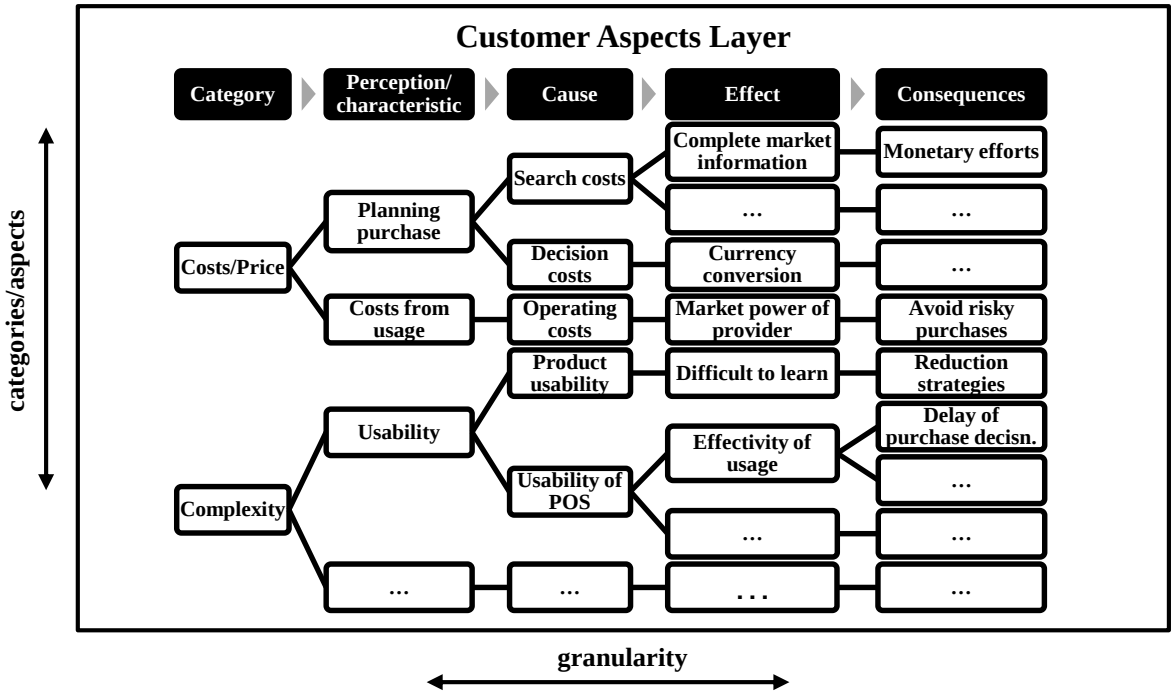

Figure 3-3 Customer aspects layer

Solution Layer

The definition of the solution layer in this work is based on the definition according to Schenkl et al. (2014c). This layer contains the design of the PSS concept consisting of service elements, tangible product elements, and the infrastructure. Ponn and Lindemann (2011) define three levels of abstraction (set by the granularity) for the elements of tangible products: product functions, working principles, and components (Ponn & Lindemann, 2011; Ponn, 2007). Bullinger et al. (2003) defines three levels of abstraction for the service elements: service functions, processes, and resources. The infrastructure is for connecting and coordinating service and product elements and also described as coupling elements (Schenkl et al., 2014c; Schumann et al., 2012). The highest level of abstraction considers service and product elements as PSS elements (Eisenbart et al., 2012). Those PSS elements originate from concrete requirements and they are not distinguishable from service or product elements. The further embodiment design process will implement PSS elements as service components, product components, or both.

The customer variety results in a variety of PSS concepts in the solution layer. A PSS concept is the abstract description of PSS elements and their relations (see section 2.2). Setting the focus

on a customer group affects the PSS concept suitable for this group. To cover a broader range of customer groups, companies offer more than one PSS. They have a PSS portfolio consisting of multiple variants.

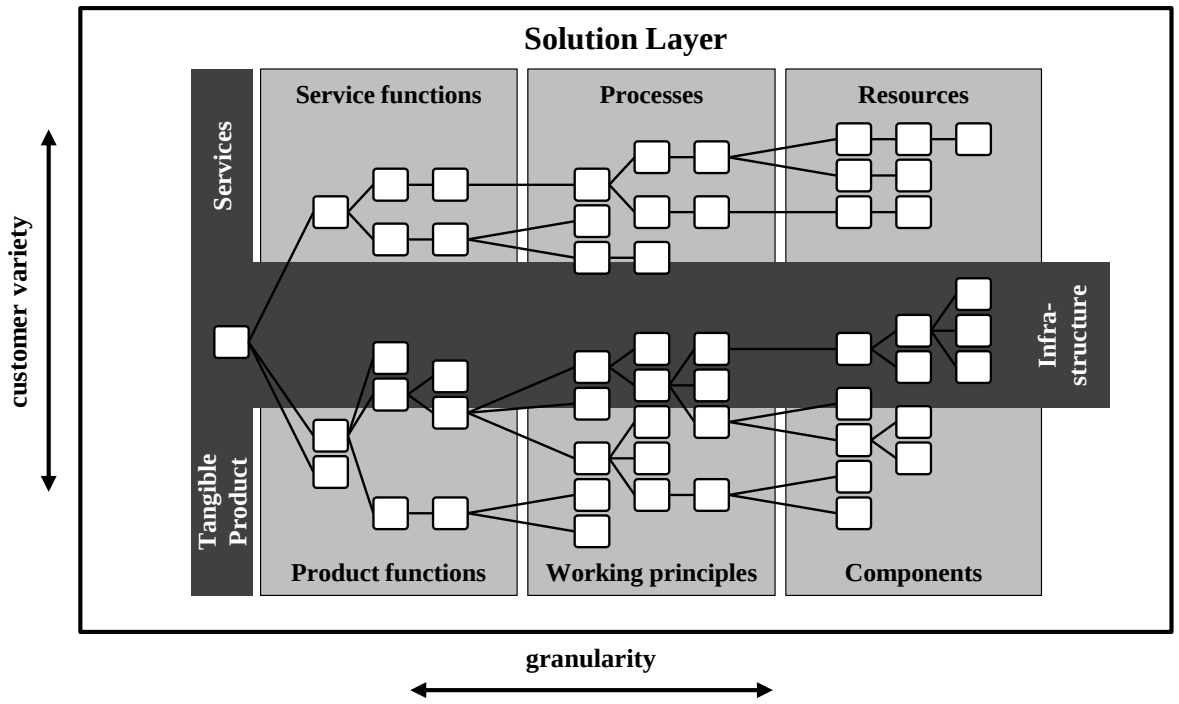

Figure 3-4 Solution layer

Figure 3-4 shows the solution layer, including the three domains of a PSS concept. This layer represents the planning and development of a PSS concept to influence customer aspects for the purpose of increasing customer acceptance.

Strategy Space

The strategy space was defined to demonstrate that planning PSS depends on more factors than just the customer. Many external factors are essential for the PSS planning. Those factors are modeled within the strategy space. As this work considers PSS planning in the context of enterprises, external factors relevant for product and PSS development are defined by the corporate strategy. This strategy analyzes the factors influencing the company and derives measures for how the company can react and handle those factors on a long-term basis. The content of this space is comparable to the goal layer of the technology-centered framework (Schenkl et al., 2014c). They consider strategic goals in this layer. In this model, the strategy is not modeled only as a layer. As strategic implications are relevant for all layers (customer, customer aspects, solution), this model has to reveal this relevance. The strategy space is depicted as orthogonal to all layers, because the strategy influences the decisions made in all of those layers.

Relations between strategy space and customer layer

Customer related implications of the strategy affect decisions in the customer layer. Those decisions can be based on the target group or the customer segmentation. Gausemeier and Plass

(2014) describe those strategic options concerning the market. They claim that companies can individualize customer segmentation, meaning to specialize in a small group of customers. The selection of the target groups should be well considered and should involve strategic implications. Hamel and Prahalad (1995) propose the competence-market-matrix to support companies in selecting customer groups based on competences available in the company or on competences the company is planning to develop. There are several approaches to managing a strategic view of customers, e.g. "one-face-to-the-customer"-strategy (Meier et al., 2010b), a closer relation to customers, or Customer Relationship Management.

Relations between strategy space and customer aspects layer

Decisions for selecting or quantifying the aspects of customer acceptance support strategic orientation. Concerning the prices, de Kare-Silver (1997) defines four categories of strategies: low-price strategies, high-price strategies, value-oriented strategies, and price segmentation (de Kare-Silver, 1997). If a company wants to be seen as a low-price company, it should focus on the aspect "costs/price". For decisions about the relevance of the customer aspects to planning and developing PSS, the customer is not the only subject to be considered. Also, strategic implications and constraints must be involved.

Relations between strategy space and solution layer

The product strategy serves as an interface between the solution, i.e. the product or the PSS, and the strategy (Gausemeier & Plass, 2014). The product strategy is a concretization of the corporate strategy on the level of the product. It includes goals and policies about the product and the way the product will achieve competitive advantages. Schenkl et al. (2014c) mention three goals in their goal layer: strategic goals, PSS-specific goals, and quality goals. While strategic goals are apparently included in the strategy (=strategy space), PSS-specific goals are derived from the corporate strategy (Schenkl et al., 2014c). Those goals belong to the product strategy. Schenkl et al. (2014c) claims that quality goals are defined by Garvin (1987) in eight quality dimensions. In the customer-oriented model, the quality goals are embedded between the solution layer and the strategy space, because the strategy (corporate or product strategy) defines a desired status of quality fulfillment, while the solution presents the actual status of quality fulfillment. Porter (1996) claims that companies have to position themselves concerning variants of products and services. Gausemeier and Plass (2014) define strategy options concerning the market value, describing the way companies present themselves on the market. In those options, Gausemeier and Plass (2014) see PSS as an approach to reach a better position in the market using innovative business models.

Work Directions

For applying practitioners, there are two functioning directions: the top-down direction (solution → customer aspects → customer) is for identifying new customers for existing products or PSS. First, the aspects that are influenced by the solution are analyzed. The analysis results in a quantification of the aspects based on the solution. Matching the PSS-elements and the model of aspects (see section 6.5), e.g. by interviewing sales employees, might quantify the aspects. Based on the quantified customer aspects, relevant customer groups are identified.

Customer groups placing value on the relevant aspects are suitable customers for the PSS and should be involved in the target group. Market analyses of customer segments or interviewing customers might identify potential customers. Wallin (2013) states in her work, that new customers are to identified within the PSS development phase. Using this work direction is an option for identifying new customers based on PSS concepts. Based on this working direction, Hanci (2016) proposes a procedure to identify new customers.

The work direction of describing the research goal and questions is the bottom-up approach (customer → customer aspects → solution). The previous sections described this approach on a more detailed level: first, customer groups or situations were selected for which the customer acceptance should be increased. At the layer of customer aspects, relevant aspects of customer acceptance are identified and quantified based at the selected customer groups. This quantification is used as an input for planning and developing PSS on the solution layer. To summarize, this bottom-up approach describes the procedure used to increase customer acceptance of product-service systems. It is mainly applicable in the planning phase but not limited to this phase.

3.3 Conclusions

To conclude the descriptive study I, the framework is discussed and the focus of this thesis is specified. Adjusting the focus sets the basis for the prescriptive study that follows after the descriptive study I. Furthermore, the requirements for the prescriptive study will be defined. Those requirements are the basis for the evaluation in chapter 7 and chapter 8.

Discussing the customer-oriented framework

This framework was developed to demonstrate the mechanism that uses PSS to increase customer acceptance by influencing aspects of customer acceptance. Increased customer acceptance leads to more customers, demanding PSS. Thus, this framework enables benefits for both customers and providers. Furthermore, the framework shows that customer acceptance is not the only issue on which the PSS planning and development should focus. Strategic implications described by the strategy space are also essential for PSS planning. The framework reveals that the layers' strategic implications have to be considered and proposes approaches for dealing with involving strategic issues on those layers. Even though the research questions themselves do not directly concern strategic issues, the strategy space reveals that for the layers, a strategy consideration is mandatory.

The framework is helpful for explaining to designers and practitioners the benefit of using PSS for increasing customer acceptance. This model is easy to understand and it describes the approach of using PSS to influence aspects of customer acceptance. One reason for PSS not being implemented in industry is that the practitioners from industry do not understand the benefits of PSS for their businesses (Hou & Neely, 2013). This framework shows the working principle of this thesis to increase customer acceptance by using PSS.

Adjusting the thesis focus

As stated in the definition of the research questions (see subsection 2.3.3), this work provides models and methods to support practitioners in defining PSS to increase customer acceptance. The state of research (chapter 2) shows that there exist many approaches to dealing with the abstract measures and strategic implications of PSS for customers and customer acceptance. To provide beneficial approaches for practitioners, this work focuses on concrete measures and excludes strategic implications. Related to the customer-oriented framework, this means excluding the strategy space for this work. On the customer layer, many approaches exist in literature, e.g. for customer segmentation or for selecting an appropriate target group. This number of various approaches shows that much research has been done in this field and those approaches shall be extended by this work. The methodology developed in this thesis involves target groups that were already defined and selected. Based on the research questions, this work looks at customers from the PSS perspective, including aspects of customer acceptance. The relevant issues of the customer-oriented framework, based on the research questions, are the solution layer and the customer aspects layer. Discussing the framework results in setting the focus on those two layers with consideration for the customer layer and the strategy space. This work provides methods, models and tools for those two layers.

Figure 3-5 shows the customer-oriented framework and which layers on which this work focuses. On the solution layer, a PSS planning process is developed in chapter 4 that enables integrated planning of tangible product elements and intangible services. Chapter 6 provides a service catalogue for influencing customer aspects. This is also included in the solution layer, involving its relation to the layer of customer aspects. The layer of customer aspects is addressed by chapter 5, which identifies and models different aspects of customer acceptance. The methods and models developed in this thesis are based on the approach to plan PSS for increasing customer acceptance. For this reason, only the work direction in the framework for increasing customer acceptance is the focus. The work direction for identifying new customers is excluded for this work.

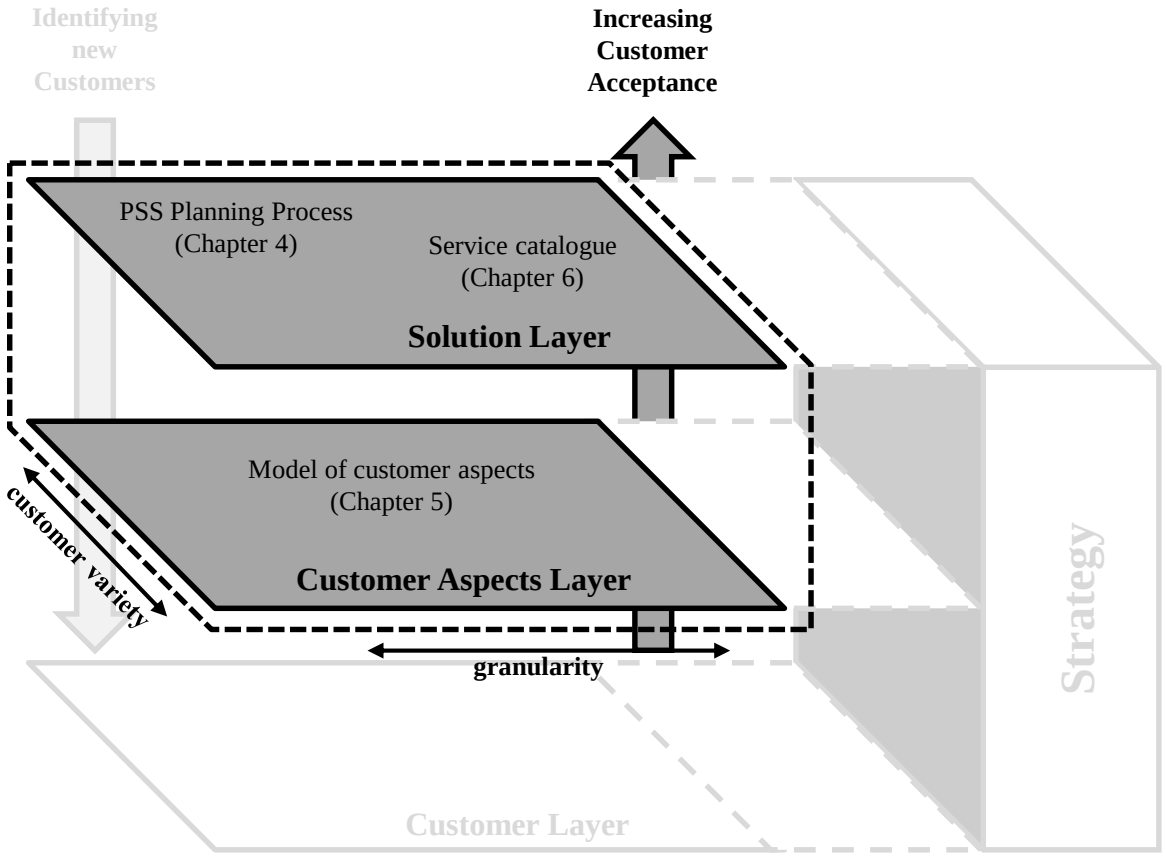

Figure 3-5 Layers of the customer-oriented framework focused by this work

Requirements on Design Support

Based on (Blessing & Chakrabarti, 2009) and the literature reviews, requirements for the design support were identified. The descriptive study II (chapter 7 and chapter 8) uses these requirements as evaluation criteria. In total, four main requirements were defined: **applicability, added value, adaptability,** and **consistency**. Depending on three detailed research questions, the prescriptive study consists of three parts (decision-making process, model of customer acceptance, and service catalogue). Those four requirements refer to all three parts. While the requirements applicability and added value have individual characteristics for those three parts of the prescriptive study, the requirements adaptability and consistency describe the prescriptive study in total.

The requirement **applicability** focuses on the issue that the design support must be applicable by potential users. It includes factors like the usability, easy to understand, and easy to use. Concerning research question #2, the model of customer acceptance has to present the aspects of customer acceptance to make them easy to understand for potential users. The aspects of customer acceptance must be clearly categorized and distinguished to prevent misunderstanding. Furthermore, the model of customer acceptance must describe relevant aspects of customer acceptance that refer to their purchase decisions. Research question #3 must result in a design support (chapter 6) that is easy applicable by users in PSS design and that the consideration of aspects of customer acceptance in such an application is given. The applicability of research question #4 requires that the process model (chapter 4) can be

implemented and integrated into in companies. For this, users (e.g. process managers, product managers) must easily understand the process model and they must be able to transfer the generic process model into an industrial planning process.

The requirement **added value** focuses on the benefit for companies. The overall objective is to increase customer acceptance using PSS. The added value of research question #2 enables companies to understand the aspects and the underlying reasons of customer acceptance that are relevant for their customers. It has to show aspects of customer acceptance that are known by the company and has to reveal aspects that the company might not be aware of. The design support of research question #3 has to add value concerning the PSS concept developed: the PSS concept must focus on and influence relevant aspects of customer acceptance. The extension of an existing product concept by adding specific services must result in a PSS concept that enables a higher level of customer acceptance. The requirement added value specified to research question #4 describes that the process model has to enable an integrated PSS development, i.e. the development of a system that combines interacting service and product elements. The process model has to improve and structure existing planning processes.

The requirement **adaptability** considers the applicability and added value for several industries, markets and products. While this work focuses on engineering companies, several kinds of markets and products are relevant, e.g. B2C and B2B markets. The prescriptive study must be adaptable and transferable for all those markets, companies, and products that are mentioned in subsection 2.3.4. Adapting the results of the prescriptive study has to fulfill also the requirements applicability and added value.

The requirement **consistency** describes the continuous connection and integration of models, methods and processes that are created in the prescriptive study. The prescriptive study should not provide several methods that are independent to each other. The objective is to create a consistent procedure integrating and connecting models and methods of PSS design to increase customer acceptance.

The most important research question RQ #1 (How can PSS planning increase customer acceptance?) includes the hypothesis for the whole work: PSS planning increases customer acceptance. This hypothesis is the basis for the other research questions:

RQ #2: Which aspects, drivers, and barriers of customer acceptance influence the customers and their perception of products, service, or PSS?

RQ #3: How can PSS affect the aspects of customer acceptance to increase customer acceptance?

RQ #4: How can a company design the PSS planning phase to increase customer acceptance?

RQ #1 is investigated by answering RQ #2, RQ #3, and RQ #4. Since RQ #1 does not directly require design support to be answered, defining requirements for RQ #1 becomes redundant. However, as the underlying hypothesis for RQ #2, RQ #3, and RQ #4, this research question will be answered in the descriptive study II (see chapter 7).

4. Decision-making Process for PSS Planning

The literature review and the research questions in chapter 2 require companies to plan and develop product and service elements simultaneously to provide PSS for increasing customer acceptance. To enable companies to plan PSS, this chapter provides a decision-making process for the planning phase of PSS. This process is the answer to the research question #4 "how can a company design the PSS planning phase to increase customer acceptance". To range the process in the customer-oriented framework of the descriptive study I, the process supports companies and designers or planners as they design an integrated solution by providing necessary activities and decision points.

The process focuses on the planning phase of PSS, i.e. the phase before the embodied design starts. Approaches from literature describe such processes as "conceptual design" (Yang et al., 2013), "concept development" (Morelli, 2002) or just as "planning processes" (Hepperle et al., 2010). In general, those different terms describe similar things, because the planning process consists of decisions relevant for the final product concept. Decision-making processes focus more on the decisions by providing support methods, instead of describing the sequence of activities only. This work also includes methods for supporting decision-making and considers decision points within the planning process. There are also approaches only for describing activities and processes that are necessary for PSS planning (Kim et al., 2011b; Tonelli et al., 2009) without referring to decisions. Depending on the organization, fixed decisions points have to be set to make sure that people involved in the planning process are pleased with the progress. The process is created at a generic level to make sure that it is applicable to a broad range of companies and markets. Appliers have to adapt this abstract description to their application case. For this reason, the process is not modeled within a domain specific language. This work visualizes the process as a verbal and graphic representation.

Building the planning process depicts a recursion of the DRM (Blessing & Chakrabarti, 2009). First, a literature review investigates relevant approaches (section 4.2). Based on the literature review and research questions (subsection 2.3.3), the requirements of the decision-making process are defined (section 4.3). As none of the planning processes from literature fulfill all requirements, a new decision-making process for planning was composed of elements of existing planning processes (section 4.4). The process-oriented requirements were the foundation for identifying relevant items of existing approaches and combining them into a new planning process for PSS. The requirements and the literature review focus on the process-describing framework but not the supporting methods and tools. This procedural framework presents the required activities in a logical sequence for planning PSS, consisting of product and service elements geared towards each other. Furthermore, the process includes important decision points that serve as milestones in the planning process. There are also methods mentioned for providing additional assistance to the framework.

After describing the process, this chapter elaborates the implications of the process for the work and for the following parts of the prescriptive study (section 4.6). Those parts are the modeling of the customer aspects and the service catalogue for increasing customer

acceptance. The process elements will be identified, whereas the other parts of the prescriptive study are to be integrated. This is to show where those parts support the PSS planning. In conclusion, this procedural framework enables companies to plan PSS and introduce approaches for increasing customer acceptance.

4.1 Model's Basis and Stakeholders

In literature, there exist many approaches dealing with planning processes for services or products. Literature also provides information about the characteristics of PSS compared to services or products. Based on existing knowledge about PSS, this work builds a decision-making process for PSS planning by synthesizing existing approaches. Instead of developing a new planning process, synthesizing and adapting existing processes reduces the effort needed to develop a new process from scratch. Additionally, existing and empirical approaches were taken into account. This procedure is based on the hypothesis that planning PSS is comparable to planning solely products or solely services. To successfully implement this procedure, the differences between planning PSS and planning products and services separately must be identified and considered. Essential information about PSS was identified in the state of research (see section 2.2). Based on the research questions, the process must help plan integrated PSS and enable customer-orientation. The process focuses on organizing the planning phase that is also described as a fuzzy front-end or conception phase; it starts with the idea for a product or service and results in a PSS concept that is delivered to the embodied design for concretization and implementation. The PSS concept is a solution description of PSS elements that can be product elements, service elements, or elements belonging to the connecting infrastructure (Schenkl et al., 2014c). Therefore, the process must consider product, service and infrastructure. To be applicable, this process must be easy to understand for practitioners. As practitioners lack time to deeply understand a complicated process, this work aims for a clear visualization for applying practitioners.

The aim of the process is to enable companies to plan PSS integrating both product and service elements. As large enterprises have usually implemented a standard process for the planning phase, the process model to be developed in this work is more beneficial for smaller companies or departments that are excluded from standard processes. Users of this process model might be product managers, project managers, or business executives and any other people responsible for organizing the planning phases and their information flows in companies. Like the focus of the entire thesis, not only are new PSS taken into account, but also developing upgrades or the next product generation are also possible fields of application. To enable this broad focus, the process must be generic enough. This means that the process cannot predetermine a concrete activity sequence. Nevertheless, planning processes are characterized by a number of decisions essential for the product success (Pahl et al., 2007; Ulrich & Eppinger, 2015): planning means deciding between product-related options. A planning process must also describe the decision-making within the planning phase. Except for building a predetermined procedure of activities, a planning process will be modeled by defining decisions made during the planning phase. To enable the application of this reference process, it must be designed to be easy to understand. Practitioners often have problems in applying abstract reference processes to underlying situations (Hollauer et al., 2016; Markham & Lee, 2013). To improve

the process applicability, the process complexity should not be too great and the level of detail must be held to a reasonable level.

4.2 Literature review on PSS Planning Processes

The literature review aims to analyze the current situation of existing planning processes, revealing the need for a new planning process, and to identify approaches which will be the basic approaches for the new planning process model. First, relevant approaches were identified that deal with organizing the planning process of products, services, or PSS. First relevant approaches were known from the previous project work, documented in (Schenkl, 2014) and (Hepperle, 2013) that were already shown in subsection 2.2.3. Some of them presented process models that were considered in this literature review. Further approaches were found by searching the database Google Scholar and Web of Science (search terms: "Product-service systems; planning process"). Other works were identified at international research conferences (CIRP Industrial Product Service Systems, IPS2, 2014; International Conference on Engineering Design, ICED, 2013). In total, 16 approaches were identified.

Excluding unsuitable approaches

To make the literature review more efficient, criteria for excluding already identified approaches are defined to reduce the number of approaches to be evaluated. Those KO criteria are based on the research clarification (see section 2.3). Approaches has to consider all those criteria to be investigated in the further literature review. As the planning process should focus on PSS, the approaches to consider have to be built for products, services, or PSS (1). If using elements and steps from other approaches, they must be adaptable to PSS (2). This thesis' results support the development of both new products and existing products (3). Innovative PSS can increase customer acceptance and improve customer benefits. The planning process has to facilitate innovative product, service, and PSS concepts (4). For utilizing elements from existing planning processes for a new process, the existing approaches must provide a description of relevant activities, processes, and steps on a detailed level that makes them beneficial for appliers (5).

Using the criteria for exclusion, five approaches were eliminated from further literature review. The approach of Sundin et al. (2009) is only applicable to existing product concepts and does not provide for the development of innovative concepts. The approach of Pahl et al. (2007) only focuses on products and is similar to the approach of (VDI, 1980) that is considered in the further literature review. Applying the process of Petzelt et al. (2010) to products is questionable and the process steps are not explained at a suitable level of detail. QFD is built for products only and it is more for supporting decisions in the planning phase than describing a process. Ming et al. (2008) propose a process for collaborative planning of PSS; however, the process description is too abstract. The approaches excluded from further investigation are shown in Table 4-1 because they did not consider all criteria.

Table 4-1 Criteria and excluded approaches

Legend: ● fulfilled ○ not fulfilled	(1) For services, products or PSS	(2) Adaptable for PSS	(3) New and existing products	(4) Innovative concepts	(5) Level of detail
[1] (Sundin et al., 2009)	●	●	○	○	●
[2] (Pahl et al., 2007)	○	●	●	●	●
[3] (Petzelt et al., 2010)	○	●	●	●	○
[4] (Akao, 2004)	○	○	●	●	○
[5] (Ming et al., 2008)	●	●	●	●	○

Criteria for Evaluating Approaches

After excluding those five approaches, the 11 remaining approaches were analyzed on a more detailed level. The analysis investigated whether the approaches facilitate planning a customer-oriented PSS concept and if they support decision-making within the planning process. The analysis resulted in an evaluation of the approaches based on criteria that describe if those approaches support the planning of a customer-oriented PSS:

The PSS infrastructure enables the delivery of PSS and includes PSS resources (Schenkl et al., 2014c), like communication systems or energy supply. Planning of the PSS infrastructure has to be considered by the planning process (*Infrastructure considered*). Before creating PSS concepts, customers' requirements have to be considered, because PSS must be oriented towards customers to increase customer acceptance. Decisions about business models (e.g. eight PSS-types according to Tukker (2004) and value streams (e.g. high price for physical product, low prices for services or low price for physical product and high prices for services) must be made before defining PSS concepts (*Customer requirements before planning*). Acknowledging the customer-oriented character of PSS requires a planning process that involves the customers or users (*Customer integration*). A market-conformal PSS uses the strengths of the company and considers the market environment. To consider market-specific requirements, the planning process has to include a market analysis (*Market analysis*). The planning process has to consider decisions and the way decisions are made in companies. Considering decisions when planning a PSS is beneficial for systematic planning; decision-making means to decide between options and to exclude less-than-ideal alternatives. This requires involving relevant stakeholders, which might be complicated for stakeholders from

different companies. PSS planning processes must consider decision-making in companies and they must be suitable for business culture (*Business culture*). As requirements change over time and even during the planning process, approaches must include iterations for adapting, improving and evaluating requirements and concepts (*Iterations possible*).

Table 4-2 shows the results of analyzing and evaluating the approaches based on the criteria. During the literature research, the list of criteria for the decision-making process in PSS planning was extended. Based on those criteria and on insights from the literature review, a list of requirements for a decision-making process was created (described in section 4.3).

Analyzing Approaches

VDI (1980) created a planning process for stand-alone products. While this process considers internal and external factors and provides a reasonable sequence for planning activities (requirements, product definition, planning-surveillance), it lacks continuous integration of customer requirements. Furthermore, it includes only those business areas the company is already competent in (Heubach, 2009) and neglects other business areas.

The strategic product planning process of Gausemeier et al. (1996) emphasizes the relevance of the strategy. However, this approach considers the planning process on an abstract level and does not include services and the PSS infrastructure.

Orawski et al. (2011) propose a planning process that takes the level of products' innovations into account and distinguishes between incremental and radical innovations. However, this approach does not consider services and has no option for customer integration and continuous adaption of requirements.

The planning process of van de Kar (2008) mainly focuses on services, organizational infrastructure and technology architecture. While this process allows companies a high level of customer integration, the way of customer integration (e.g. meeting customers, testing phase at customers) makes huge efforts for planners.

The approach of Aurich et al. (2006) is an approach to support planning products and services and integrates physical product and service. However, this approach does not plan a whole PSS concept; it just combines product and service. A PSS is more than just the combination of a physical product and a service: as the physical product can only be provided in combination with the service, both the physical product and the intangible service must be compatible with each other. Both types of elements must have corresponding interfaces. This interlacing between physical product and service must be considered within the planning process, something which is not provided by this approach (Aurich et al., 2006).

The planning process of Morelli (2002) distinguishes between the solution space and the problem. It considers physical products as well as services. The late integration of results from market research and a lack of customer integration increase the probability of development beyond the market.

The approach of Yang et al. (2013) is a planning process allowing adaptions of PSS concepts by iterations, if concepts do not meet the requirements. Even though the concepts are

changeable, Yang et al. (2013) do not consider adapting requirements during the planning process. Late adaptions of the concepts will be very expensive (Pahl et al., 2007).

Tonelli et al. (2009) developed an abstract procedure for creating PSS-strategies. Their approach neglects the physical product part of the PSS and the connecting infrastructure.

The planning process of Maussang et al. (2007) considers the physical product elements and the service elements, as well as the connecting infrastructure. They take all relevant external factors into account; but the customer is only involved at the beginning and not available for evaluating PSS concepts.

Geum and Park (2011) developed an approach integrating all relevant PSS elements based on service blueprinting. While they describe the PSS elements in detail, the procedural part is too abstract. Like service blueprinting, this approach is for managing the structure of PSS and does not provide a sequence of activities necessary for planning PSS. Furthermore, it does not provide for the integration of market research.

The approach of Kim et al. (2011b) provides a sequence of activities for planning PSS. They offer a set of methods that support the PSS planning process. Their process more focuses on the methods while the procedural framework is neglected; decision points are not defined and the process is not suitable for applying and adapting to companies as a whole.

Conclusions

Table 4-2 depicts the approaches to planning PSS and their fulfillment of the criteria. The approach of Yang et al. (2013) was identified as the most suitable for decision-making in planning PSS: the abstraction level of process description in this approach is detailed enough for users to understand the whole planning process, and abstract enough to apply this process to all kinds of PSS. This planning process is a structured approach and considers requirements from the very beginning and facilitates iterations.

Despite these strengths, several weak points of this approach were identified: as the phase “concept development” considers services only, this approach values intangible services more than tangible products. The planning process does not consider the connecting infrastructure and a strong customer integration is missing.

To eliminate those deficits, elements from other approaches were included. To further investigate the weak points of the approach of Yang et al. (2013), process-oriented requirements for a decision-making process for planning PSS were defined, based on the evaluation criteria.

Table 4-2 Approaches for planning PSS and criteria

Legend: ● fulfilled ◦ partly fulfilled ○ not fulfilled	PSS	Physical products	Services	Infrastructure considered	Requirements before planning	Customer integration	Market analysis	Business culture	Iterations possible
[6] (VDI, 1980)	○	●	○	○	●	○	●	●	●
[7] (Gausemeier et al., 1996)	○	●	○	○	○	◦	●	●	○
[8] (Orawski et al., 2011)	○	●	○	○	●	○	●	●	●
[9] (van de Kar, 2008)	○	○	●	●	●	●	●	◦	●
[10] (Aurich et al., 2006)	◦	●	●	○	○	●	●	○	○
[11] (Morelli, 2002)	●	●	●	○	○	○	◦	●	○
[12] (Yang et al., 2013)	●	○	●	○	●	◦	●	○	●
[13] (Tonelli et al., 2009)	●	○	●	○	●	●	●	○	○
[14] (Maussang et al., 2007)	●	●	●	●	●	◦	●	○	●
[15] (Geum & Park, 2011)	●	●	●	●	◦	●	○	○	○
[16] (Kim et al., 2011b)	●	○	●	●	◦	●	●	○	○

4.3 Process-related Requirements for an improved PSS Planning

During the literature review, process-oriented requirements of the PSS planning process were determined. Those requirements are based on the PSS characteristics, the research questions, and issues described as essential by the approaches considered. The requirements describe the needs a decision-making process for PSS planning has to fulfill. Planning PSS is more than just adding services to an existing product: customers have to be involved, PSS infrastructure has to be designed and the planning must fit the strategic objectives. The following requirements were identified:

- Uninterrupted documentation
- Strong contact with the customer
- Customer integration during planning
- Identification of customer requirements before planning

- Adaptable requirements list
- Considering results from a market analysis
- Support for the selection of main PSS elements
- Evaluating the defined PSS concepts
- Considering tangible product and intangible service elements
- Support for concept definition
- Consideration of services associated with the product
- Planning PSS infrastructure
- Planning infrastructure necessary for providing services
- Considering scenarios and strategies
- Support for selection of the best suitable PSS concept
- Deployment of a complete PSS concept

The approaches identified were checked to see if they fulfill these process requirements. It turned out that the approach of Yang et al. (2013) fits most requirements. This qualified the process (Yang et al., 2013) to serve as a basic framework for creating a new decision-making process for PSS planning.

4.4 Synthesizing a new PSS planning process

The approach of Yang et al. (2013) is suitable to be the foundation of the planning process of this work. However, the process (Yang et al., 2013) still lacks some requirements. The approach (Yang et al., 2013) was analyzed in more details to discover existing weaknesses. To remove these deficits, measures for improvement were defined or taken from other approaches. Table 4-3 shows deficits, unfulfilled process requirements, and measures for improvement.

Table 4-3 Analyzing (Yang et al., 2013) for process requirements

Identified deficit	Unfulfilled process-oriented requirements	Measure for improvement
(Product) requirements are defined at the beginning only, they are not adapted during the process	• Uninterrupted documentation • Adaptable requirements list	Check and adapt the (product) requirements at important decision points.
Customers are considered at the beginning only within the customers' requirements, but not directly	• Strong contact with the customer • Customer integration during planning	Method for strong customer integration by van de Kar (2008)

Strong focus on services, neglecting the planning of tangible product elements	• Considering tangible product and service elements	Integrating the approaches (VDI, 1980) and (Aurich et al., 2006) to consider tangible product elements
No consideration of PSS infrastructure	• Planning PSS infrastructure • Planning infrastructure necessary for providing services	Involving the approach (van de Kar, 2008) to plan PSS infrastructure to ensure the service supply
Insufficient integration of strategic objectives	• Considering scenarios and strategy	Adapting the approaches (Morelli, 2002) and (Maussang et al., 2007) for considering the future

Besides defining measures for removing deficits, one more improvement was made; for the phase "concept evaluation" another decision point was added. This enables iterations for the beginning of the concept evaluation. The synthesized process includes a requirements check at each review point, not only at the end of concept evaluation. This reduces the range and time of iterations or changes. It enables earlier identification of weak or critical points during planning. Implementing these changes and the measures described in Table 4-3 resulted in a new planning process that is described in the next section.

4.5 Adapted Decision-making Process for PSS Planning

An overview of the whole planning process is shown in Figure 4-1. It consists of three review points that serve as milestones and describe the stages of which decisions have to be made. Those review points are characterized by preceding steps of collecting and processing information. At the review points, decisions about the information collected are made.

The planning process consists of three parts that terminate at associated review points, i.e. a decision. Those three parts are *requirements*, *concepts generation*, and *concepts evaluation*, based on (Yang et al., 2013). The three terminating review points are called design reviews: *R(eview) 1, R2, and R3*. While R1 describes the decisions about requirements, R2 is about PSS concepts, and R3 selects a final concept. The design reviews also serve as milestones where essential decisions are made and that structure the entire planning process into three parts. As most activities during planning run parallel, those design reviews bundle multi-dimensional activities. An overview of the whole process is shown in Figure 4-1. The dashed arrows stand for iterations that are possible in the process, while the regular lines describe the logical sequence of planning PSS.

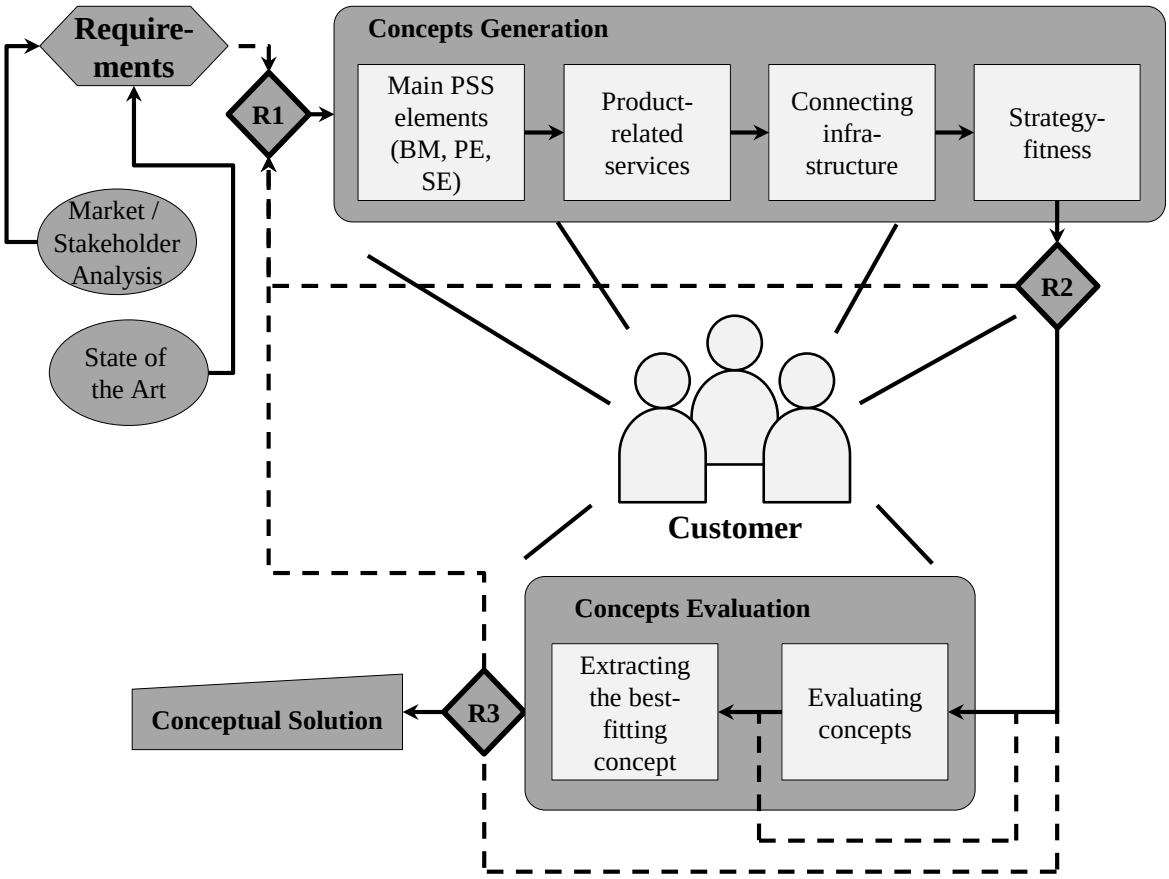

Figure 4-1 Overview of decision-making process for planning PSS

To apply this process, the description should not be used as a concrete manual or as a list of instructions. Before starting to plan PSS, this process, its activities, and the activity sequence have to be adapted, depending on the application case. The case study I in section 7.2 showed that changing the sequence might be reasonable based on the application requirements.

R1-review: Requirements

In the first part of the process, planners have to collect and define customer requirements that are the basis of the following planning process. There are many methods that support this step for identifying and specifying customer requirements, e.g. interviews, surveys, or informal chats with customers, potential customers, or sales employees. Parallel to this, requirements originating from other sources have to be defined and a market analysis has to be conducted. Schenkl et al. (2013c) provide methodical support for defining the requirements of PSS. They built a checklist for decision criteria that can be seen as sources for requirements and that can be used as criteria for decisions made during the planning process (Schenkl et al., 2013c). This list is justified for PSS that have a broader range of requirements sources than tangible products have (Schenkl et al., 2013c). To better understand customer behavior concerning buying or not buying the PSS, the model of customer aspects is helpful (see chapter 5). By implementing interviews or surveys, planners get a clearer conception of the reasons for purchase decisions. Furthermore, the system of requirements management has to be designed to be adaptable. As the requirements defined in this step are just a first version, planners and developers must be able to change or redefine requirements. The R1-review terminates at this step. This design

review includes decisions about acquired information concerning requirements originating from customers, the market, and other sources. The aim of the R1-review is to make sure that all needed information and requirements are documented and at a suitable level of detail. At this stage, customer requirements and information about the market and state of the art are the most relevant domains. Besides checking the level of detail and the suitability and applicability of the requirements identified, planners have to check the requirements for obvious critical interdependencies between requirements. If requirements are not suitable for the following steps of the planning process, requirements have to be adapted or more information must be gathered that can be acquired by iterating the market research. The output of this review step is a requirements list that is considered feasible.

R2-review: Concepts Generation

The first part of the concepts generation is to define the main PSS elements. The most important element of a PSS is the detailed business model. It includes the target customer group, relevant stakeholders, value stream, benefit customers receive etc. (Rese et al., 2011). There are many approaches to creating business models; an often cited approach is given by Osterwalder and Pigneur (2010). The business model canvas according to Osterwalder and Pigneur (2010) provides methodical support for determining relevant elements of the business model orientated towards customer value. A business model is the basis for defining requirements and PSS functions (Bochnig et al., 2013) that describe abstract functions the PSS should fulfill. PSS functions are not defined if they will be implemented by a service or a product component. Other main PSS elements are main service and product elements. Customer integration is essential to defining those main elements. Processing this step might trigger an adaption of the requirements, because planners get more knowledge about the solution to be designed. Then, product-related services will be identified. Those services are not main or core services, they can be derived from PSS main elements, e.g. if a main product element requires continuous maintenance, this maintenance is a product-related service. For the steps of defining major elements and product-related services, chapter 6 provides methodical support: a classification scheme for services, i.e. a service catalogue, can serve as a checklist for planners of potential services. Connecting this scheme to customer and customer aspects enables the definition of services for increasing customer acceptance. Based on the product and service elements, the connecting infrastructure has to be planned. This infrastructure enables the operation of product and service elements. The last step of concepts generation is to check the PSS elements and the requirements identified concerning the fitness of future scenarios and corporate strategy. This step might lead to the identification of additional requirements. After that, the R2-review terminates at the concepts generation. It verifies the product parts, services, and infrastructure identified. The aim of the R2-review is to make sure that all PSS elements or partial concepts were identified that might be realized in the final system. This review checks whether the PSS elements are sufficient to fulfill the requirements. Those elements are not fixed as product components; they also can be partial concepts covering a broad range of requirements. This decision makes sure that enough elements were defined by checking that every requirement is covered by at least one element. For this review, additional information might be gathered. However, the elements are not evaluated against each other or valued concerning their suitability for further realization. This is to prevent premature decisions caused by a lack of

information. If all requirements are covered by at least one element, the R2-review has been successfully terminated. If there are still requirements not covered by an element, elements have to be adapted, new elements have to be identified, or the requirements must be adapted. The output of this review is the set of PSS elements identified that are composed of concepts discussed in the next step.

R3-review: Concepts Evaluation

The third and last part of the planning process deals with evaluating the concepts and selecting the best concept. This step can also include a configuration management by selecting and combining the best-fitting partial concepts. Besides the customer requirements, issues like the sustainability, technical feasibility, or applicability are relevant to those decisions. Decision criteria relevant for PSS development are mentioned by Schenkl et al. (2013c). Taking into account the customer aspects quantified within the first part of the process enables the planners and deciders to select concepts which have a more positive influence on the relevant customer aspects. The cost utility analysis provides methodical support for this part. Another helpful method is given by the scenario techniques for building use scenarios or process scenarios. Conducting a Failures Modes Effect Analysis (FMEA) can reveal failures resulting from the product use. The R3-review terminates this part of the process by making a decision concerning the final concept. Before a positive decision can be made, this review can cause several iterations if information is missing or if the concepts do not sufficiently fulfill the requirements. A method for combining partial concepts and evaluating at the same time is the matrix-based compatibility analysis. This checks level of compatibility between partial concepts and quantifies the total value of overall concepts, based on the compatibility and other criteria defined before. This compatibility analysis is based on Hepperle (2013) and further described in Schmidt et al. (2014c). The aim of this last design review is to confirm the final concepts of realization in the embodied design. Since a set of concepts and elements has already been defined, decision-makers have to ensure that they have understood the reasons why concepts or elements were excluded from further processing. The confirmation itself is to check whether the concept selected fulfills all requirements. A positive result of this investigation is when the planning process is finished and the final concept is confirmed. For a negative result an iteration is necessary: either the requirements have to be adapted or the PSS concepts and its characteristics must be changed.

Documentation and Iterations within the process

Plenty of influences and interdependencies that must be considered and processed by the decisions and the decision-makers characterize decisions within PSS planning. This requires a detailed and uninterrupted documentation of all relevant information. A detailed documentation enables the traceability of the planning process. This is needed to make the decisions replicable. The three design reviews discussed here are suitable for checking the completeness of documentation. However, companies have problems to guarantee an uninterrupted documentation because employees are not always motivated to document their work including all detailed information (Mader et al., 2009). A way to force involved employees to take the documentation more seriously is to create a policy that decisions will only be made after checking the documentation.

The sequence proposed just describes the logical sequence of activities in the planning process. However, the sequence will change in real cases for several reasons: the start of the planning process is not a fixed starting point or there are many planning projects that are based on an already existing market analysis or on a previous product. During the planning process, the state of the art might change or competitors might launch new products on the market. These issues influence the requirements list. Also, customer requirements that are essential for the planning phase can change over time. Enabling the integration of those changes into the planning phase iterations is necessary and the planning activities may not follow the sequence proposed. Also, the case study in section 7.2 has shown that the sequence is not a premise for a successful planning process. The illustration of the entire decision-making process (see Figure 4-1) depicts iterations that are possible because of the composition of this process: the design reviews reflect the previous work and concepts and support the detection of deficits and sources for iterations. For this reasons, most iterations will start from design reviews. The review points can be also seen as bundling points for the planning stages. Many processes during the planning phase run in parallel with many iterations. The decision points are capable to structure the whole phase by setting the target for all partial processes.

4.6 Conclusions

To conclude the decision-making process, this subsection describes the implications for work. A final conclusion from scientific and practical perspective is given at the end of this work (see section 9.2).

Implications for the Work

This decision-making process for PSS planning provides a procedural framework for the planning activities. It helps companies to process required information and to define essential decision points for planning PSS. However, this is a procedural framework only and supporting methods are only mentioned and not described. This reference process is beneficial for companies that have not defined a standard process yet. Enabling increased customer acceptance by PSS, companies require more support than just this process. Analyzing the parts of the whole process yields the following parts as the most essential for customer acceptance: market/stakeholder analysis, main PSS elements, and product-related services. They are considered relevant for defining PSS for increasing customer acceptance because these steps analyze the customer or identify the elements relevant for customer acceptance. They define the basis for the following PSS planning and designing. However, other steps are also important for providing a customer-oriented PSS concept (e.g. evaluating concepts depending on evaluation criteria). This work aims to support SMEs for the steps of market/stakeholder analysis, main PSS elements, and product-related services using further methods and models. To improve customer analysis, chapter 5 provides a model of customer acceptance. This helps designers to better understand the customers and their reasons for purchasing or not purchasing a product. To support the step of defining the main PSS elements, chapter 6 proposes the catalogue to increasing customer acceptance by influencing certain aspects. This catalogue also implies a decision based on the customer aspects. The model of customer aspects focuses on the research question #2 (Which aspects, drivers, and barriers of customer acceptance influence

the customers and their perception of products, service, or PSS?). The service catalogue discusses the research question #4 (How can a company design the PSS planning phase to increase customer acceptance?), and this decision-making process is about the research question #3 (How can PSS affect the aspects of customer acceptance to increase customer acceptance?). It enables companies to the shift from product only to PSS planning from the process perspective. This process also facilitates a high customer-orientation; however, concrete measures for orienting on customer needs and wants are not provided. As the process is created and illustrated for practical use, it promises to be easily understandable and applicable for practitioners. In terms of the customer-oriented framework (chapter 3), the decision-making process is located in the solution layer, because it supports companies in designing the solution or the PSS. It also implies interfaces for involving information and knowledge that stem from the customer layer and the layer of customer aspects. However, the decision-making process does not provide concrete measures for integrating customers into PSS planning.

5. Modeling Aspects of Customer Acceptance

To provide PSS for increasing customer acceptance, companies have to know which factors and aspects influence their customers' acceptance. To support companies in identifying and quantifying those aspects, the model of customer acceptance is proposed. This chapter deals with the research question #2 "which aspects of customer acceptance influence the purchase decision" as a part of the prescriptive study. This part is a recursion of the DRM just limited to the model of customer acceptance. The aim is to create a model that enables practitioners to understand the reasons why customers buy or use products, services, and PSS or why they do not.

By covering and describing as many aspects relevant for purchase decisions as possible, the model helps companies to identify unknown aspects and to understand the working principles behind them. However, providing a large list of aspects might be confusing and difficult to handle for practitioners. A model of customer acceptance must be easy to use without neglecting important aspects to be beneficial for practical applications. To create a clear model, relevant aspects of customer acceptance are first identified and then classified into eight categories. The aspects are divided into five layers: categories, perceptions/characteristics, causes, effects, and consequences.

Like the customer-oriented framework for PSS development (see chapter 3), the procedure of creating the model of customer acceptance is based on the process according to (Stachowiak, 1973). Section 5.1 declares the model's purpose and suggests potential users of the model. A literature review in section 5.2 investigates existing models of customer acceptance and detects the research gap for creating an adapted model. Some of those approaches from literature are used to identify aspects of customer acceptance (section 5.3). In section 5.4, the model and all aspects are roughly described, a more detailed description of the aspects is provided in several master and semester theses (see the appendix 12.6). To support the application of the model of customer acceptance, section 5.5 proposes several methods for application, e.g. a generic catalogue of questions or methods for quantification. The conclusion of this chapter investigates the benefit of this model for PSS planning and the implications for this work.

5.1 Model's Basis and Purpose

As stated in section 2.1, the literature provides a broad-ranging basis of aspects of customer acceptance. The literature review in the next section checks if approaches from literature suit this work (see section 5.2). This literature review reveals that approaches from literature focus on other companies and markets than this thesis. However, some of those aspects mentioned in literature are also relevant for this work. Many approaches are based on Rogers (2003). Moreover, the definition of aspects of customer acceptance made by Rogers (2003) is similar to the definition made in this work (see section 2.1). The classification of aspects of customer acceptance (see section 5.3) relies on the attributes defined by Rogers (2003). From this perspective, the model of customer acceptance can be seen as an extension and as a specification of the work of Rogers (2003). However, Rogers (2003) deals only with innovative products in

B2C markets and neglects aspects from B2B markets. Especially the categorization of Rogers (2003) is not suitable for companies because many relevant aspects are included into the attribute "relational advantage".

The purpose of the model of customer acceptance is to help companies to identify aspects of customer acceptance that are relevant for their customers. Employees and departments having direct or indirect contact to customers might apply this model, e.g. marketing, sales, business development, (in field) service employees, product management, etc. The method for applying this model depends on the situation, but different methods are possible: surveys or interviews with employees or customers can be based on this model (see section 5.5). This model provides a theoretical framework for creating surveys or interviews and the results of those surveys or interviews help companies understand their customers. Even besides the service aspect, this work is focused on, the model of customer acceptance might be helpful in other areas of application (e.g. for use cases or user scenarios, see case study II in section 7.3).

5.2 Literature Review on Models of Customer Acceptance

The literature review focuses on models of customer acceptance describing aspects, attributes, and causes of customer acceptance, perception, or satisfaction. This broad focus means a broad range of relevant aspects considered in this work. Table 5-1 shows the results of this review. To integrate those approaches into this work, they must have the same focus considering the product and the market (see subsection 2.3.4). Since customers of varying markets behave differently, approaches focusing on other markets are not necessarily applicable to this work. The approaches were analyzed concerning the acceptance object (product/service), the branch, and the market (B2B/B2C). To show that many approaches are based on Rogers (2003), Table 5-1 depicts this issue as well.

Table 5-1 Approaches of Models of Customer Acceptance

● fulfilled ○ not fulfilled						
Author	**Object of acceptance**	**Branch**	**B2B markets**	**B2C markets**	**Based on Rogers**	**Exemplary aspects**
(Boonstra & Broekhuis, 2010)	Electronical medical records	Medical industry	●	○	○	Complexity of the system, lack of reliability
(van der Sanden & van Dam, 2010)	Energy Systems	Energy	○	●	●	Perceived Ease of Use, Pleasure
(Rogers, 2003)	Innovative products	Several, not specified	○	●	●	Easy to understand, relative advantage

(Veryzer Jr, 1998)		Several (electronics, chemical…)	●	●	●	Lack of familiarity, irrationality
(Eid et al., 2002)	Internet Banking	Banking industry	●	○	○	Trust, Internal Culture, Security
(Polatoglu & Ekin, 2001)			○	●	●	Reliability, access, savings
(Qureshi et al., 2008)			○	●	●	Ease of use, enjoyment, quality of internet
(Choi et al., 2008)	m-commerce, e-commerce of physical/virtual products	digital content business	○	●	●	Price, Convenience, Customization
(Kotler & Armstrong, 2014)	products and services	Several, not specified	●	●	○	psychological, organizational, interpersonal
(Ho & Ko, 2008)	Self-service technology, internet banking	Banking industry	○	●	●	cost saved, usefulness, self-control
(Parasuraman et al., 1985)	Services	service firms (retail banking, product maintenance)	●	●	○	Credibility, Communication, Reliability
(Cao et al., 2011)	Several	Several, engineering (cell phones)	●	●	○	function, shape, cost
(Balta-Ozkan et al., 2013)	Smart Home Devices	Household	○	●	○	Interoperability, Privacy and security, Costs
(Paetz et al., 2012)			○	●	○	Money savings, technological orientation
(Garvin, 1996)	Tangible products	Several, not specified	●	●	○	Conformance, durability, Serviceability

Several approaches focus on products that are a subset of products this work is focused on (Balta-Ozkan et al., 2013; Boonstra & Broekhuis, 2010; Paetz et al., 2012; van der Sanden & van Dam, 2010). The aspects identified by these authors are on a too concrete level for this work; however, they might be useful on a more abstract level. Other approaches deal with services (Choi et al., 2008; Eid et al., 2002; Ho & Ko, 2008; Parasuraman et al., 1985; Polatoglu & Ekin, 2001; Qureshi et al., 2008), e.g. internet banking, while this work considers the servitization of tangible products. The product and branch focuses by Cao et al. (2011) and Garvin (1996) are relevant for this work, but they mainly investigate product specifications instead of aspects of customer acceptance. Rogers (2003) and Veryzer Jr (1998) focus on

innovative products and they present aspects of customer acceptance that are relevant for this work. The book of Kotler and Armstrong (2014) is focused on a broader industry range than this work does, although many aspects he mentions are relevant for those industries. To identify and categorize aspects of customers, the sources of Rogers (2003), Veryzer Jr (1998), and Kotler and Armstrong (2014) were used as a basis. In the next section, they are extended by other aspects, adapted to this work's focus and categorized to make them easier to understand for practitioners.

5.3 Identification and Classification of Aspects of Customer Acceptance

The aspects of customer acceptance were identified by a literature research based on the work of Rogers (2003). This literature research considered sources from different areas to provide a broad range of aspects of customer acceptance: approaches from business (marketing, accounting etc.), engineering (product design, product development etc.), social science (political science, ethnology etc.), and psychology were taken into account. The literature review first focused on barriers (negative aspects) of customer acceptance but was extended to aspects (both positive and negative) of customer acceptance. The analysis of around 200 sources resulted in 68 detailed aspects of customer acceptance. Since this number of aspects is too high to be easily handled by potential practitioners, the aspects of customer acceptance were categorized.

In a workshop, four participants (three master students and one PhD student from mechanical engineering) categorized the aspects of customer acceptance. The first step in this workshop was to present all aspects identified to ensure that each participant understands all aspects. For this, two master students presented their results from literature research. Every aspect of customer acceptance they have identified was summarized on one note card. In the workshop, they presented the aspects by pinning the note cards on a pin board. After this explanation step, all aspects were visible at the pin boards. The next step consisted of clustering and structuring the aspects. This included to move similar aspects together. Aspects were considered as similar if they overlap or if they focus on similar issues, e.g. the aspects "overall costs" and "investment costs" were put together, because both aspects focus on the product's costs. The last step was a discussion about allocating the clusters to categories (i.e. broader clusters). This discussion resulted into the definition of eight categories: values and beliefs, unawareness of needs, trust, psychological phenomena, perceived complexity, costs and prices, interoperability, and reliability and availability. Some of the categories' names were adapted after applying them in practical case studies. To give an example, the initial name of "perceived complexity" was "complexity". Since the term complexity is also related to the inner product complexity, it was changed to perceived complexity, to better distinguish from the inner product complexity and to prevent misunderstanding. The eight categories identified arise from two areas: product characteristics and customer behavior. Figure 5-1 presents the model of customer acceptance consisting of the eight categories and their belonging to these two areas.

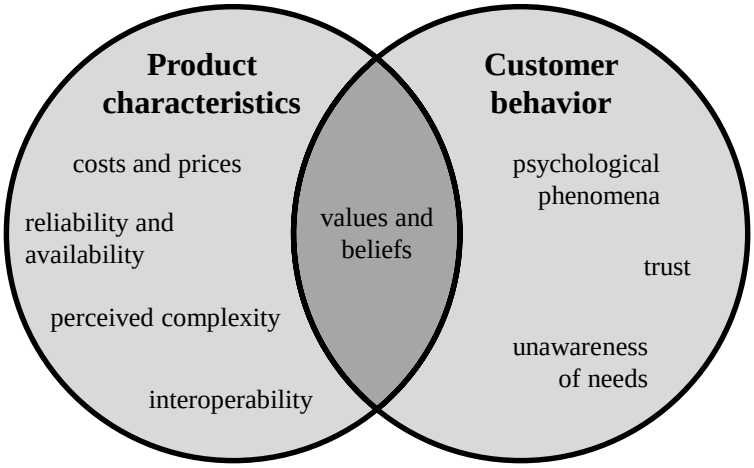

Figure 5-1 Categories of customer acceptance allocated to product characteristics and customer behavior

The aspects partly overlap each other and they could be allocated to more than one category, i.e. the allocation of aspects to categories is not distinctive. Therefore, some categories have overlaps. However, the categorization helps to provide an easy overview of all aspects of customer acceptance. Those eight categories are easy to understand for practitioners and easy to use, i.e. practitioners will easily identify relevant aspects and get a broad overview of potential aspects. The next subsection will further investigate those eight categories. An overview including a short description is given in Figure 5-2.

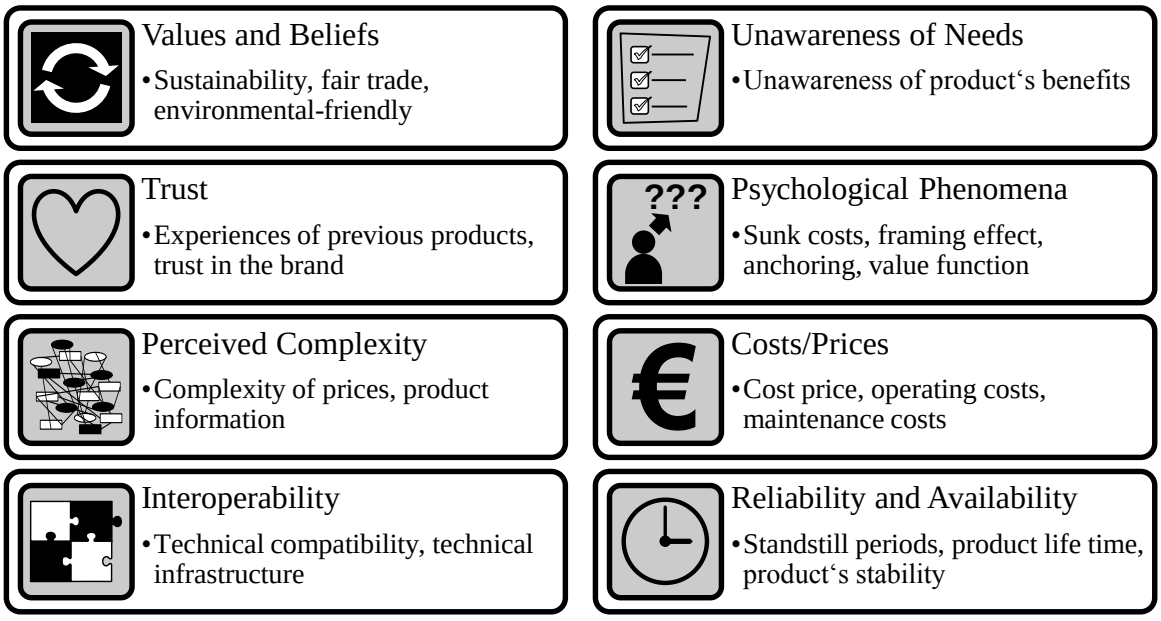

Figure 5-2 Categories of customer acceptance including a short description

Kano et al. (1984) proposed a categorization of customer needs in delighters, performance, and basic needs, as it is shown in Figure 5-3. The aspects of this work’s model of customer acceptance could be allocated to those three categories. Depending on the market, customers, and products the aspects of customer acceptance might be delighters or basic aspects.

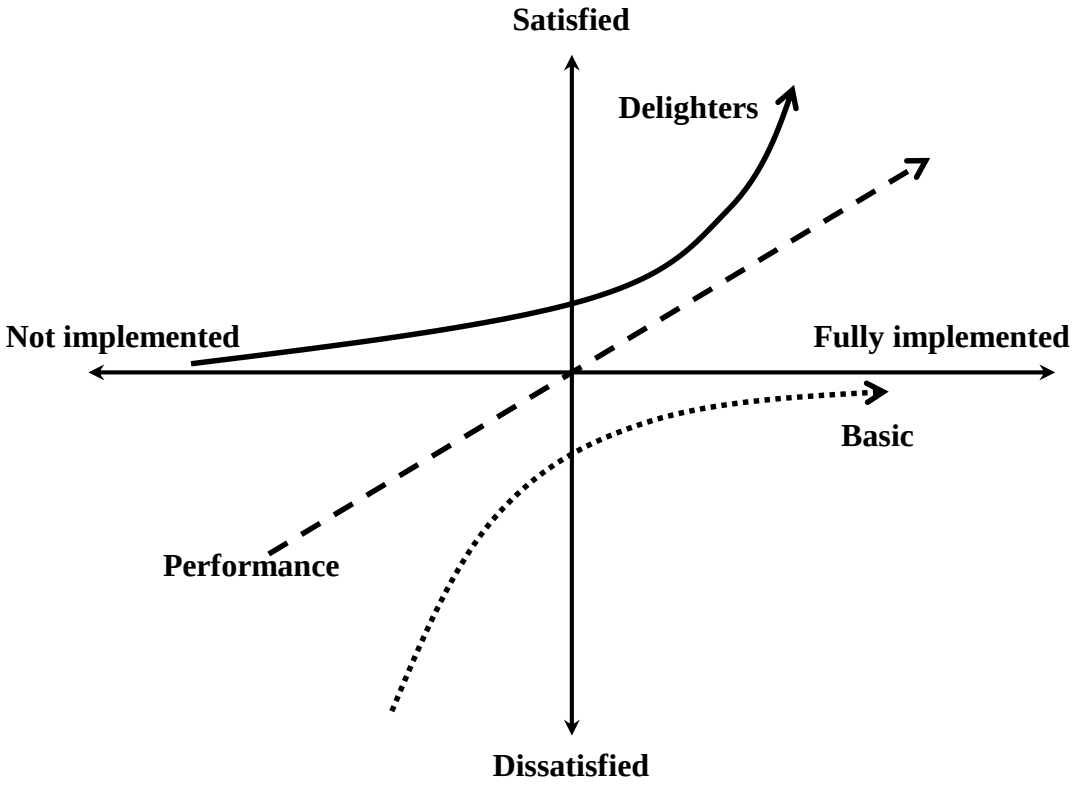

Figure 5-3 Kano model of customer needs, source: (Kano et al., 1984)

Most aspects of this work's model of customer acceptance could be allocated to basic and performance needs. This thesis supports companies in the first step of PSS transition. PSS concepts that are based on this model of customer acceptance might be incremental innovations, because most aspects are basic or performance aspects of customer acceptance. To create disruptive innovations that have a high level of innovativeness, delighting aspects should be taken into account (Schenkl et al., 2014a). The design support is helpful for companies that are willing to implement incremental innovations by staying in existing markets and dealing with small technological progress (Assink, 2006). To facilitate disruptive innovations, delighting aspects of customer acceptance must be considered. Cho et al. (2010) come up with economical, ecological, and experience values that can be seen as delighting aspects. The category values and beliefs includes most of those delighting aspects. Figure 5-4 shows a ranking of the categories of customer acceptance allocated to the basic, performance, and delighters needs of Kano's model (Kano et al., 1984). This figure also shows if categories are capable of being a basis for incremental or disruptive innovations. The author of this work allocated the categories to the needs of Kano's model, however, the allocation differ for varying branches, products, and customers.

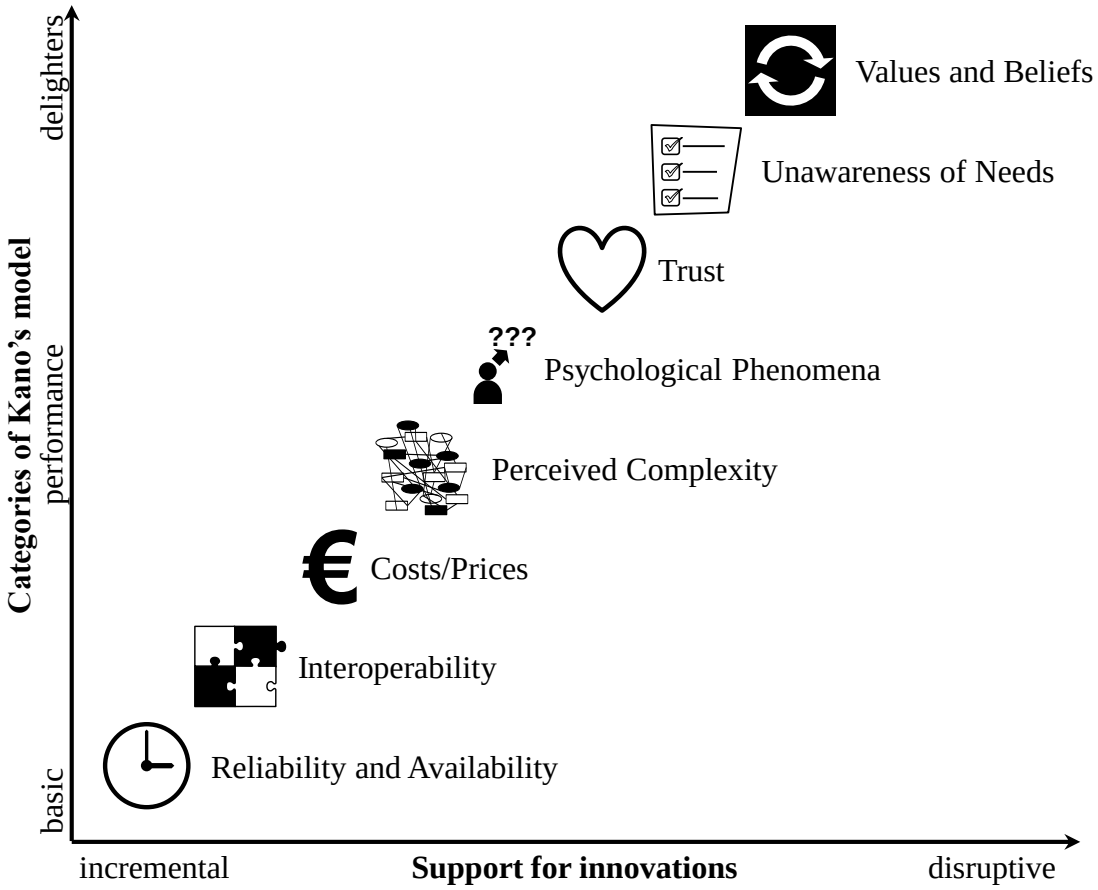

Figure 5-4 Ranking the categories of customer acceptance based on Kano's model

5.4 Aspects of Customer Acceptance

The aspects of customer acceptance describe factors depending on customer perceptions. An aspect of customer acceptance is not a one-dimensional phenomenon; it is based on the customer, his perception and the effects or consequences on customer acceptance. To better structure and present the aspects, this work shows the aspects on five layers (see Figure 5-6). The top-level is the *category* (see the previous section 5.3), then follow the *perception/characteristic*, the *cause*, the *effect*, and the *consequence*. While the levels *category* and *perception/characteristic* serve as a thematic structuring, the levels *cause*, *effect*, and *consequence* can be seen as a cause-and-effect-chain focusing on aspects of the level *perception/characteristic*. The level ***perception/characteristic*** describes the aspects of customer acceptance on a more precise level than the level *category* does. It refers to the basic characteristic of the aspect or how this aspect is perceived by customers. Dependent on the category, the structuring was handled differently to make them as easy to understand as possible. E.g. while the category costs and prices was structured based on the temporal occurrence in the purchase process, the category interoperability is partitioned based on different kinds of interoperability systems. The level ***cause*** describes the underlying reasons for the aspects in the level *perception/characteristic*. The aspects of customer acceptance are based on these reasons. The level ***effect*** presents implications of those reasons on the customer

and how those reasons affect the customer. The level *effect* is the connecting link between the level *cause* and the level ***consequence***. The level *consequence* includes the reaction of customers on the effects. These consequences describe why customers might buy or not buy a product. They can be seen as the links to the definition of a PSS that focuses on aspects of customer acceptance; they reveal customer behavior and anticipate how customers are influenced. Figure 5-5 depicts this cause-and-effect chain.

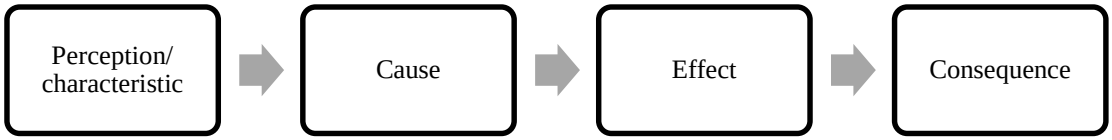

Figure 5-5 Cause-and-effect chain of aspects of customer acceptance

This cause-and-effect-chain better explains the aspects of customer acceptance to potential users and makes them easier to understand. This structure is also beneficial for selecting PSS measures for increasing customer acceptance: the customer acceptance can be increased by influencing different layers of the aspects:

- Reducing or eliminating the causes
- Influencing or restricting the effects
- Influencing or restricting the consequences

To better present the aspects of customer acceptance, appendix 12.2 provides detailed descriptions of all categories and aspects. Figure 5-6 shows an excerpt for the aspect *costs from the usage phase* of the category *costs and prices*. The structure of this description is based on the cause-and-effect chain. The description includes references to literature sources.

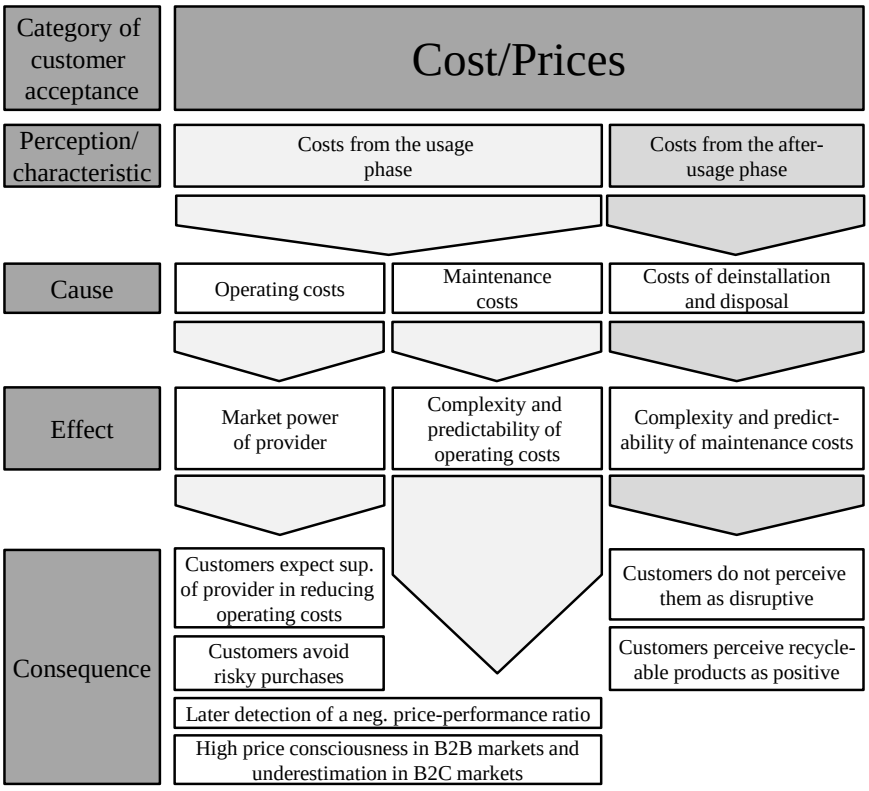

Figure 5-6 Cause-and-effect chain of costs from the usage phase

The following subsections describe the detailed aspects for each category. To keep the description short, only the superficial aspects are shown. Several papers and student theses that are part of this work describe the theory and context behind those aspects. The student theses are shown in the appendix 12.6. The overview of the categories (Schmidt et al., 2014a), the category perceived complexity (Schmidt & Mörtl, 2015), the category psychological phenomena (Schmidt et al., 2014b), and the category interoperability (Schmidt et al., 2016d) were published in conference papers.

5.4.1 Values and Beliefs

Values and beliefs describe aspects of customers and their backgrounds influencing the purchase decision. The elements in the layer perception/characteristic are organized based on aspects determining customers' backgrounds. Those determinants are as follows: *contentment, ethics, emotions, social, culture, religion, politics,* and *sustainability*. The aspect sustainability is divided into the phases of a product's lifecycle: *sustainability in producing and processing raw materials, sustainability in development, sustainability in manufacturing, sustainability in distribution and packaging, sustainability in product usage,* and *sustainability in recycling and disposal*.

Contentment

The cause for the contentment aspect is that people *negate to their status and prestige*. As an effect, *classic status symbols* like luxury cars are *less beneficial* for customers. *Self-fulfillment is more important* for humans *than showing off. Product's functions* are *more important than owning a product* (consequence layer), e.g. mobility is more important than having an own car (Bratzel & Lehmann, 2010; Doll et al., 2011; Tews & Perryman, 2009).

Ethics

Causes for the ethics aspects are *conscious consumption* and the will to *follow own ideals*. This makes people *feeling guilty* about *using products that are critical* concerning own ideals (Priddat, 2000) (effect layer). Consequences are boyc*otts of products that are not compatible to own ethics* or other *boycotts* with the objective *to support social claims* (Priddat, 2000). Another consequence is that *ethical consumption is communicated to the society* (Priddat, 2000).

Emotions

Purchase decisions might be caused in *rational or emotional* aspects (Copeland, 1924). As an effect, *negative or positive emotions trigger incentives for purchases* (Kotler & Armstrong, 2014). People might *refuse to purchase products because emotions are missing or competitive products are emotionally similar*, which is especially relevant for luxury products (Catry, 2003). Furthermore, *intense branding or emotional benefits of products* can lead to *positive purchase decisions* (Lynch & de Chernatony, 2004) (consequence layer).

Social

Causes might be that people *identify themselves with certain social groups* (Bröring & Griese, 2011) and that people own a *position and fill a role in the society* (Bröring & Griese, 2011; Foscht et al., 2011). The *social group* might be a *reference point* for people and the *position in the society generates expectations of their behavior* (Bröring & Griese, 2011; Foscht et al., 2011) (effect layer). As a consequence, *lifestyle and behavior pattern influence consumer behavior*, i.e. *purchase decisions are based on expectations by the society* (Bröring & Griese, 2011). Another consequence is that *opinion leaders*, like experts, politicians, or celebrities, might *influence the opinions with social groups* (Bröring & Griese, 2011; Foscht et al., 2011).

Culture

Causes are the influences of culture on *emotional and rational parts of decision-making* (Albers-Miller & Stafford, 1999; Hofstede, 1980; Triandis, 1993) and *different sensitivity and perceptions of emotions* (Triandis, 1993). As an effect, people *from different cultures perceive products' characteristics differently* (Kisabaka, 2001). This might lead to *cultural differences in product evaluation* and *culture-dependent emotions generated by products' characteristics* (consequence layer). The *globalization* can make *differences of consumer behavior assimilate* (Kisabaka, 2001) or *further diverge* (Böhm, 1998; Ingelhart & Baker, 2000).

Religion

Causes are *religious traditions as basic patterns of value systems* (Kisabaka, 2001). This defines *rules for customer behavior* (effect layer). The consequence is that the *compatibility to religion is a decision criterion for purchases*.

Politics

The cause is that different *political opinions can generate tensions between societies*. As an effect, people assign *those tensions to specific products* and have *negative associations*. Consequences are *negative purchase decisions for products from other societies* or *for products that are associated with other societies* (politically motivated boycotts).

Sustainability

The aspect sustainability is a broad area that became relevant during last decades, especially for industrial nations. There are various causes emerging from different phases of the product lifecycle. Since the effects and consequences on customers are quite similar for different lifecycle phases, this model of customer acceptance distinguishes between causes emerging from different lifecycle phases but not between effects and consequences from different lifecycle phases. The following paragraphs will describe the causes separately for the different lifecycle phases. The effects and consequences are the same for the different lifecycle phases.

Causes of Sustainability in Producing and Processing Raw Materials

Producing and processing raw materials can *destruct natural habitats* (Schüpbach et al., 2007) or cause *air pollution, water pollution,* and *soil pollution* (Schüpbach et al., 2007; Voigt, 2013). It might require a *low level of working conditions and salaries* or *child labor* (Ranalli et al.,

2009; Schüpbach et al., 2007; Voigt, 2013). Providers might *not sufficiently accept social responsibilities* (Voigt, 2013), they might have a *high consumption of energy and resources* (Ranalli et al., 2009; Rückert-John et al., 2013; Schüpbach et al., 2007), or they might *use toxic substances* (Gilg et al., 2005; Ranalli et al., 2009; Schüpbach et al., 2007).

Causes of Sustainability in Development

Some companies might perform *animal testing* within the development phase (Ranalli et al., 2009).

Causes of Sustainability in Manufacturing

The causes in manufacturing are similar to the causes in producing and processing raw materials: *high consumption of energy and resources, using toxic substances, destructing natural habitats, low level of working conditions and salaries, child labor, air pollution, water pollution, and soil pollution*.

Causes of Sustainability in Distribution and Packaging

Besides a *low level of working conditions and salaries*, *long routes of transportations* or *unsustainable transportation* (e.g. using old trucks) (Schüpbach et al., 2007) are causes of sustainability in distribution and packaging. Furthermore, *large amounts of package material* might be needed and the *package material might be unsustainable* (Craig-Lees & Hill, 2002; Gilg et al., 2005; Ranalli et al., 2009).

Causes of Sustainability in Product Usage

If products do not include *economic possibilities for repair or upgrades*, the product usage might be unsustainable. *Short product lifetimes* (Voigt, 2013) and *emitting substances that are harmful to the climate and the environment* (Rückert-John et al., 2013; Voigt, 2013) are other causes in product usage. The product might *consume fossil energy sources* (Rückert-John et al., 2013; Voigt, 2013) or needs a *high amount of energy and resources*.

Causes of Sustainability in Recycling and Disposal

Causes might be a *high amount of waste* (Voigt, 2013) *or missing recyclability and unsustainable disposal* at the end of product life (Gilg et al., 2005; Ranalli et al., 2009; Voigt, 2013).

Effects of Sustainability

The causes of sustainability or unsustainability lead to an *increasing consciousness in the society for limited resources, social equity, conserving habitats for other people and future generations* (Belz & Peattie, 2012; Deloitte, 2014; Rückert-John et al., 2013).

Consequences of Sustainability

A consequence is that people are w*illing to spend more money for sustainable and efficient products* (Belz & Peattie, 2012; Schüpbach et al., 2007; Voigt, 2013). They might *reduce their consumption of resources* (McDonald et al., 2006; Shaw & Newholm, 2002) and *waive material products* (Belz & Peattie, 2012). There might be a *higher customer loyalty to companies fulfilling aspects of sustainability* (Belz & Peattie, 2012). *Pressure from public and value chain* might ask for more sustainability (Goedkoop et al., 1999; Sheehan, 2012). In general, *societies*

tend to more sustainable products and *legal regulations force more sustainability* (e.g. exhaust emission standards) (Dütschke et al., 2012; Goedkoop et al., 1999). Customers *share their positive and negative experiences concerning sustainability* (Belz & Peattie, 2012). During last decades more and more *consumer groups emerged that focus on sustainable consumption*, e.g. LoHaS (Lifestyles of Health and Sustainability) or LoVoS (Lifestyle of Voluntary Simplicity) (Belz & Peattie, 2012; Glöckner et al., 2010; McDonald et al., 2006; Schramm, 2013; Schüpbach et al., 2007).

The appendix 12.2 (see Figure 12-1 and Figure 12-2) provides an overview of the aspects of values and beliefs.

5.4.2 Unawareness of Needs

The aspect *unawareness of needs* describes factors of customers concerning their consciousness of needs. On the layer perception/characteristic, the aspect is divided into the four dimensions that have been identified: *unknowingness of needs* (Sickel, 2010), *unknowingness of product* (Kotler & Keller, 2011), *problem not known* (Rogers, 2003), and *lacking necessity of purchase* (Rogers, 2003; Schulz, 2008).

Unknowingness of Needs

This aspect describes the issue that a customer does not know his need for a new product or that he is not aware of this need for a new product. This is caused in *lack of information* (cause layer) with the effect that the customer does not know about the *benefit of purchasing* a new product. If a customer uses a product for several years and if he is happy with the product, he might not think about advantages and benefits of buying a new product. The consequence of this aspect is that the customer *declines a product* because he is *not aware of his needs* or he does *not know his needs* (lack of information).

Unknowingness of Product

The cause for not knowing a product is *lack of information*. The effect of this aspect describes the case that a customer has a *problem or a need he is aware of but he does not know a product* that is capable of solving the product or of satisfying the need. This results in the consequence that the customer *cannot solve a problem or satisfy his need even though he is willing to*.

Problem not Known

If the customer does not know the problem two causes can be relevant: either *lack of information* or *incentive problem*. The lack of information is relevant for larger companies, if some employees know about a problem (e.g. mechanics) but relevant persons do not receive this information (e.g. employees in purchasing department). This might be caused in lack of communication between departments and the effect is *unknowingness of the problem*. *Incentive problem* describes the case that customers are not motivated to identify a problem. The effect of the incentive problem is that customers are *not aware of the problem*. The consequence is that customers do *not have incentives for purchasing a product* if they do not see a need or a problem.

Lacking Necessity of Purchase

The cause for lacking necessity of purchase is based on an *incentive problem*, because the customer perceives the *benefit of purchasing a product as too low* (effect layer). The consequences are that the customer *contests the positive cost-benefit-ratio* of a product and that he *perceives the cost-benefit-ratio as negative*.

The appendix 12.2 (see Figure 12-3) provides an overview of the aspects of unawareness of needs.

5.4.3 Trust

The aspect *trust* includes factors influencing the customers and their trust to companies, brands, and products. The layer perception/characteristic is divided into aspects about the trust to product, the customer loyalty to companies and brand loyalty. The following aspects were identified: *benevolence of a company* (Butler & Cantrell, 1984), *integrity of a company* (Schoorman et al., 2007), *ability of a company* (Schoorman et al., 2007; Smith & Barclay, 1997), *trust to the product*, *brand loyalty*, and *point of sale*.

Benevolence of a Company

This characteristic describes a factor of customer loyalty to a company. The benevolence might be influenced if customers need to spend *extra costs* for *canceling the current contract* of a provider or for *changing the provider or product* (cause layer). Customers might *feel* being *dependent* on or *bonded* to this company (Morgan & Hunt, 1994) (effect layer). As a consequence, a *disloyalty* of customers might appear (Morgan & Hunt, 1994).

Integrity of a Company

This aspect also influences the customer loyalty to a company. A cause might be that the provider shows *opportunism* in his behavior or *lacks commitment* (Morgan & Hunt, 1994). This makes customers to perceive that the company only *pursues own interests* and is *dishonest* with the customer (effect layer). Customers might be *uncertain and concerned* that the company *fulfills its tasks*. Another cause lays in the *complaint management* (Ganesan, 1994) that might have *long-winded processes* and that might be *uncomfortable for customers* (effect layer). Consequences are that customers *perceive this behavior as opportunism* (Ganesan, 1994) or they do not *feel supported and cared* by the company (Athaide et al., 1996).

Ability of a Company

This characteristic influences the customer loyalty to a company. It describes the abilities and competences of companies to be a worthy business collaborate to their customers. One cause could be the *communication* between provider and customers, also after purchase, and the *availability of information*. Potential effects are that *information* (e.g. about the product's performance or function) is not *sufficiently provided* (Catulli, 2012) or that the *sales person* consulting the customer is *not competent* (Bergen et al., 1992; Rexfelt & af Ornäs, 2009). Other effects are *vague descriptions of the performance and function* that are fulfilled by the product

(Rexfelt & af Ornäs, 2009) or *lacking knowledge of the company*, e.g. about customer's expectations. Consequences are *information asymmetries* or additi*onal efforts for customers to generate and process information*. Another underlying cause is that the company *does not provide innovative products or new technologies*. This makes customers think that the *business relation to the company is not beneficial* (effect layer) (Ball et al., 2004; Morgan & Hunt, 1994). Customers might *not* see *material and objective benefits* (e.g. cost savings) or *immaterial and subjective benefits* (e.g. emotions or experiences) in purchasing another product at this company (Tukker, 2004) (consequence layer).

Trust to the Product

A cause that customers trust a product might be *customers' ability to evaluate products*. This ability depends on *customers' experiences with same or similar products* (Riedemann, 2011) (effect layer). Consequences are that customers are *afraid of mispurchases or that they make unreasonable purchase decisions*. They might *purchase only products they knew before* (Godefroid & Pförtsch, 2003) or they *need to test products before they are willing to buy* them (Rogers, 2003) (consequence layer). Another cause might be that customers *compare products to the previous generation*. As an effect, they ad*opt those experiences or knowledge that originate from previous products to the current version of those products* (Kittl, 2009). A consequence is that customers might *not make rational decisions* based on *declared decision criteria, only by comparing to previous products* (evaluation anchor). Another consequence is that customers *evaluate known products and brands better than new ones*. Trust to the product might be caused in the *quality and the perception of the package*. Customers *assign the perception of the package to the product's characteristics* (Iserman, 1991) (effect layer). This makes the *product's design and the package to marketing measures and measures to differentiate to other competitors* (Iserman, 1991), which is quite relevant *for impulse purchases* (Keuper & Hannemann, 2009) (consequence layer).

Brand Loyalty

Causes for the brand loyalty are the *image and the perception of the brand*. Customers *assign the perceived characteristics of a brand to the characteristics of its products* (Riedemann, 2011) (effect layer). This can generate *emotions* that companies can use to *distinguish themselves from their competitors* (Kotler & Keller, 2011; Lorenz, 2008). Furthermore, customers are *less motivated to change products or the provider* (consequence layer).

Point of Sale

The *design of the point of sale* (POS) can influence the trust (cause layer). Effects are that the *first impression of the product or brand is based on the physical* (Scheuch, 2001) or *virtual* (Éthier et al., 2006) *POS* and based on the *interactions to customers and sales conversations* (Loy, 2006; Zschuckelt, 2003). Customers might *evaluate* products and brands based on this *first impression*. The *POS* can be designed as an *emotional experience* for customers and the POS is a chance for companies to *differ from competitors in markets* where products from different competitors are similar. This is also relevant for complex products, because

unprofessional sales conversations lead to f*ast and negative purchase decisions* (consequence layer).

The appendix 12.2 (see Figure 12-4 and Figure 12-5) provides an overview of the aspects of trust.

5.4.4 Psychological Phenomena

The category *psychological phenomena* includes irrational behavior of customers that mainly occurs at the point of sales (POS). It is based on the assumptions that humans' decision-making differs from the behavior of the so called *homo economicus* who makes rational decisions only to maximize his utility (Kahneman & Tversky, 1979; Simon, 1959; Smith, 2008). The elements' structure on the layer *perception/characteristic* is based on the issues the psychological phenomena refer to. There are phenomena based on *product presentation, design, and package*, based on *additional product functions and services*, based on *branding and prestige*, and based on *product functionalities*.

Psychological Phenomena Based on Product Presentation, Design, and Package

The *framing effect* is based on the cause that *decision-making is not strict rational and emotionless*. Consequences are that the *way of presenting products influences the decision behavior* (Bauer & Koth, 2014), that *customers focus on the presentation of products instead of focusing on product functions*, and that *(personal) interaction between customer and provider influences the decision behavior* (Werth, 2010). Another cause is that *customers make decisions based on a reference point (anchor)* and do *not deviate from this anchor* (Tversky & Kahneman, 1974), i.e. the *anchor effect*. The *first impression (e.g. product design) influences the first product evaluation* (consequence layer). If *customers evaluate other product characteristics after this first impression*, they *orient to this first evaluation* (consequence layer). The *branding or the company's image can also be anchors and influence purchase decisions* and *products might be excluded from the relevant set because of the brand* (Bauer & Koth, 2014) (consequence layer). Additionally to the anchor effect, the *status quo bias* is based on the cause that *it feels wrong for customers to deviate from a first evaluation* (status quo). As a consequence, it is difficult to *change an anchor that is already set* and *customers might accept disadvantages in keeping the anchor-brand* (Kahneman et al., 1991). Customers use *simple classification schemes to manage complex environments* (Liebel, 2011) (cause layer). They also *evaluate and classify products based on associations* (e.g. linking a brand to product characteristics) (Doyle, 1990) (cause layer). This leads to the *representativeness bias* and to the consequence that *psychological stimuli influence the product evaluation* (e.g. design of successful products is used for other products) (Pohl, 2004; Schmidt et al., 2014b; Sutherland, 2007). Another consequence is that the *branding generates positive or negative product perceptions*. Customers *make their decisions based on purchase decisions of other people*, which is the cause for the *herding effect*. As a consequence, people *prefer products that are used by other customers or associated to other customers*. Another consequence is that the brand *recognition or the product recognition have positive effects on purchase decisions*.

Psychological Phenomena Based on Additional Product Functions and Services

The *discount effect* describes the causes that *one-off profit is perceived as better than over time profit* and *that costs over time are perceived as less paining than one-off costs*, i.e. the *influence of time on profit and costs* (Mowen & Mowen, 1991). *Portioning costs over time might increase the willingness to buy* and the *one-off costs of purchase are overestimated compared to the lifecycle costs* (consequence layer). *Repeatedly presenting a stimulus generates a positive perception of this stimulus* (Blüher & Pahl, 2007) and *repeatedly contacting a product or a company upgrades the product or the company* (cause layer). This leads to the *mere-exposure effect* and the consequence is that the n*umber of interactions between customers and companies influences the purchase decision*. If custo*mers own or use a product, they might rate the product value higher* and they might *overestimate product values compared to the objective and monetary value* (Bauer & Koth, 2014) (cause layer). This is described by the *endowment effect* and the consequence is a low*er probability to return or resale products that are used or owned by customers* (Werth, 2010). The *sunk-cost effect* includes the causes that *previous purchase decisions influence future purchase decisions* (Bauer & Koth, 2014) and that customers might *avoid a reorientation on the market to maximize utility if they have also made purchase decisions*. As a consequence, people tend to h*old on products they are owning because of earlier investments*.

Psychological Phenomena Based on Branding and Prestige

Unconscious feelings and instincts influence rationality, which is the cause for the *emotional bias* (Sutherland, 2007). As consequences, customers might *unconsciously preselect products based on the brand or physical stimuli* (e.g. color, design) (Bauer & Koth, 2014; Doyle, 1990; Pepels, 2005) and *emotions generate psychological benefits that can overbalance the actual product value* (Capaul & Steingruber, 2013). The *availability bias* includes the causes that *evaluation is based on associations and events available for customers* (Tversky & Kahneman, 1973) and that *events and associations occurred recently are more important for decisions*. *Famous brands might serve as anchors and reach better evaluations if customers have positive and recent associations with them* (consequence layer). The availability effect might make customers to make *false evaluations based on those associations*.

Psychological Phenomena Based on Product Functionalities.

Humans perce*ive greater pain in losing money than perceiving joy of getting the same amount of money* (Werth, 2010). People perceive *various small losses (wins) as lower (higher) than one loss (win) with same total amount* (Werth, 2010). The *value humans perceive does not grow proportionally to the actual value* (Kahneman & Tversky, 1979). Those are causes for the effect *value function* (Kahneman & Tversky, 1979). A consequence is that the *main function of the product is more important than several additional functions or services*. The *product value and product benefits are more important for customers than the product functions or product performance* (Bauer & Koth, 2014) (consequence layer). Another consequence is that customers do *not cumulate the benefits for partial functions or services*. Therefore, offering *more functions and services does not necessarily provide more benefits for customers* (Bauer

& Koth, 2014). The *relativity bias* includes the cause that customers make *relative evaluations and not absolute evaluations* in comparing alternative products. As consequences, the *perceived product value depends on the comparison to alternative products* and a *decoy variant might increase sales figures of other variants* (Bauer & Koth, 2014).

The appendix 12.2 (see Figure 12-6, Figure 12-7, and Figure 12-8) provides an overview of the aspects of psychological phenomena.

5.4.5 Perceived Complexity

The category perceived complexity is distinguished into six aspects on the layer perception/characteristic that are relevant for different phases of the buyer decision process: *price complexity* (Krämer, 2010), *complexity of variants* (Buchholz & Souren, 2008), *usability* (Dix, 1998; ISO, 1998; Nielsen, 2007; Shneiderman, 1998; van Welie et al., 1999), *availability of product information*, *processes in the usage phase*, and *time pressure*. However, time pressure is not a real aspect of perceived complexity, it works in combination with other aspects and increase the effects of other aspects. Time pressure is a gain factor for other aspects.

Price Complexity

According to Krämer (2010), the price system of a product portfolio includes all prices and price elements (e.g. prices for additional features, monthly fee). There are three causes: the *size of the price system*, the *configuration of numbers* and the *configuration of calculation types*. The number of price elements determines the *size of the price system*. The vertical size of a price system describes the elements the total price consists of, e.g. the classification in fixed and variable prices or surcharges to a basic price. The number of options that are available for the customer for purchase describes the horizontal complexity. The *configuration of numbers* depends on the diversity of numbers and digits used for quantifying the prices. The *configuration of calculation types* depends on the difficulty of the calculation type (Estelami & Hooman, 1999) and on the number of calculation steps. Those causes have effects on the perceived complexity consisting of *stress caused by the price system, efforts for calculation and efforts for evaluation*. Time pressure intensifies those causes. Based on those causes, the effects are *information overloading* (Buchholz & Souren, 2008), *efforts for information processing*, and *efforts for evaluation*. These effects result in consequences for the customer's position concerning the *price fairness, reduction strategies* (e.g. transferring the purchase decision to others) or in *postponing or negating the purchase decision*.

Complexity of Variants

According to Buchholz and Souren (2008), there are two causes for the complexity of variants: *number of variants* and the *diversity of variants*. If there are too much product alternatives, the customer perceives this number as an overloading of stimuli. A too high number of variants can also cause a perceived unclarity of stimuli. This describes unclear or contradictory product information that confuses the customer (Walsh, 2002). The diversity of variants can cause perceived complexity, if the variants are similar to each other. Since the customer has problems in distinguishing between different variants, he has a vague idea about the stimuli. This results

in the effects *information overloading*, *efforts for information processing* and *efforts for evaluation*. As a consequence customers tend to *reduction strategies, a delay of the purchase decision,* and *information overloading*.

Usability

Two subjects of usability are relevant for perceived complexity: the *product* itself and the *point of sales (POS)* (cause layer). Several authors deal with product usability and its effects on the customer (Dix, 1998; ISO, 1998; Nielsen, 2007; Shneiderman, 1998; van Welie et al., 1999). All of them mention similar points relevant for the customer perception: *difficult to learn*, *efficiency of usage*, *difficult to remember*, *effectivity of usage*, *dissatisfaction*, and *errors* (effect layer). Those aspects of usability are not limited to the product only, they are also relevant for the POS. If the purchase process on the POS is easier to use and perceived as uncomplicated, customers can faster pass through the purchase process. This is essential for online shops, because the competing shop and product is just one click away. The issues of usability of the product or of the POS can result in *reduction strategies* or in *postponing the purchase decision* (consequence layer). Time pressure can increase the effects of those issues.

Product Information

The product information is relevant for the information search of the buyer decision process (Kotler & Keller, 2011). The cause is the *availability of product information*. If there is a lack of product information relevant for the purchase decision, customers cannot make decisions as they planned to make. This means for the effect layer, customers have to spend more efforts to obtain the missing information (*efforts for information processing*) or they have to make a decision based on an insufficient information content (*efforts for evaluation*). If customers have to decide under time pressure, the perceived complexity based on the lack of product information might more intensive. Consequences are *reduction strategies* if customers feel that they do not have enough information for a robust decision. If customers need time to collect the required information or if they need more time to make a decision, they will *delay the purchase decision*.

Processes in the Usage Phase

Causes for processes in the usage phase are activities that are necessary for enabling the operating of the product: *administrative activities* (e.g. obtain official approval for using a car), *installation*, and *maintenance*. They imply a certain level of complexity that is not apparent for customers before purchasing the product. Effects of those activities might be *information-overloading*, *efforts for information processing*, they might be *difficult to learn*, or they can cause *inefficient usage*. The additional factor time gains these effects. Consequences of complex processes in the usage phase are *reduction strategies* or de*laying the purchase decision*.

Time Pressure

The time pressure is not an own aspect of perceived complexity. Time pressure is a gain factor increasing the effects and consequences of other factors of perceived complexity. Krämer

(2010) states that time pressure can overload customers, Buchholz and Souren (2008) reason that time pressure can lead to stimuli overloading; however, it cannot cause the overloading by itself. Time pressure is only effective in combination with other factors causing perceived complexity. The worsening ratio of information to be processed per time explains the negative effects of time pressure. Time pressure makes customers to *reduce the time for searching information* and to decide based on *less rational product information* (Strohschneider, 2003). *Emotions are more relevant* for purchase decisions for people under time pressure (effect layer). The consequences of time pressure are *simplified decision-making*, *less conceived purchase decisions* and *delay of purchase decisions*.

The appendix 12.2 (see Figure 12-9 and Figure 12-10) provides an overview of the aspects of perceived complexity.

5.4.6 Costs and Prices

The category costs and prices includes aspects that are relevant for the price, other costs, or efforts deriving from purchasing or using the product. The structure of the layer perception/characteristics relies on an extended version of the lifecycle model from the customer perspective. Schweiger (2009) defines a lifecycle model consisting of three phases: Acquisition, Usage and After-Usage. This model was extended by the phase *Planning the Purchase* (based on the buyer decision process according to Kotler and Armstrong (2014)), because customers spend costs and efforts in planning a product's purchase. Figure 5-7 shows this adapted model of lifecycle costs model.

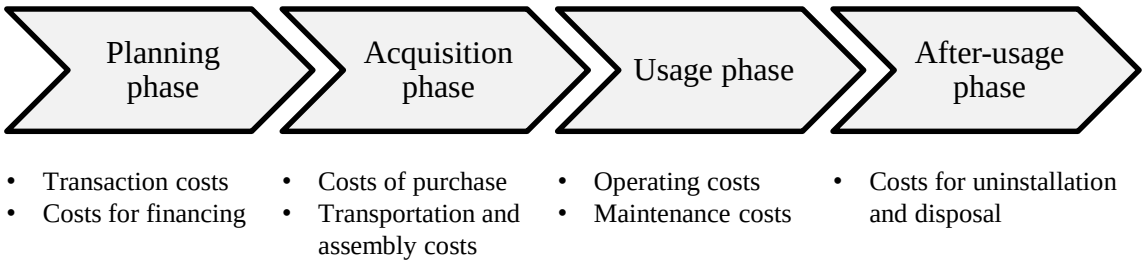

Figure 5-7 Product lifecycle model from customer perspective

The phases of this model serve as the basis for the elements on the layer perception/characteristics. Those elements are *costs emerging from planning the purchase, costs from the acquisition phase, costs from the usage phase and costs from the after usage phase* (Ehrlenspiel et al., 2014; Schweiger, 2009).

Costs From Planning the Purchase

A cause for costs from the planning phase could be the *search costs* that describe the costs and efforts needed for finding the product or product information (Ehrlenspiel et al., 2014; Kotler & Keller, 2011). On the effect layer, the search costs can stem from the efforts that are needed to identify relevant competing products and product information that is difficult to access (*identifying and completing market information*) (Arnolds et al., 2013). Other elements in the effect layer are the *bid solicitation and collecting practical knowledge about the products* (Zeithaml et al., 2012). These effects can lead to the consequences of *additional efforts for*

customers, e.g. *time exposure for gathering information* (Zeithaml et al., 2012) or a *higher price sensitivity* if customers can easily compare products (Kotler & Keller, 2011). Other causes in the planning phase are the *decision costs* (Ehrlenspiel et al., 2014) that are generated by evaluating and comparing products. The decision costs influence the purchase decisions if customers want *avoid false investments* (especially for higher amounts of money), if they have to *improve the level of information* (e.g. overestimating the purchase costs and underestimating the usage costs), or if they need to *define a reference point* (Pechtl, 2005) or to *convert the currency* (effect layer). If customers need to *evaluate the price and price decline* (Kotler & Keller, 2011; Zeithaml et al., 2012) or if they need to *determine the price-performance ratio* to be able to follow the utility maximization, decision costs are also quite relevant for the purchase decision (effect layer). The consequence of those effects are additional *efforts for the customer*. Other causes during the planning phase are the *change costs* (Blut, 2008; Ehrlenspiel et al., 2014) describing costs emerging from changing the product or provider. Change costs include effects like *new investments* that must be financed for buying a different product and its equipment (Blut, 2008). Those investments could be of non-monetary nature if customers need to change their behavior for using the product or if changing the product has psychological effects on the customer (Blut, 2008). Change costs can also include *sunk costs* that have been spent for the previous product. Another effect relevant for the change costs is the *vendor-lock-in* (Brösel & Keuper, 2003). Consequence of change costs are additional *efforts for customers*, e.g. for *buying new products and components* or for *changing their behavior* (Blut, 2008; Brösel & Keuper, 2003). Other causes in the planning phase are the *efforts of financing* (Ehrlenspiel et al., 2014). The efforts of financing might be a negative aspect for the purchase decision if customers are *risk-averse* or if they have problems in *capital procurement* (Kotler & Keller, 2011) (effect layer). Customers avoid risky purchases (Rabin & Thaler, 2001) and permanent credits might lead to psychic strain. The capital procurement might be a problem if the payment method is not suitable (Kotler & Keller, 2011), if the credit includes unpredictable fluctuations in the rate of interest, or if customers need to provide a collateral. Those effects might result in the consequence of additional *efforts for customers*, e.g. because of the *dependency on debt investors* or because *permanent debts might lead to insolvency*.

Costs From the Acquisition Phase

One cause for costs from the acquisition phase is the *cost price* that could be *incompatible to the customer's reference point* or the offer could fail in meeting the *customer's price stimulus* (Coulter & Coulter, 2005; Haugtvedt et al., 2008; Pechtl, 2005; Pechtl, 2014) (effect layer). This could lead to *negative purchase decisions* because of the *price and its presentation* (Coulter & Coulter, 2005; Haugtvedt et al., 2008; Pechtl, 2005; Pechtl, 2014) or because the *benefit in terms of utility maximization is not given* (Pechtl, 2005). Other causes for costs from the acquisition phase are *costs for transportation, assembly or startup* (Ehrlenspiel et al., 2014) that are unavoidable for a proper operating of the product. Customers have a *high cost sensitivity* for those kinds of costs (Bergmann et al., 2013; Haugtvedt et al., 2008; Weber, 2007) (effect layer), e.g. costs of the startup of process engineering plants is around 5%-20% of the total costs (Weber, 2007). In e-commerce, consumers expect free delivery and return (Bergmann et al., 2013). Consequences of those points might be the acceptance of *costs for transportation, assembly, or startup, if they are justified*. This is very relevant for complex

products if transportation, assembly, or startup is requires specific know-how. Customers might prefer to *collect the products by themselves* because they want to be independent of the delivery date and they want to reduce the price they pay for transportation (Schneider et al., 2012).

Costs From the Usage Phase

Costs from the usage phase can be *operating costs* (Ehrlenspiel et al., 2014) or *maintenance costs* (Ehrlenspiel et al., 2014; Männel & Bloß, 1992) (cause layer). Those costs could be *difficult to predict* or they could be *complex* for customers (effect layer) (Ehrlenspiel et al., 2014; Männel & Bloß, 1992). Consequences could be a negative purchase decision because customers *avoid risky purchases* (Rabin & Thaler, 2001). Furthermore, customers *expect their providers to support them in reducing the operating costs*, e.g. by availability and quality of maintenance measures (Kelp, 2008) or by giving hints to reduce operating costs (Noack & Westner, 2013). Another consequence could be that the *costs-performance ratio changes* compared to the determination before the purchase in a negative way (Männel & Bloß, 1992). While B2B customers are conscious of operating and maintenance costs (Kelp, 2008), B2C customers underestimate those costs (Schweiger, 2009).

Costs From the After-usage Phase

Costs from the after-usage phase are costs of *deinstallation and disposal* (cause layer) (Ehrlenspiel et al., 2014; Tietz, 2007). In most cases, customer perceive those *costs* as *low, unavoidable and not to reduce* (Albrecht et al., 2011) (effect layer). As a consequence, customers do not consider those costs as *disruptive* and they perceive *recyclable products as* positive (Albrecht et al., 2011).

The appendix 12.2 (see Figure 12-11) provides an overview of the aspects of costs and prices.

5.4.7 Interoperability

The term interoperability is defined as the ability of systems to work together (Duden, 2015), while those systems can be of different kinds, e.g. technical systems or social systems. This model distinguishes between three categories of interoperability: *technical compatibility* (between technical systems and their components) (Riedemann, 2011), *technical infrastructure* (infrastructure necessary for using a technical system) (Dütschke et al., 2012; Rogers, 2003), and *market penetration* (market as the social system the product is embedded in) (Kittl, 2009). Those categories structure the aspect interoperability on the layer perception/characteristic.

Technical Compatibility

Underlying causes for technical compatibility are the *exchange of system's components* and the *compatibility between products and systems* (Diedrich et al., 2011; Köster, 1998). The *exchange of system's components* can influence the customer in terms of *recovery/maintenance*, *customization*, and *upgrading* (effect layer). Consequences of those effects might be found in the *operating reliability*, *risks of costs*, *sustainability*, *benefit for customers*, *degree of identification*, *consumption of resources*, *adaptability to new technologies*, and the *duration of usage phase of a product* (Dütschke et al., 2012; Mörtl, 2002; Reinhart & Zäh, 2003; Werner,

1995). The *compatibility between products and systems* (cause layer) is split into the effects *compatibility to complementary products* and *maturity levels of connected products* (Altschuller, 1984; Eversheim, 2003). These effects might influence the *net value* (Welge et al., 2000), *uncertainty of the whole system* (Altschuller, 1984; Eversheim, 2003). They might result in the *Lock-In-Effect* or the *Vendor-Lock-In* (if changing the vendor is too expensive, customers are locked in one vendor) (Clement & Schreiber, 2010; Welge et al., 2000) or require *follow-up purchases or additional costs* (Welge et al., 2000).

Technical Infrastructure

Technical and economic risks are on the cause layer of technical infrastructure (Bähr-Seppelfricke, 1999; Kittl, 2009). Those risks might influence *limitations and uncertainties concerning the usability, flexibility and spontaneity* (Götz et al., 2011), *follow-up purchases* and the *risk of false investment* (consequences).

Market Penetration

The market penetration (Kittl, 2009) as an aspect of customer acceptance is divided into two degrees on the cause layer: too low and too high market penetration. The effect of a low market penetration is a missing *installed basis* of products (Brückner, 2008; Hensel & Wirsam, 2008; Köster, 1998). This is relevant for network products whose success depends on the installed network, e.g. mobile phones: the more mobile phones exist in the same network, the more phones can be connected to each other and gain a benefit for their users. Consequences of this installed bases could be lacking *complement products*, a low *critical mass* and the *risk of false investment* (Bähr-Seppelfricke, 1999). Causes for a too high market penetration might be the *product's exclusivity* (Brückner, 2008), the *provider's market power* (Lippe et al., 2001; Nullmeier, 2001), or *negative network effects* (Köster, 1998). The exclusivity can influence the *differentiation from others* (especially for luxury goods) and the orientation to *quality or sustainability* (Brückner, 2008). If a provider gains too much market power the consequences could be too much power to adjust the *prices*, to provide products of *lower quality*, of a lower level of *innovativeness* and to *neglect customer wishes* (Lippe et al., 2001; Nullmeier, 2001). Negative network effects of too high market penetration could result in the consequences *overloading the physical supporting networks* or *availability of additional products* (Köster, 1998). A provider-specific ecosystem can lead to the consequences *lock-in-effect* and *usage restrictions* (Bläsi & Rothlauf, 2013; Buhse & Günnewig, 2008).

The appendix 12.2 (see Figure 12-12) provides an overview of the aspects of interoperability.

5.4.8 Reliability and Availability

The category reliability and availability describes two aspects that are closely correlated to each other. If a customer wants to use a product, the product has to be properly functioning and ready to use. The layer perception/characteristic is structured according to the different aspects of reliability and availability of products as they were identified in literature. This layer includes the following aspects of availability: *general availability of a product or its properties*, *obsolescence* (Bartels et al., 2012), *availability of required resources*, and *sequential*

availability. The following aspects of reliability are modeled: *perceived risk of purchase* (Murray & Schlacter, 1990), *knowledge about the product(-type)*, *product's stability* (Avizienis et al., 2000), *product's safety* (Ericson, 2005; Neudörfer, 2014), *product lifetime*, *monetary avoiding damage at product failure* (Blischke, 1995), *maintainability*, and *protection of personal and confidential information*.

General Availability of a Product or its Properties

This aspect includes the following issues: time, quantity, quality, maintenance, and individualization. The causes for the time issue are the *waiting time* and the *time of delivery* that describe the time between ordering and delivery. This affects the *acceptance of waiting time* (Dempsey et al., 2014) with the consequence that customer might *search and decide for an alternative product* (Dempsey et al., 2014). There are two quantity-related causes: the *quantity of products supplied by provider* and the *attractiveness to purchase a low number of products* (Kotler & Keller, 2011). If the quantity of products supplied is *not suitable to the demand* (effect layer), customer might *change their purchase decisions* based on a *too low inventory* or a *too high demand* (Kotler & Keller, 2011). The number of pieces/products customers require influences the level of how attractive they perceive those products (Baron & Greene, 1996). E.g. if a person needs a copy of a document, he will get a copy at a copy shop instead of purchasing a copier. The *insensitivity to quantity* describes this phenomenon for three different characteristics (effect layer): *embedding*, *insensitivity to numerical quantity*, and *adding up* (Baron & Greene, 1996). This might lead to the consequence that customers purchase superior products (e.g. a copier is the superior product to copies) (Baron & Greene, 1996). The cause for the quality issue is the level of *fulfillment of quality criteria*. According to Garvin (1996), those quality criteria are performance, features, technical stability, conformance, durability, maintainability, aesthetics, and perceived quality. The level of fulfillment influences the *quality-value-ratio* perceived by the customer (effect layer). Based on this ratio, customers might change their *purchase decisions* (consequence layer). The maintenance issue might be caused in the *delivery time of spare parts*. This can affect the *uncertainty concerning the productivity* (of the product) (Biedermann, 2008) and the *fulfillment of the life cycle* expected by the customer (Winzker, 2008). As a consequence, customers orient their *purchase decisions towards the time of repair* (Biedermann, 2008) and *costs risks* (especially relevant for products of high investments) (Winzker, 2008). The cause layer of the individualization issue includes the aspect that the provider has to trade off the *degree of individualization against the efforts for providing individualization*. The customer also has to *decide between standardized or individualized products* (effect layer) (Lindemann, 2006; Stojanova et al., 2013). As a consequence, customers might *decline standardized products* or they are *not willing to pay more for individualized products* (Lindemann, 2006; Stojanova et al., 2013).

Obsolescence

Obsolescence describes the aging of a product and might be caused in the following factors: *technological obsolescence* (Bartels et al., 2012), *functional obsolescence* (Albrice, 2013; Bartels et al., 2012), *logistical obsolescence* (Bartels et al., 2012), *legal obsolescence* (Bartels et al., 2012), *style/aesthetic obsolescence* (Albrice, 2013), *economic obsolescence* (Albrice, 2013). Those causes influence the *benefit the customer gains in using the product* (effect layer).

As a consequence, customers' purchase decisions are based on the *support by provider, the benefit and functions, legal restrictions, aesthetics,* and *efficiency and effectivity* (Albrice, 2013; Bartels et al., 2012).

Availability of Required Resources

The product's availability depends on the availability of resources required by the product, e.g. material resources, such as machines, facilities, buildings and various types of tools, or immaterial resources, such as required know-how, patents and licenses (Opresnik & Rennhak, 2015). The cause layer includes the *intermediate and long-term availability* of those necessary resources that affect the *uncertainty of the product's operation and of the product's benefit* for customers. *Guaranteeing and maintaining the operation of the product* influence customers' purchase decisions (consequence layer).

Sequential Availability

Not all products can work during the whole lifetime, there must be down times or repair times. This aspect is described by the term sequential availability, because just a few products might have a continuous availability. The cause for this sequential availability are *down times, fault times, repair times, delay times, break times* etc. (Katukoori, 1995). Those times have effects on the *productivity and the benefit of the product*. As a consequence, *purchase decisions* are based on *time of errors* and *time for trouble shooting* as well as on *time for restoring the performance* (e.g. charging time) (Götz et al., 2011).

Perceived Risk of Purchase

There are different kinds of risks perceived by customers (cause layer): *financial risks* (e.g. potential loss of money), *performance risks* (e.g. product will not work properly), *physical risks* (e.g. safety, healthy, or hygienic concern), *psychological risks* (product's compatibility to customer's image), *social risks* (others might criticize the product) (Jacoby & Kaplan, 1972). The effect is that customers *focus on safety and security* (Rabin & Thaler, 2001). As a consequence, they buy the product with the highest level of *safety and security and the lowest risk* (Ericson, 2005).

Knowledge About the Product(-type)

The causes for the aspect of product knowledge are *knowledge about the product(-type), experiences with the product(-type),* and the av*ailability of information about the product(-type).* As an effect, customers need to spend *efforts for acquiring existing knowledge or for generating new knowledge*. This leads to the consequences that customers might negate or delay the purchase decision because they feel *uncertain in terms of the benefits* of using the product.

Product's Stability

The stability of the product describes its sensitivity of technical failures and the failure management. Underlying causes are *failure prevention*, *fault tolerance*, *failure correction*, and *failure prognosis* (Avizienis et al., 2000). This can affect the *level of function fulfillment*, the

product's productivity, the *quality and cycle times*. Another effect is that customers have to spend *efforts for correcting the failures*. The consequence is that customers make *negative purchase decisions* because of the *low technical reliability* and the *high probability of failure*.

Product's Safety

The safety of a product describes the requirement that products should not hurt or damage humans or the environment. *Risks at faulty operation*, the possibility of *bypassing safety devices* of the product, or the *product design and its fulfillment of safety requirements* are causes for product's safety (Neudörfer, 2014). The effects are *risks of injuring* humans who might be *long-term damaged*. Consequences might be *negative purchase decisions* because of *potential risks for humans and environment* (Neudörfer, 2014).

Product Lifetime

The product lifetime is the period that customers are able to use the product. This period is influenced by the *product's quality*, *repair susceptibility*, *new technologies coming up within shorter cycles*, or *changing external variables* (Garvin, 1984) (cause layer). This might lead to the *economic amortization* that might not be given anymore. As a consequence, customers tend to buy *products that have the longest expectable lifetime* (Wright et al., 1997).

Monetary Avoiding Damage at Product Failure

This aspect describes the monetary compensation in case of product failure. In a case of an *unexpected product failure* (cause layer), customers expect the provider to *avoid the damage* and to *arrange protection* (Blischke, 1995) (effect layer). The consequence is that customers make *negative purchase decisions* for several reason: there is *no protection in case of product failure*, the *guarantee* is only applicable for *specific components* or for a *limited time period* (Rink, 2006), *provider is not accessible*, or the *provider's reaction time is too long* (Rink, 2006). Further reasons are *additional costs despite the guarantee* (Rink, 2006), *unsatisfying obligingness* (Rink, 2006), or an *unclear definition of the warranty*.

Maintainability

The maintainability describes the *possibility for maintaining the product during the lifecycle* (Blanchard et al., 1995) (cause layer). Effects are that customers need to spend *more efforts to maintenance* and other *influences on the product and its environment* (e.g. product failures) (Blanchard et al., 1995). In this case, customers *tend to buy products* with *low lifecycle costs* and a *high effectivity* (consequence layer).

Protection of Personal and Confidential Information

Causes for this aspect are customers being afraid of revealing their *privacy and the personal integrity* and customers being afraid of *unintended knowledge drain* (Boie, 2014). Based on their high sensitivity for those kinds of information and knowledge, they have a quite *low level for accepting security gaps* (effect layer). They might make *negative purchase decisions*

because of the *possibilities of falsifying, spying, and deleting customer information* (Pommerening, 1991).

The appendix 12.2 (see Figure 12-13, Figure 12-14, and Figure 12-15) provides an overview of the aspects of reliability and availability.

5.5 Methods of Application

After describing the model of customer acceptance, this section deals with the application of the model. The model is described before in a way that might be difficult to use for practitioners. Since companies need simple approaches for using the model of customer acceptance, some methods are proposed:

1. A compromised overview of all categories should provide a summary of all detailed aspects at a glance.
2. The generic catalogue of questions serves as a foundation for an interview guideline or a survey that should support identifying aspects of customer acceptance.
3. Two methods for quantifying the relevance of the aspects of customer acceptance.

Overview of Aspects of Customer Acceptance

One way of using the model of customer acceptance is the overview of all aspects of customer acceptance. This overview shows the detailed aspects for every category of the model. The structure of presenting the aspects relies on the cause-and-effect-chain to make the aspects easier to understand for practitioners. A more detailed description would confuse practitioners and it would reduce the clarity. These overviews can support sales managers in reflecting which aspects of customer acceptance are relevant. Market studies, e.g. acceptance tests, might be based on these overviews to investigate the relevance of aspects of customer acceptance. An exemplary overview of the aspects *costs from the usage phase* of the category *costs and prices* is shown in Figure 5-6. Appendix 12.2 provides detailed descriptions of all categories and aspects.

Generic Catalogue of Questions for Interviews and Surveys

To identify the relevance of aspects of customer acceptance, interviews or surveys with sales managers, experts, or customers might be necessary. In some case studies, (see sections 7.5, 7.4, and 7.3), interviews with sales managers were conducted to identify and quantify the relevance of the aspects of customer acceptance. The interviews turned out to be beneficial for this purpose. To support those interviews or surveys this work provides a generic catalogue of questions for creating interview guidelines or questionnaires. The questions are allocated to the categories and they rephrase the aspects as questions. How the questions were created is shown at the example of *Processes in the Usage Phase* (Perceived Complexity). The question linked to this aspects is as follows:

After buying the product: Which processes/activities have to be done to use the product for the first time?

This generic catalogue of questions must be adapted to the product, the market, and the customer segment. It just provides a fundamental collection of questions that might be suitable. Depending on the product, market, customers, company, strategic focus etc., further questions might be added to get a comprehensive view of customer acceptance.

For interviews, semi-structured guideline-based interviews are suggested. To have interviews with questions from all categories might be too exhausting for interviewees and might take too much time. Thus, to have a better accuracy of interviewees' statements, the interview should be divided into two parts. The first part is an introduction of the categories of the model of customer acceptance. Based on this model, the interviewee selects two or three categories he considers as most relevant. The second part consists of detailed questions belonging to the categories selected by the interviewee. The generic catalogue of questions is given in the appendix 12.3.8.

Quantification Methods

In most projects, it is not sufficient to only identify relevant aspects of customer acceptance; they also must be weighed against each other, because the PSS cannot focus on all of them. Quantifying the relevance of those aspects means to set a focus for the PSS planning.

The literature provides different evaluation methods for weighing criteria, e.g. pairwise comparison (Breiing & Knosala, 1997), block model (Schenkl et al., 2013c) etc. There are also weighing functions for customer-relevant criteria, e.g. the Kano analysis (Kano et al., 1984), conjoint analysis (Green & Rao, 1971), experience values (Kim et al., 2011a), and other evaluation methods (Cao et al., 2011). In principle, all those methods are applicable for quantifying the aspects of customer acceptance. Depending on the case of application, some of them might be more suitable. This depends on the methods of data elicitation, on the quality of data acquired, or on the data accuracy needed for the project. Other approaches of weighing deal with criteria that are more concrete than aspects of customer acceptance, e.g. customer requirements or customer preferences.

A more differentiated method for evaluating aspects of customer acceptance is a combination of Kano's method and a conjoint analysis. Kano's method evaluates if a criterion is a delighter, a performance, or a basic criterion. However, it does not value how much the customer would spend to prefer a delighter compared to a performance criterion. Combining the results from Kano's method with a conjoint analysis facilitates a more specific quantification that is proposed by this work. A detailed description of this method is given in (Schmidt et al., 2014d).

This work proposes another quantification method based on qualitative interviews. This method requires a transcription or a written note of the interviews (based on the interview guideline). It is also applicable for surveys. The principle procedure is as follows:

1. Allocating interviewees' statements to the detailed aspects of customer acceptance
2. Valuing the aspects based on a pre-defined scale
3. Calculating the values for aspects and categories by summing up

Other sources and statements than the interviews are also applicable for step 1, e.g. market analyses. Statements that are compatible to the detailed aspects of customer acceptance must be extracted from those sources. The evaluation scale can reach from 1 to 3 based on the number

and the stresses of mentions. An exemplary scale is shown in Table 5-2, while the variable *X* is a pre-determined number describing the difference between value 1 and value 2.

Table 5-2 Evaluation scale

Criterion	Value
Number of mentions < X AND Interviewee did not declare the aspect as important	1
Number of mentions ≥ X AND Interviewee did not declare the aspect as important	2
Interviewee declares the aspect as important	3

The person responsible for analyzing the interviews uses this scale and evaluates the detailed aspects by himself. After valuing every single detailed aspects, the values for the aspects on a higher level are calculated by summing up the values of detailed levels. This results in a score for every aspect and category that measures the relevance and the importance of them.

5.6 Conclusions

The model of customer acceptance focuses on the RQ #2 (Which aspects, drivers, and barriers of customer acceptance influence the customers and their perception of products, service, or PSS?) and describes a broad collection of aspects influencing customers' purchase decisions. The principle categorization relies on the attributes of the theory of innovation diffusion according to Rogers (2003). However, this work's model of customer acceptance is not limited to innovative products. The model of customer acceptance deals with every kind of product from the branches this work is focused on (see subsection 2.3.4).

To complete the chapter of the model of customer acceptance, the next subsections will show the benefits the model of customer acceptance can gain for PSS planning. Furthermore, the model of customer acceptance will be integrated into the other results of this work.

Benefits for PSS planning

The model of customer acceptance helps companies to identify relevant aspects of customer acceptance, to find aspects that they have not been considered before, and to determine aspects on which the PSS should focus. This model is beneficial for market analyses and it supports the work of sales managers or in the marketing department. The case studies have shown that investigating the relevant aspects of customer acceptance with the context of PSS can result in new ideas for PSS – without any other PSS-specific methodical support. If practitioners use the model of customer acceptance having the PSS categories according to Tukker (2004) in mind they might identify suitable PSS categories or potential changes of the business model.

The business model of PSS should rely on those more abstract aspects of customer acceptance instead of more concrete customer requirements or preferences. The definition of the basic

business model should include insights from customers and their behavior instead of detailed requirements. Aspects of customer acceptance might include indicators or suggestions for defining a business model that is focused on the customers.

Implications for the Work

This model is basically used at the beginning of the planning process. To locate the model of customer acceptance within the design support, this model is usually used at the beginning of the decision-making process in PSS planning (see section 4.5, market analysis). The results from using the model of customer acceptance can also be used in later stages of the planning phase, e.g. to check if the PSS concept is focused on the relevant aspects of customer acceptance. As mentioned in section 3.3, the model is located on the layer of aspects of customer acceptance, connecting the target group of customers with the solution, i.e. the PSS concept. Basically, the model of customer acceptance is not limited for PSS, it is also useful for standalone products or services. This model can be seen as a supporting model for the decision-making process (see chapter 4): it supports the stage of market analysis and describes an additional dimension for the decision points to evaluate the PSS concepts.

To provide a stronger embedding of this model in the planning process, the model can be combined with the service catalogue that is introduced in the next chapter 6. This enables the PSS planners in identifying service elements based on relevant aspects of customer acceptance. A more detailed analysis of this linkage between the model of customer acceptance and the service catalogue is provided in section 6.5.

6. Service Catalogue for Increasing Customer Acceptance

As a last part of the prescriptive study, this chapter proposes the service catalogue. This catalogue is a collection of concrete services to support PSS planners in finding suitable services or service ideas. The service catalogue aims to the research question #3 "how can PSS increase customer acceptance by affecting the aspects of customer acceptance". The procedure of creating the service catalogue is a recursion of the DRM. The service catalogue enables PSS planners to orient the PSS planning towards customer acceptance: the elements of the service catalogue are matched with the elements of the model of customer acceptance. This linkage can serve as a decision support in selecting suitable services: it proposes services that can potentially affect those aspects of customer acceptance. The service catalogue and its connection to the model of customer acceptance can be located into the concepts generation phase of the decision-making process (see chapter 4).

The chapter starts in section 6.1 with a literature review of service classification schemes to distinguish themselves from other approaches and to have an initial list of concrete services. Section 6.2 creates the service catalogue by identifying services from literature and from real industrial offers. Measures from Structural Complexity Management (StCM) create a hierarchy for those services consisting of three layers: concrete services, service clusters, and superclusters. To make the service catalogue easier to use and understand for practitioners, section 6.3 defines another layer consisting of four categories. The resulting hierarchy of the service catalogue is described in section 6.4. The matching between aspects of customer acceptance and the service catalogue is created in section 6.5. Section 6.6 presents how to apply the service catalogue. The conclusion of this chapter shows how the service catalogue is integrated into this work and summarizes the prescriptive study.

6.1 Literature Review on Service Classification

This literature reviews has two objectives: first to check if literature already provides a kind of a service catalogue applicable for this work. The second objective is to identify concrete services that could be the basis for creating a new service catalogue. The literature provides service classifications, categorizations, ontologies or taxonomies that structure or group services. These artifacts are capable of supporting PSS designers in finding services for their products. The next subsections discuss the different kinds of service categorizations and different literature sources that propose collections of services.

Service Categorizations, Ontologies and Taxonomies

The literature provides several approaches for categorizing services (Gaiardelli et al., 2014; Tukker, 2004; White et al., 1999). Tukker's classification of PSS is also applicable for services (Tukker, 2004). It considers the ownership of PSS and differs between product-oriented, use-oriented and result-oriented PSS. Other sources like Gaiardelli et al. (2014) provide a similar categorization, they also mention information-based services or process-focused services. White et al. (1999) differ between non-material services and material (i.e. product-based)

services. Kapletia and Probert (2010) divide services concerning their aims. Beyond providing final results, enabling platforms, or added value to the product life cycle, services focus on the product, customer, or their relations (Burianek, 2009). Those service categories are an abstract classification of services, most of them origin from the PSS research. Since they are just groups or categories of services, they only propose abstract and broad fields for new services. However, they do not support practitioners by providing a high number of specific services.

Service ontologies can be seen as a classification of services (de Groot et al., 2002; Hepp, 2008; Maximilien & Singh, 2004; Nardi et al., 2013). Hepp (2008) defines product and service classes that provide same functionality and that are used for same targets. He focuses on web-services only and mentions criteria like "payment method", "validity" or "business entity type" to differentiate between services. Approaches dealing with service ontologies focus on web-services only and are not applicable for the industries which this thesis focuses on (see subsection 2.3.4) (de Groot et al., 2002; Hepp, 2008; Maximilien & Singh, 2004; Nardi et al., 2013). Furthermore, ontologies do not suggest new and concrete services; they are just used for giving a structure to services. Ontologies might be used to better understand the integration of services (e.g. into a socio-economical system) and this can help to identify new services. However, this way of identifying new services is more complex and requires a higher level of knowledge about services. Service taxonomies (Höfer & Karagiannis, 2011; Lee & Park, 2009; Wemmerlöv, 1990; Yan et al., 2012) are used for the differentiation of services by defining criteria on several levels. Höfer and Karagiannis (2011) focus on services for cloud-computing and define criteria like "license type" or "security measures". By defining different scales for the criteria, taxonomies can be used to identify new services. This way of identifying new services is not easily applicable for practitioners, as they first have to understand the taxonomy and derive their services from the taxonomy. Additionally, the service taxonomies are mostly focusing web-services (Höfer & Karagiannis, 2011; Lee & Park, 2009) or pure service industries (Wemmerlöv, 1990; Yan et al., 2012). However, these approaches do not consider the industries on which this work is focused.

Concrete Services

The literature review resulted in eleven sources proposing collections of services. Since those sources are not comprehensive enough to be a service catalogue, the concrete services mentioned in these works were used as a basis for a new service catalogue.

Goedkoop et al. (1999) analyzed PSS of ten companies and they mention services like "maintenance" or "needed accessories". They suggest product-oriented companies to create additional value for their customers. One possibility to achieve that is the "supply of a total offer", which can include "lease services", "additional insurance contracts", "product upgrading", "repair" and "take-back agreements" (Goedkoop et al., 1999).

Roy (2000) considered industrial cases like a producer of copiers. He assigned services to the PSS categories identified before, e.g. "repair" or "supply of consumables" are result services.

Mont (2002a) carried out a literature study on product-services and eco-efficient services. They identified typical PSS services, e.g. "maintenance". This maintenance service is not linked to the product only (product-service), it is supposed to prolong the product life cycle (eco-efficient service). To ensure the long use of a product, additional upgrades are included in this

maintenance services (Aurich et al., 2007). At the end of the product's life cycle "take-back agreements" and a "recovery", "reuse", "refurbishment", and "remanufacturing" of the product are sensible approaches.

Morelli (2003) analyzed potential customers of a telecenter. The identification of the services for the telecenter relies on an analysis of different criteria according to Bijker (1997). He found services like "financial services" or "technical assistance".

Oliva and Kallenberg (2003) investigated eleven "[…] capital equipment manufacturers developing service offerings for their products". They identified product-related services like selling and maintenance in the first phase. They stated that these services have to be combined and improved in efficiency and effectivity. Hereby it is important to consider services not as supplementary but as core business (Oliva & Kallenberg, 2003; Schenkl, 2014).

Besch (2004) investigated, similar to Goedkoop et al. (1999), the usability of PSS for office furniture. Therefor she identified services that are useful in this context. Office furniture is not constantly in use. Renting office furniture on a flexible basis is supposed to be beneficial for companies (Besch, 2004). This concept saves high acquisition costs as well as room for storing chairs and tables not in use. This is covered by the service "leasing" that suits this kind of PSS.

Aurich et al. (2006) focus on the development of a systematic design process for technical services of PSS. They state properties technical services have to fulfill. Services like "inspections", "preventive maintenance", and "repair" ensure products to provide its designed power and functionalities (Aurich et al., 2006; Aurich et al., 2007; Aurich et al., 2009). Furthermore, customers expect services like "maintenance", "upgrading", "user trainings", and "process improvements" more often (Aurich et al., 2009).

Oliveira and von Hippel (2009) investigated commercial and retail banking services. Despite the fact that the main scope of this work is to identify services that can be self-provided, this work included services relevant for PSS as well. Hereby, some services had to be adapted to technical products. Exemplary services are "consumer forums" and "communities" for discussing problems about a specific product.

Gaiardelli et al. (2014) proposed a classification model for product-service offerings. To apply their model to an empirical study, they identified product service offerings and clustered them based on the dimensions proposed by Tukker (2004). One service is the "delivery of products". Providers can support customers by offering "financial services" to make customers able to afford a new product.

Table 6-1 shows an overview of all approaches dealing with concrete services considered in the literature review. The sources mention concrete services for various industries. All of them come up with a few services and present how they can support the customer or extend the product life cycle. However, those approaches are focused on special industries and they suggest services on a quite abstract level. Furthermore, most of them focus on special kinds of services, e.g. financial services: they do not provide a broad variety of services. Those approaches can serve as a first draft for the service classification. However, there are more fields of potential services thinkable than the single sources offer. To provide a more useful method supporting PSS planners, this list has to be enlarged. For this reason, these approaches were the starting point of creating a service catalogue. The concrete services identified in

different sources is combined and extended by analyzing existing service offers from industries. Searching services in offers from industry, might not guarantee the identification of all possible services. However, including services from industry provides a model of services that includes a broader span of services.

Table 6-1 Approaches dealing with concrete services

● considered ◐ partly considered ○ not considered					
Author	**Focused industries**	**Categories of services**	**B2B**	**B2C**	**Exemplary services**
(Goedkoop et al., 1999)	Various: hotel, launderette, car-sharing	Not applicable	●	●	Needed accessories, take-back agreements, repair
(Roy, 2000)	Various: copiers, floor/carpets, launderette	Result services, Shared utilization services, Product-life extension services, demand side management	●	●	Repair, supply of consumables, maintenance
(Mont, 2002c)	Not clarified, but various	Services at the point of sales, maintenance services, revalorization services	◐	●	Take back, recovery, reuse, refurbishment, remanufacturing.
(Morelli, 2003)	Tele-center: providing workspaces	Not applicable	●	○	Financial services, technical assistance
(Oliva & Kallenberg, 2003)	Manufacturing industry	Basic installed base services, Professional services, Maintenance services, Operational services	●	○	Preventive maintenance, transport to client, business-oriented training
(Besch, 2004)	Office furniture	Not applicable	●	○	Recycling, reuse, change of apparitional parts
(Aurich et al., 2006)	Manufacturing industry	Technical services = product related services	●	○	maintenance, retrofitting, refurbishing, user training
(Oliveira & von Hippel, 2009)	Banking	Retail banking services, Corporate banking services	●	●	Overdraft protection, telephone banking, remote deposit
(Gaiardelli et al., 2014)	Various, not specified	Product-oriented, use-oriented, result-oriented	●	●	Pay-per-use, sharing, updates, extended warranty

6.2 Creating the Service Catalogue

The service catalogue is a classification/structure of services that provides on the one hand a broad coverage of specified services and that is on the other hand easy to understand and easy to use for practitioners. The service catalogue needs to include a high number of specific services from industries this work is focused on (providers of technical complex products, see subsection 2.3.4). Since just a high number of unstructured services confuses practitioners and has a low level of usability, the service catalogue needs to provide a structure that is easy to understand and use by practitioners.

The procedure for creating the service catalogue consisted of the following steps: after identifying services from literature (see section 6.1) and from real industrial offers, services are aggregated by eliminating and summarizing redundant services. To reduce the complexity in modeling the dependencies, services are pre-clustered. Then, the dependencies between services and customer functions are modeled. Based on this structure, the services are clustered into 65 service clusters and 19 superclusters. At the end, four categories are defined and the service clusters were allocated to those categories. Figure 6-1 shows the overall procedure, the next paragraphs explain the procedure on a more detailed level.

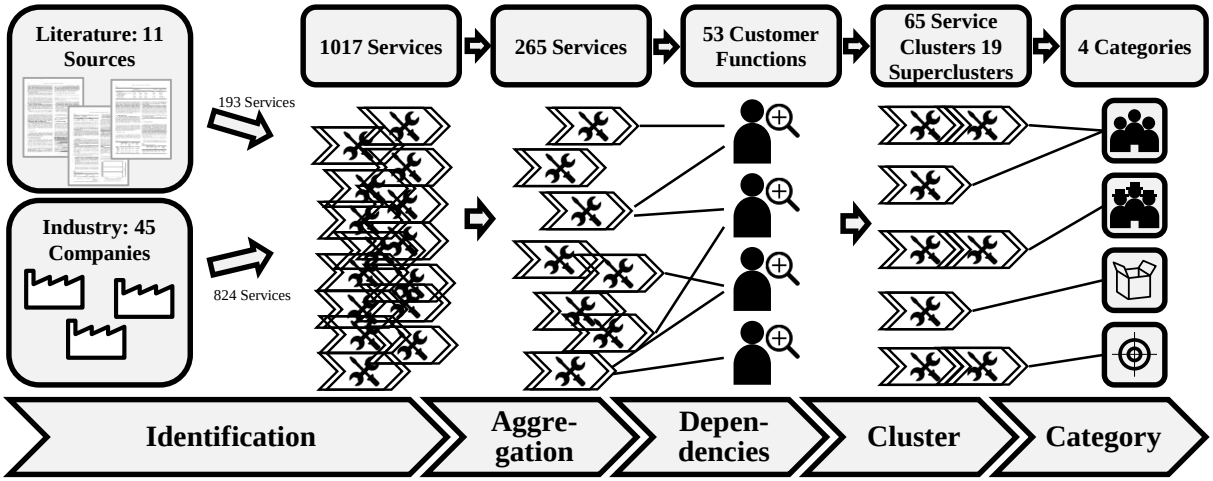

Figure 6-1 Procedure of creating the service catalogue

Identifying Existing Service Offers

To facilitate a comprehensive basis for the service catalogue, the first step was to identify a high number of services from different industries. These basic services were found in literature (see appendix 12.3.1) and in industry (see appendix 12.3.2). The eleven approaches from literature resulted in 193 concrete services. While the literature sources did not present these services explicitly as a service offer, the services identified in industry were presented as offers for customers: literature describes services on a precise level, companies describe them to convince potential customers. To analyze the range of a service offer from industry was quite challenging, because only the marketing term of the service was available. Thus, the comprehension of every service might be slightly incomplete. This comprehension depends on the subjective perception of the author. However, a complete and granular understanding of services is not a necessary requirement, since the service classification should serve as an

inspiration method for PSS planners. To identify service offers from companies, suitable companies were determined, based on the focused companies (described in subsection 2.3.4). The product brochures and web pages of those companies were analyzed concerning service offers and 824 concrete services were extracted from this analysis. In total, 1017 services were identified from literature and industrial offers. Table 6-2 shows a small excerpt of these service list. Since the number of 1017 services is too high for being easy to handle for practitioners and several services overlap or described the same performance range, this list of services are aggregated to a smaller one.

Table 6-2: Identified Services (excerpt only)

Source	**Service**
Atlas Copco Holding GmbH	Advisory
Dematic GmbH	Analysis
Eaton Corporation plc	Analysis
Atlas Copco Holding GmbH	Calibration
Samhammer AG	24/7 Call center
OTIS Gmbh & Co. OHG	24/7 hotline
...	...

Compromising and Aggregating Services

The services identified in the first step are just a raw collection of services. Some of those are duplicates or their levels of detail might be too abstract or too concrete for integrating into the service catalogue. For these reasons, duplicates were eliminated (based on the names/labels of the services) which reduced the number of services from 1017 to 380. 32 services were removed based on a too high level of detail, e.g. “full services” or “outsourcing” are too abstract to be beneficial in a service catalogue. Seven services described a PSS category according to Tukker (2004) instead of a concrete service: they were removed from the list. Nine more services are deleted because they describe too concrete services for specific businesses, e.g. “car services” or “color mixing formulas”. Considering the performance range and the services’ outputs, 47 more services are removed based on lacking differentiation. Those aggregation mechanisms reduced the number of services to 265.

Pre-clustering Services

The number of 265 services is still too high to be easy to use for practitioners. To reduce the number of services the services were grouped to service clusters consisting of one or more concrete services. To group these services, they must be interlinked to each other, either directly or indirectly. To make the whole system easier to handle for automatic clustering, the services were manually pre-clustered. The target of this pre-clustering was to order the sequence of the services because of two advantages: first, determining direct or indirect dependencies between services is simplified, because similar services are processed in a row. Second, the cluster

algorithm needs less iterations for clustering, because the services are in an order, which is closer to the optimized order than a random distribution. For the pre-clustering, three mechanisms were defined (see Figure 6-2):

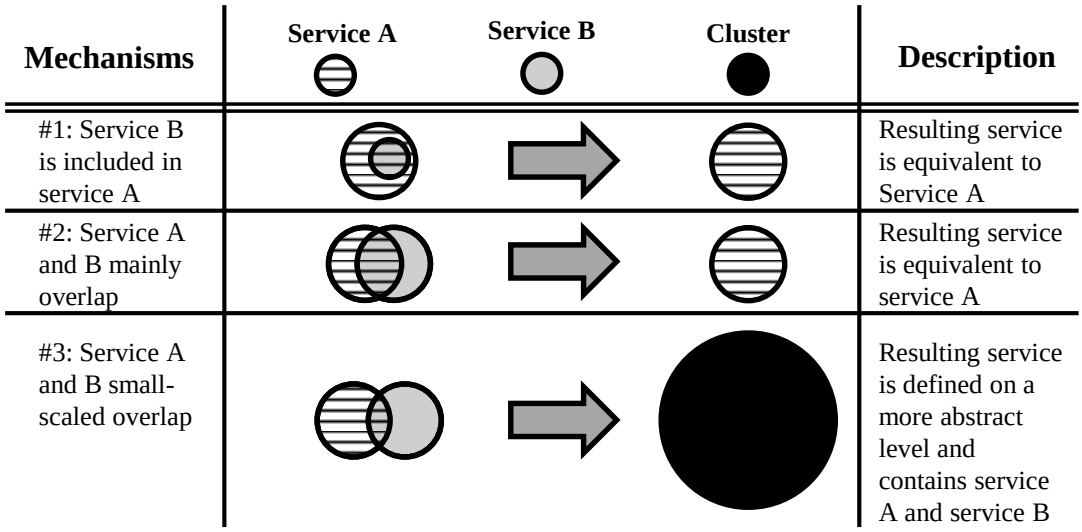

Figure 6-2 Mechanisms of pre-clustering

1. Considering service A and service B, while the performance range of service B is completely included in the range of service A: Summarizing both services to a cluster consisting of the performance range of service A. Example: Service A: “Repairs”, Service B: “Repairing out-of-guarantee”, Cluster: “Repairs”.
2. Considering service A and service B, while the performance ranges of both services mainly overlap: Summarizing both services to a cluster consisting of the performance range of one of the services. Example: Service A: “Copying”, Service B: “Duplication Service”, Cluster: “Copying”.
3. Considering service A and service B, while a small part of the performance ranges of both services overlap: Summarizing both services to a cluster on a more abstract level, which includes the performance ranges of both services. Example: Service A: “Mechanical Design”, Service B: “Concept Design”, Cluster: “Design”.

For this pre-clustering, the mechanisms were not applied for a single pair of services: In most cases, more than two pairs were summarized and combined mechanisms were used for same services. This pre-clustering resulted in 55 service clusters. Table 6-3 shows an excerpt of how the services were allocated to the clusters.

Table 6-3: Pre-clustered services (excerpt only)

Service cluster	**Concrete services**
Help desk	Help desk
	Helpdesk software
	Service desk
	Service help desk
Technicians	Qualified technicians
	Service engineers
	Technicians
...	...

A simple plausibility analysis (checking concrete services belonging to the same service cluster) revealed that the allocation were not clear and consistent. To provide a better clustering of the service, an automatic cluster algorithm was applied to the system.

Dependencies Between Services and Customer Functions

An automatic clustering of services requires the definition of direct or indirect dependencies between services. The service catalogue is supposed to serve as a checklist for PSS planners to identify services for increasing customer acceptance. To orientate the service catalogue towards customer acceptance, services were interlinked to customer functions. Those customer functions are the functional benefit the customer gains from making use of the service. For linking and clustering the services, the procedure of structural complexity management was applied (StCM) (Lindemann et al., 2009). The first step of StCM is the **system definition** by creating a Multiple-domain matrix (MDM). Figure 6-3 shows this MDM consisting of the domains customer functions and services. The MDM consists of two domain mapping matrices (DMM) connecting two different domains and two design structure matrices (DSM) showing the relations between elements of the same domain. The DMM *Services – Customer Functions* presents the only matrix with direct relations in this system. Those relations will be defined manually, while the relations between the services will be calculated based on the DMM *Services – Customer Functions*. The DSM *Services* includes those relations between services. The relations between services rely on their fulfillment of customer functions: if two services fulfill similar customer functions, they have a stronger relation, while two services have a weaker relation if they fulfill different customer functions.

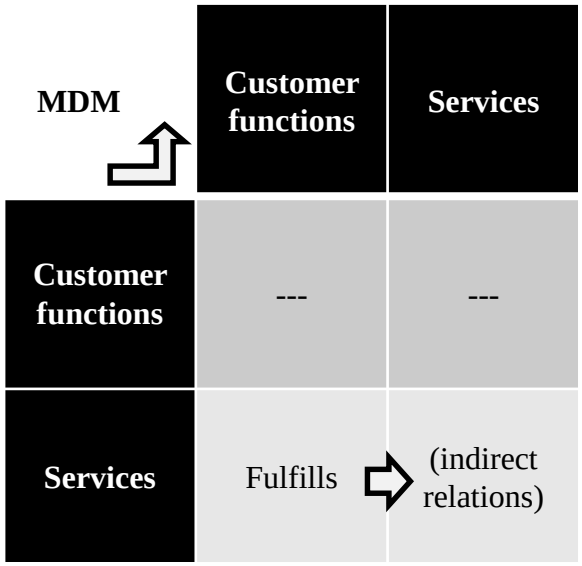

Figure 6-3 MDM for services and customer functions

The step **information acquisition** was to identify elements of the domains services and customer functions. Collecting the elements of services is described in the paragraphs before. Customer functions were identified based on analyzing all services regarding their benefits for customers. In total, 53 customer functions were found, like "improve product usage", "organize suppliers" or "clean the product" (see appendix 12.3.3).

The next step of the information acquisition was the identification of direct system's dependencies. To link the services to the customer functions, the DMM *Services – Customer Functions* was created that consists of the domains services and customer functions. In a two-sections workshop (in total nine hours), two master students filled the DMM *Services – Customer Functions* by setting the relations between all services and customer functions. Those relations were quantified as a zero or a one: a zero means that the service does not fulfill this customer functions, while a one means that the service fulfills this customer functions. If the customer function is the main target of the service, the relation was set to one. However, when a service included a part of a customer function, which was not the main service's target, the relation was set to zero. This strong selectivity was used to limit the number of system's dependencies. If too much dependencies were defined, the clustering might not be beneficial because too many services were connected to each other. Of 13886 possible dependencies, 422 relation were set to one.

The target of applying StCM was to cluster the services. According to StCM, the next step is to **deduce indirect dependencies**. In this case, the DSM *Services* was calculated by squaring the DMM *Services-Customer functions* (using Microsoft Excel). This DSM is based on the assumption in Figure 6-4: if two services fulfill the same customer function, they are indirectly connected. The DSM *Services* shows the indirect relations between services. This DSM *Services* was the input for the final clustering.

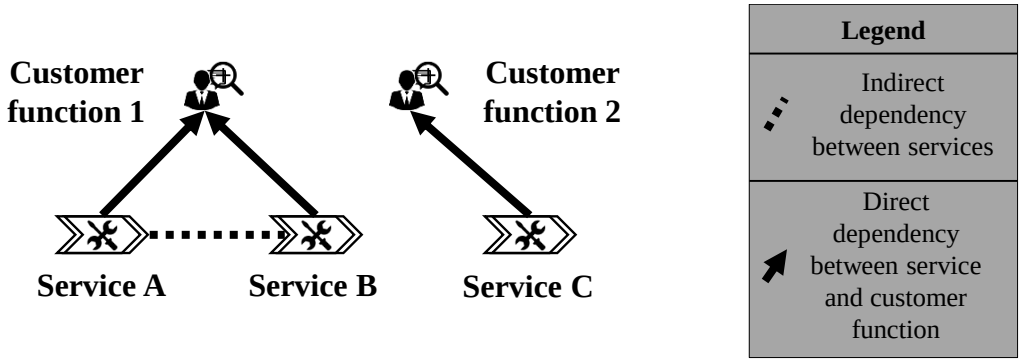

Figure 6-4 Direct and indirect dependencies between customer functions and services

Final clustering of Services

The clustering of services to create a structure for the service catalogue is a part of the **structure analysis** in the StCM. The tools and methods for clustering are made for clustering DSM that models the dependencies between elements of the same domain (Lindemann et al., 2009). The tool Cambridge Advanced Modeller and its clustering algorithm was used to identify the service clusters (Wynn et al., 2010) because this is one of the few tools that can handle systems with more than 250 elements. The Excel-file of DSM *Services* was imported to the tool and the cluster algorithm was used to cluster the system. The first run of applying the cluster algorithm resulted in a clustered DSM that included several services that do not refer to a cluster. If there are too many service clusters, practitioners still need many efforts to understand the service catalogue. To reduce the number of service clusters, some of those one-service-clusters were assigned to other service clusters. To give an example: the concrete service “rescue service” was assigned to a one-service-cluster by the automatic algorithm. There was a cluster consisting of two services “security” and “safe keeping”. The “rescue service” was added to this cluster that is now called “personal safety services”. Applying this cluster algorithm resulted in 65 service clusters (black boxes in Figure 6-5), that were summarized into 19 superclusters (grey boxes in Figure 6-5).

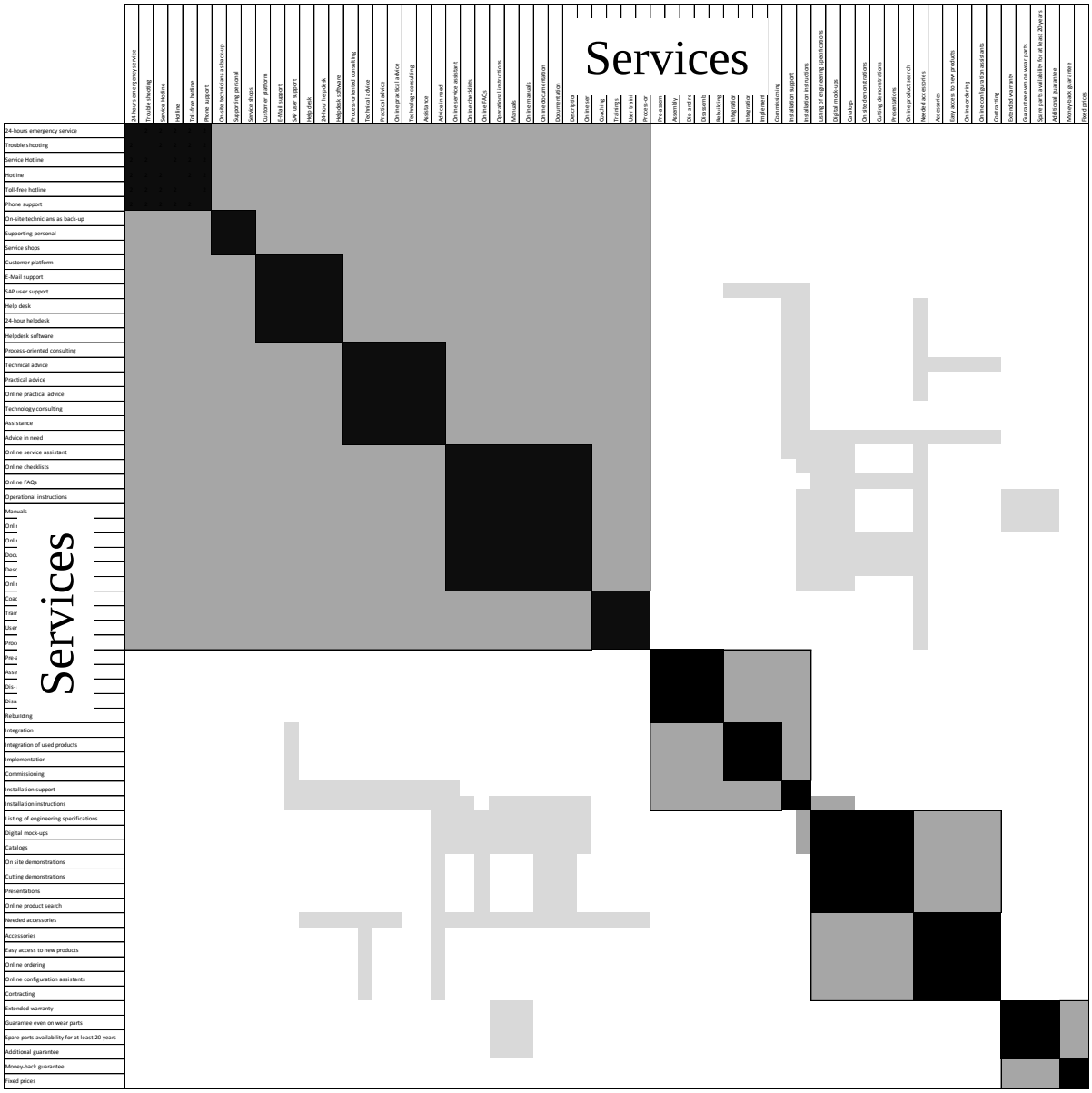

Figure 6-5 Clustering of services (excerpt)

After creating this structure, the service clusters and superclusters were named after the concrete services belonging to the service clusters. Table 6-4 shows exemplary the service clusters and the concrete services for the supercluster *guarantee*.

Table 6-4 Service clusters and concrete services for the supercluster "guarantee"

Supercluster	**Service cluster**	**Concrete services**
Guarantee	Price guarantee	Money-back guarantee
		Fixed prices
	Product guarantee	Extended warranty
		Guarantee even on wear parts
		Spare parts availability for at least 20 years
		Additional guarantee

After clustering the 265 services to 65 service clusters and 19 superclusters, a theoretic check of this service catalogue is needed to make sure that the clustering provides a useful structure for the service catalogue.

Plausibility Check of the Service Catalogue

The plausibility check investigates if the elements of superclusters and the elements of service clusters are on a comparable level of details. First, the elements of the service clusters were evaluated to each other: the author analyzed and compared the names of all services clusters. Some service clusters were perceived as too abstract and they were defined as superclusters and divided into service clusters. After that, the superclusters were checked concerning their level of details. Some superclusters were evaluated as too concrete. Those superclusters were declared as service clusters. The clustering of those super was removed. Furthermore, the service catalogue was checked if the allocation of the concrete services to the service clusters makes sense: this includes to check if the concrete services suit the superior service cluster. In some cases, the names of superclusters or service clusters were adapted. However, unlike the plausibility analysis after the pre-clustering, the plausibility analysis of this service catalogue resulted in the finding that the service catalogue is logically structured.

6.3 Categories of the Service Catalogue

Since practitioners might need some time to overview and understand all 19 superclusters, a further categorization of those superclusters increases the clearness of the service catalogue. A low number of categories could make the service catalogue easy to understand at first glance. This categorization also reduces the information content of the service catalogue: the categories should not be considered without looking at the other levels of the catalogue. A first structuring based on the dependencies between services and customer functions (bottom-up approach) did not help because the dependencies were not distinct enough to enable a clear categorization. The top-down approach seemed to be more promising by first defining categories and then allocating the superclusters to those categories. As stated in section 6.1, literature provides many approaches for categorizing services.

Definition of Service Categories

The first version of the service catalogue was categorized into four categories that were defined based on (Burianek, 2009):

- **Product-oriented services**: orienting the product, focusing on the customer, e.g. assistance, installation
- **Maintenance services**: focusing on the product, e.g. reuse, maintenance, spare parts
- **Services for optimizing the product usage**: supporting the customer in using the product, e.g. planning, product tests
- **Provider services**: Supporting the customer only, e.g. management, financial

However, applying this kind of categorization to case studies (see section 7.1) revealed weaknesses of this categorization: practitioners confused services from B2B and B2C markets, they also confused services with lifecycle processes. Furthermore, some of the services seemed

to be not clear enough for practitioners and a clearer categorization could help users to better understand services. Instead of defining those categories based on literature, categories should be defined to support users in understanding the service catalogue.

Kim et al. (2015a) define a categorization for services based on (Baines & Lightfoot, 2013) that describes the target system of the services, e.g. *services supporting customer* or *services supporting product*. This categorization describes what the services aim to even though a clear allocation of all services might be challenging. However, this categorization seems to be beneficial for overcoming the problems that were identified in the case studies. While Baines and Lightfoot (2013) mainly focus on B2B markets and Kim et al. (2015a) mainly focus on B2C markets, the service catalogue of this work should support both B2B and B2C markets. To meet the requirements of those two markets, the categorization scheme of Kim et al. (2015a) was extended and adapted to the following categories:

- **Services Supporting Consumer Customer (SSC):** Supporting the customers and their processes independent of the product and independent of the direct activities of the customer‘s value chain. Mainly for B2C customers but also applicable for B2B customers.
- **Services Supporting Business Customer (SSB):** Supporting the customers and their processes independent of the product and independent of the direct activities of the customer‘s value chain. Only for B2B customers.
- **Services Supporting Product (SSP):** Services that focus on the tangible product parts of the PSS and affect the tangible product parts only. For optimizing and improving the tangible product and its lifecycle.
- **Services Supporting Outcome (SSO):** Services supporting customers‘ processes that are direct activities of the value chain. This means to support the customers‘ outcomes (directly or indirectly), the products/components the (business) customer is producing.

The value chain according to Porter (2014) is used to distinguish between SSO services and SSC/SSB services. The value chain includes two different kinds of activities: primary activities that directly address the creation of a product, e.g. production or design, or the support activities that indirectly address the creation of a product by supporting primary activities, e.g. human resource management or purchasing. In this manner, SSO describe services that focus on customers’ primary activities, while SSB (and SSC) focus on customers’ support activities. Figure 6-6 shows this differentiation based on the value chain.

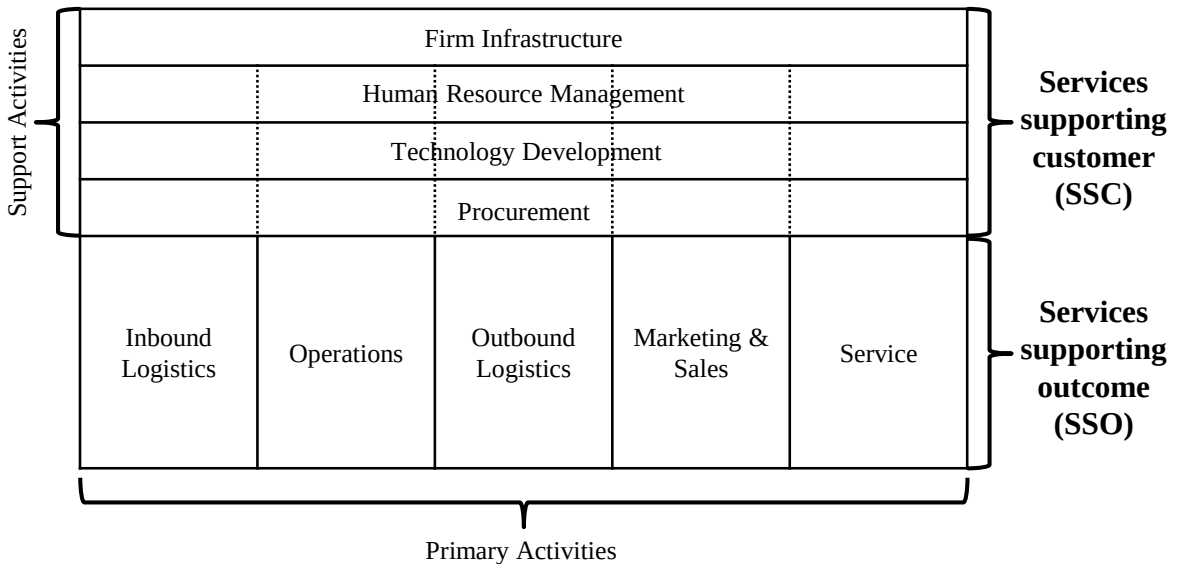

Figure 6-6 Differences between SSC and SSO based on the value chain model according to (Porter, 2014)

To better explain the differences of those categories, Figure 6-7 provides an exemplary picture of services offered between stakeholders.

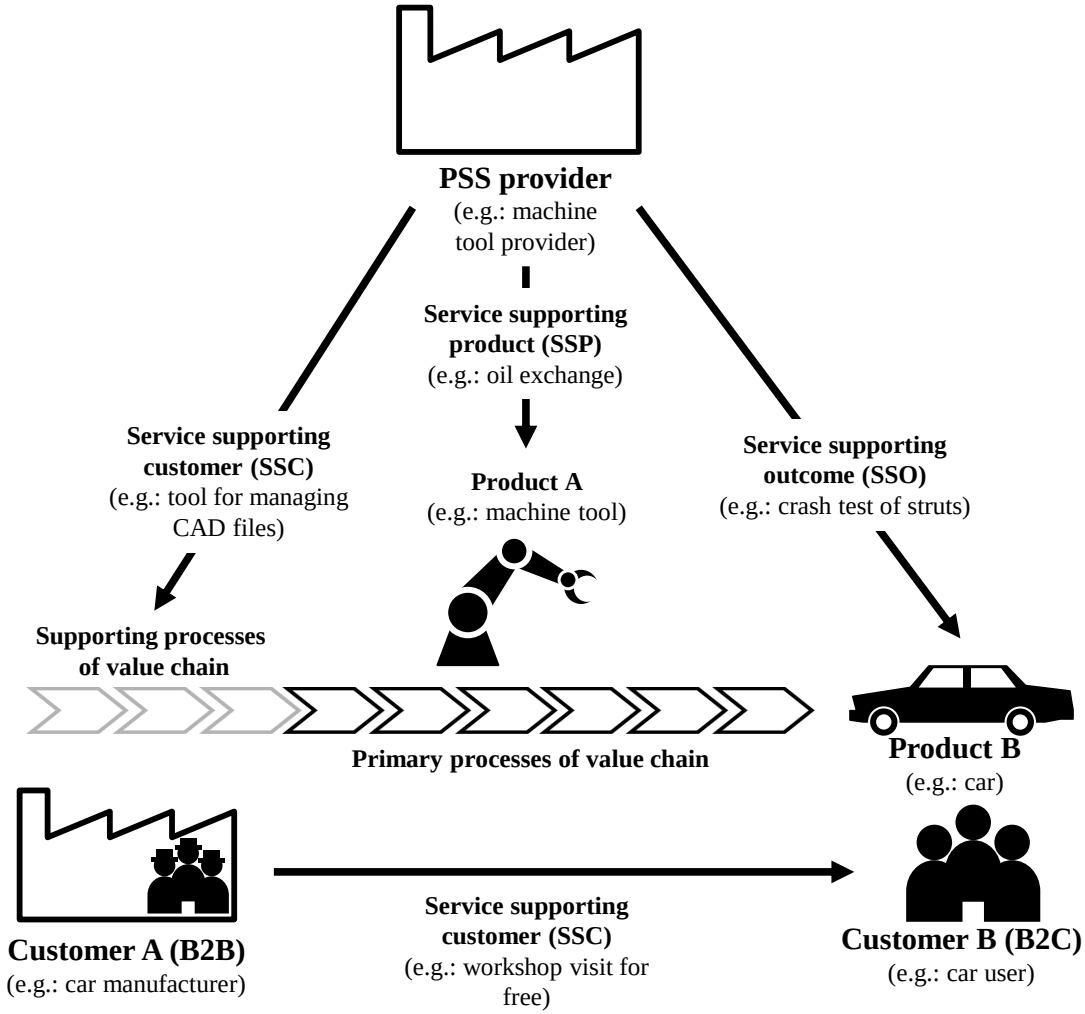

Figure 6-7 Service categories based on the relations between providers and customers

The PSS provider (e.g. a machine tool provider) has a business customer A (e.g. car manufacturer) that uses the product/PSS of the PSS provider. An example for an SSB service is a tool that manages the data for using the PSS (e.g. tool for managing CAD files). An example for an SSP services is a maintenance contract to maintain the PSS (e.g. oil exchange at the machine tool every three months). An exemplary SSO service is to test the components/products customer A is producing using the PSS (e.g. crash tests of struts) of the PSS provider. In this relationship (between PSS provider and customer A), an SSC service could be to consult customer A how to use the PSS (e.g. machine tool). Customer B is a consumer customer of customer A that uses the product/component customer A is providing (e.g. car). In this B2C market, only SSC services (e.g. five years product guarantee) and SSP services (workshop visits for free during the first two years) are thinkable.

The superclusters of the service catalogue were allocated to the categorization *literature* (see appendix 12.3.5). To integrate the categorization *target* into the service catalogue, all service clusters were allocated to the four categories. This allocation for service clusters was summed up for the superclusters to allocate superclusters to the four categories (see appendix 12.3.4).

Selection of a Categorization Scheme

The two kinds of categorizations introduced in the paragraph before are two different ways of structuring the service catalogue on the top level. One of them is based on approaches from literature for service categorization (*literature*), the other one is based on the target system the service aims to (*target*). A theoretical analysis of those two categorizations did not result in evaluating one of them as more suitable than the other categorization. After allocating the superclusters to the categories, experiments were conducted to find out which one is easier to understand and use for practitioners. For this, four PSS planning cases were defined that require the usage of the service catalogue, two from B2B markets and two from B2C markets (see appendix 12.3.6). In total, four participants used the two kinds of categorizations for two cases. The participants came from industry and research and they already had touching points with services or PSS. Table 6-5 shows the design of experiments.

Table 6-5 Design of experiments for testing the categorization schemes

Participant	**B2B: Case #1**	**B2B: Case #2**	**B2C: Case #3**	**B2C: Case #4**	**Favorite**
Researcher	Literature	Target			Literature
Practitioner			Target	Literature	Target
Researcher	Target	Literature			Literature
Practitioner			Literature	Target	Target

The participants were first introduced into the service catalogue and had to solve the first case. Then, a short interview followed by asking questions about the service catalogue and its usage. After solving the second case, another interview focused on the differences between the two kinds of categorization.

Two of the participants preferred the categorization *target* (for B2C cases), while two evaluated the categorization *literature* (B2B cases) as better. The participants reasoned that the

categorization they prefer better supports their way of thinking in planning services. The differences between the kinds of categorizations were not considered as very relevant for using the catalogue. Even though the small number of experiments cannot provide significant statements, a reason why people preferred different kinds of categorization was the application for different markets. Using *literature* could better support B2B markets, while *target* could better support B2C markets. Another reason could be that people just have different ways of thinking and developing services based on their experiences and knowledge. Investigating the real reasons requires a quantitative study including a higher number of experiments. The costs for such a study does not justify the findings from it. The advantage of the categorization *target* was that two categories could be extracted for B2C markets (SSO and SSB) that helped the participants to faster find suitable services. This advantage is not sufficient to exclude the categorization *literature*. The categorization *target* better prevents confusing B2B services with B2C services. The case studies turned out that people confused B2B services with B2C services while using the categorization *literature* (see section 7.4 and section 7.5). Based on these findings, this work focuses on the categorization *target*. However, there might be cases of application that the categorization *literature* is more suitable. One participant of the experiments stated that using both categorizations at the same time might beneficial.

Besides comparing those two kinds of categorizations, other ideas for improving the service catalogue were identified, e.g. depicting services of the same category in the same color to make the allocation of services to categories more clear for users.

6.4 Hierarchy of Service Catalogue

The service catalogue consists of four levels: 4 categories, 19 superclusters, 65 service clusters, and 265 concrete services. Since there is a 1:n-relation between elements of different layers, the service catalogue's structure is a hierarchy. Figure 6-8 shows the elements of different layers for the supercluster guarantee.

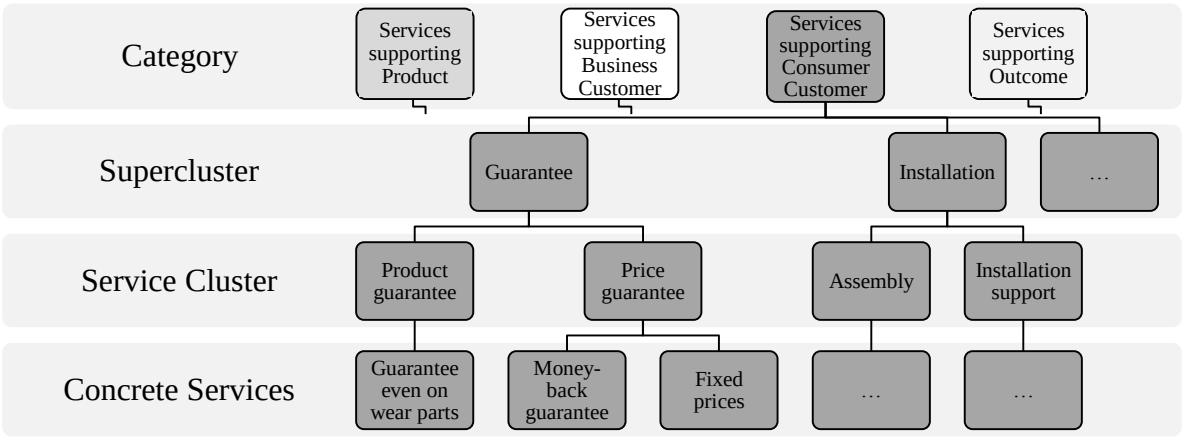

Figure 6-8 Hierarchy of the service catalogue

The four categories depict the structure of the whole service catalogue. They support users in excluding services that are not relevant (e.g. SSB or SSO for B2C markets). They describe the target the services focus on and they are not abstract kinds of services. Allocating the superclusters to those four categories was challenging because it was not always clear which

category a supercluster belongs. Therefore, the range of categories might overlap and the allocation of superclusters to categories are based on subjective evaluation of the author.

Every of the 19 superclusters is allocated to one category. The superclusters can be seen as services on a very generic level, e.g. guarantee or maintenance. They just have small overlaps between each other and they can be used as fields of actions for services. The superclusters include in total 65 service clusters. Each service cluster is allocated to one supercluster. Service clusters are services on a more concrete level and they can be used as service offers. On this layer, most services are offered and discussed within companies. The overlap between service clusters might be broader compared to the overlap between superclusters, however, an overlap between service clusters is not intended. These service clusters consists of in total 265 concrete services. Those services were identified from literature or industry and they describe services as they are offered by companies. They might be specific for a product or a market and the overlap between them is quite large because services with different names focus on similar contents. They are used to better describe service clusters instead of presenting various services.

6.5 Matching Services to Aspects of Customer Acceptance

A matching between the elements of the service catalogue and the elements of the model of customer acceptance helps practitioners to understand the links between services and customer acceptance. This matching has various fields of application:

- Based on quantified aspects of customer acceptance, PSS planners can use the matching to identify services that potentially increase customer acceptance. In this case, the matching serves as a filtering function for the service catalogue.
- Combining the matching with the services of the current PSS portfolio shows which of the customer aspects are targeted by the current PSS portfolio. This identifies lacking customer aspects of PSS portfolios.
- The matching evaluates how much a service is capable of influencing an aspect of customer acceptance: this compares services to each other concerning their capability of influencing customer aspects. PSS planners can use this matching to identify services that focus particular aspects of customer acceptance, like a PSS configurator for the service part of a PSS.

The matching is created based on comparing the elements of the service catalogue with the elements of the model of customer acceptance. In this comparing, the links between those elements were evaluated by the author. This matching should be valid for industries and products defined in subsection 2.3.4 (provider of technical complex products). However, different market situations might affect the linkage between two elements. The matching provided by this work is just a vague measure to support PSS planners: they might not be valid for all market situations.

The elements of the service catalogue considered in this matching are the service clusters. The concrete services were not taken into consideration for two reasons: the number of links between services and customer aspects to be determined would be too high. Furthermore, most concrete services overlap and the service clusters include the main implications of concrete services on customer aspects. The aspects of customer acceptance were summarized to 77

elements that are relevant for providers: instead of taking every detailed aspect into account, aspects were summarized to reduce the number. This means, the matching includes to determine links between service clusters and provider-relevant elements of the customer aspects.

For the dependencies between those elements, a scale of four stages was used. This scale includes the kinds of influences from a service on a customer aspect. Table 6-6 depicts this scale and it shows how many values were set in the matching.

Table 6-6 Scale for evaluating the interdependencies between services and customer aspects

Value	**Interdependency**	**Number of values set**
-1 (negative)	Service cluster influences the customer aspect in a **negative** way	323
0 (neutral)	Service has **no** effect on the customer aspect	3805
1 (positive)	Service cluster influences the customer aspect in a **weak positive** way	343
2 (positive)	Service cluster influences the customer aspect in a **strong positive** way	365
3 (positive)	Service cluster influences the customer aspect in a **very strong positive** way	169

In total, the dependencies of 65 service clusters and 77 customer aspects were evaluated, i.e. 5005 values were set. A domain-mapping Matrix (DMM) includes this matching and this DMM is shown in Figure 12-25 and in Figure 12-26 in the appendix 12.3.9.

6.6 Methods of Application

The service catalogue, as it is described in section 6.4, is presented in a demonstrator, built in Microsoft PowerPoint (see appendix 12.3.7). This demonstrator first gives an introduction and a manual how to use the service catalogue. After that, the categories and their superclusters and service clusters are shown. The presentation of the categories starts with an overview slide of the category's hierarchy. The experiments of section 6.3 revealed that these slides support users to get a short overview of the whole catalogue. In this first phase of getting to know the catalogue, users mainly looked at those slides. After the overview slide, the service clusters were presented on a more detailed level, consisting of a short description and the concrete services. To make it easier for users to handle the catalogue and to distinguish between categories, services of different categories were kept in different colors. Another way of documenting the service catalogue is provided by a table. Table 6-7 shows an excerpt of this table, the entire version is presented in the appendix (see appendix 12.3.4). It includes the same information like the PowerPoint demonstrator. Both the PowerPoint demonstrator and the table can be provided in a printed version to support product mangers in identifying new services. Dependent on the case of application, printed versions can be handed to workshop participants or used for teamwork or single person working. The experiments of section 6.3 provided the PowerPoint demonstrator to participants in a printed version and helped them to identify new service concepts.

Table 6-7 Service catalogue documented as a table (excerpt)

Category	Supercluster	Service cluster	Concrete services	Description
SSC	Guarantee	Product guarantee	Extended warranty	Guarantee about the product's availability that guarantees that the product is working properly for a certain period.
			Guarantee even on wear parts	
			Spare parts availability for at least 20 years	
			Additional guarantee	
		Price guarantee	Money-back guarantee	Guarantee that there is a limit for the price (also for consumables).
…	...	…	…	…

The matching between services and aspects of customer acceptance is documented in matrices (Microsoft Excel). The matching supports the analyses of aspects of customer acceptance to identify and weight ideas for new services. It is usually used for single person working with tools to calculate values for those weightings. Microsoft Excel is a tool that might support this analysis and that is widespread in industrial practice. Even though the matching is provided in Microsoft Excel, other tools of complexity management might be helpful, e.g. Soley (Kissel, 2016). More tools are provided at the website DSMweb.org (see (Lindemann, 2016)).

6.7 Conclusions

These conclusions deal with the aspects the service catalogue implies for the whole work to locate this chapter into the thesis. Furthermore, a short summary of the completely prescriptive study (see chapter 4, chapter 5, and chapter 6) is provided to motivate the descriptive study II that follows in chapter 7 and chapter 8.

Implications for the Work

The service catalogue is the answer to the research question #3 (how can PSS increase customer acceptance by affecting the aspects of customer acceptance?) and the third part of the design support. It is a method to support PSS planning. The matching between the model of customer acceptance and the service catalogue (see section 6.5) depicts a concrete linkage between PSS design and customer acceptance. This enables companies to use the approach PSS to increase customer acceptance. In the decision-making process, the service catalogue can support several stages (see chapter 4). In the first stage, to identify the state of the art, the service catalogue can serve as a checklist for identifying the PSS currently offered. The service catalogue itself demonstrates service offers from various industries and it is a collection of state of the art services. Companies missing a comprehensive product management for all product and service elements can use the service catalogue to identify the services that are a part of the current PSS offer. This is relevant for companies that have not finished the PSS transition yet and that have

strict boundaries between service and product departments. In those companies, services are offered additionally to the product parts and the strong connection between product and service elements is still missing. However, the PSS approach claims a strong linkage between product and service elements. The service catalogue can also support the concepts generation phase of the decision-making process. It can help PSS planners to identify new service concepts or new fields of action for service development. The elements of the service catalogue can serve as evaluation criteria in the concepts evaluation stage. It might be useful for the evaluation stage to check the level of PSS concepts fulfilling different fields of services. In this case, the service catalogue defines service areas that are used as evaluation criteria. The case study III (see section 7.4) applies the service catalogue in the concepts evaluation stage. Considering the customer-oriented framework of PSS development (see chapter 3), the service catalogue mainly supports the solution layer, while the matching between the service catalogue and the model of customer acceptance is a linkage between the solution layer and the customer aspects layer.

Summary Prescriptive Study

The prescriptive study consists of three parts; the decision-making process for PSS planning (see chapter 4), the model of customer acceptance (see chapter 5), and the service catalogue (see chapter 6). The overall goal is to enable companies in planning PSS with intertwined service and product elements and in planning PSS that focus on customer acceptance. The decision-making process structures the activities in the PSS planning phase and organize the decisions and the information required for those decisions in PSS planning. The model of customer acceptance focuses on the reasons and drivers of purchase decisions and summarizes different aspects of customer acceptance in one model. The service catalogue is connected to the model of customer acceptance and provides and overview of services that might be offered within a PSS. Those three parts are compatible to each other and complement each other. The results of the prescriptive study are the design support for the PSS planning phase. The research question RQ #1 (How can PSS planning increase customer acceptance?) is the underlying hypothesis of the whole work. The prescriptive study focuses on the research questions RQ #2, RQ #3, and RQ #4 and provides possible solutions for them:

- Which aspects, drivers, and barriers of customer acceptance influence the customers and their perception of products, services, or PSS? (RQ #2)
- How can PSS affect the aspects of customer acceptance to increase customer acceptance? (RQ #3)
- How can a company design the PSS planning phase to increase customer acceptance? (RQ #4)

After creating this design support, the descriptive study II will apply and test those results of the prescriptive study. Since the prescriptive study is based on theoretical considerations, most parts of the DS II are real case studies from industry. DS II needs to check the relevant industries and application cases the design support can be used for. Furthermore, the case studies have to investigate if the design support is applicable and beneficial for those industries.

7. Case Studies: Application and Evaluation of the Results

This chapter represents the first part of the descriptive study II of this work, i.e. the evaluation. For evaluating the design support, several case studies used the methods and models. The cases had different objectives and they are from different branches. After the case studies and as the second part of the descriptive study II, an evaluation interview study with product managers and executive managers were conducted to investigate the benefit and applicability of the design support (see chapter 8). The evaluation is based on the requirements of the prescriptive study that were defined in section 3.3.

The description of the case studies in this chapter is focused on the essential results and not on detailed aspects. Some of them were already presented in master theses or in conference papers. This chapter starts with explaining the overall evaluation concept and introducing all case and interview studies. After that, selected case studies will be presented. There will be cases from truck industry (see section 7.2), dealing with lawn mowers (section 7.3), construction tools (section 7.4), and home appliances (section 7.5). The interview studies are presented in chapter 8, as well as the concluding evaluation that discusses both case and interview studies.

7.1 Overview: Evaluation Concept

The aim of the descriptive study II is to check the benefit of the design support for industry and to investigate if the research questions are answered. Several case studies and interview studies have evaluated the design support. In the case studies, the design support was applied in an industrial context and the benefit for appliers was identified (described in chapter 7). The interview studies discussed if the research questions are answered and if the design support is beneficial for industry (described in chapter 8).

The requirements on the design support, defined in section 3.3, serve as evaluation criteria (applicability, added value, consistency, adaptability). The aim of the evaluation is to check if the research questions are sufficiently investigated concerning the requirements. Since RQ #1 (How can PSS planning increase customer acceptance?) is the underlying hypothesis for the other research questions (see subsection 2.3.3), the evaluation requirements are not applied to RQ #1:

- Which aspects, drivers, and barriers of customer acceptance influence the customers and their perception of products, service, or PSS? (RQ #2)
- How can PSS affect the aspects of customer acceptance to increase customer acceptance? (RQ #3)
- How can a company design the PSS planning phase to increase customer acceptance? (RQ #4)

The validity of RQ #1 is investigated by an interview study that only focuses on this question (see section 8.1). The design support answering RQ #2, RQ #3, and RQ #4 is analyzed by both case studies and interview studies.

Table 7-1 provides an overview of all case studies. They were mainly performed in industrial companies that fit to the companies and markets this work is focused on (section 2.3.4). Some of the companies agreed with publishing their company's names, while others disagreed because of reasons of secrecy. The companies that disagreed are paraphrased by the business area and the organization form.

Table 7-1 Overview case studies

#	**Organization**	**Product / PSS**	**Presented at**	**Context**
I	Consulting4Drive GmbH	Truck	Section 7.2, (Schmidt et al., 2015a), (Preuß, 2015)	Industrial
II	Technology GmbH	Robotic lawn mower	Section 7.3	Industrial
III	Construction machines GmbH	Construction tools	Section 7.4, (Brüderle, 2016)	Industrial
IV	Consumer goods GmbH	Home appliances / dishwasher	Section 7.5, (Felber, 2016), (Nguyen, 2016)	Industrial
V	Automotive AG	Car / tire pressure system	(Schmidt & Mörtl, 2015), (Kleinmichel, 2015)	Industrial
VI	Technical University of Munich, Chair of Product Development	Electric skateboard sharing system	(Schmidt et al., 2016b), (Breyer, 2016)	Academics, student's project
VII	Vehicles AG	Motor cycles	(Klanner, 2015)	Industrial
VIII	Construction machines GmbH	Construction tools	(Schmidt et al., 2016c), (Brüderle, 2015)	Industrial

The interview studies are shown in Table 7-2. The objective of #A was to analyze and validate the hypothesis of RQ #1, that is the basis for RQ #2-4. Interview study #B provides the concluding evaluation of the design support. This retrospective analysis of design supports and of case studies provides an overall evaluation. #C considers the completeness of the model of customer acceptance. This completeness claims that the model covers all relevant aspects of customer acceptance and that none essential aspect is neglected. While this chapter 7 presents the concept of evaluation and the case studies, the chapter 8 shows the interview studies and the concluding evaluation.

Table 7-2 Overview interview studies

#	Interviewees	Context	Presented at	Objective
A	Providers and customers	Electrical car-sharing system	Section 8.1, (Schmidt et al., 2016a), (Braun, 2014)	RQ #1: PSS for increasing customer acceptance
B	Managers, product managers	Automotive industries, home appliances	Section 8.2	Overall evaluation
C	Sales employees	Tool manufacturer AG - Drilling machines	(Bauer, 2014)	Completeness of model of customer acceptance

Table 7-3 depicts the requirements of research questions on which the case and interview studies are focused. Interview study #B reflects the requirement adaptability to companies and markets (described in section 2.3.4) based on the case studies that were performed in several industrial sectors and markets. The consistency describes the compatibility of all parts of the design support that stem from different research questions: the requirement consistency cannot be analyzed focusing on one particular research question. The requirement adaptability (design support is adaptable to various industries) is not referred to one particular research question. To check the adaptability, the entire design support was analyzed in interview study #B and in the concluding evaluation.

Table 7-3 Requirements focused by evaluation studies

Legend: ● considered ○ not considered								
Requirements	**Applicability**			**Added value**			**Consistency**	**Adaptability**
Case Study \ **RQ**	**#2**	**#3**	**#4**	**#2**	**#3**	**#4**		
#I	○	○	●	○	○	●	○	○
#II	●	○	○	●	○	○	○	○
#III	●	●	●	●	●	●	●	○
#IV	●	●	○	●	●	○	●	○
#V	●	●	○	●	●	○	●	○
#VI	●	●	●	●	●	●	●	○
#VII	○	○	●	○	○	●	○	○
#VIII	●	●	○	●	●	○	○	○
#A	●	○	○	○	○	○	○	○
#B	●	●	●	●	●	●	●	●
#C	●	○	○	●	○	○	○	○

Besides the case studies and evaluation studies, the results were evaluated by presentations and discussions at several international scientific conferences. Besides presenting papers on those conferences, the work was also discussed with other researchers participating those conferences. To mention some of those conferences:

- Academy of World Business, Marketing and Management Development Conference
- Dependency Structure Modeling Conference
- International Conference on Business, Marketing and Management
- IEEE International Conference on Industrial Engineering and Engineering Management
- CIRP Conference on Industrial Product-Service Systems
- International Conference on Business, Information, and Service Science
- Asian Design Engineering Workshop
- Korea Conference on Service Design
- CIRP Design Conference
- International Conference on Serviceology
- International Conference on Engineering Design
- International DESIGN Conference

People from various disciplines and backgrounds (e.g. design, engineering, production, service science, PSS, marketing, business, economics, management, social science etc.) discussed these results or reviewed papers and articles dealing with parts of this work. All publications listed at the beginning of this work successfully proceeded a peer-review process, except for (Schmidt et al., 2016b).

7.2 Case Study I: PSS planning in Truck Industries (Consulting4Drive)

The first case study focuses on the decision-making process (see chapter 4) and its application, adaption, and benefits in a project in truck industries. The paper (Schmidt et al., 2015b) presents the case study on a more detailed level. During the case study, other methods and models supporting the PSS planning were applied that are not part of this thesis, e.g. the model of the PSS architecture (Kammerl et al., 2014b), the method for evaluating uncertainties (Kammerl et al., 2015), or the quality assessment (Schenkl et al., 2013c). However, the process model of this work served as a surrounding framework for structuring and connecting those models and methods. To present the case study, first the initial situation is described. Then, the application and adaption of the decision-making process on the actual case is shown and main results of the application will be presented. At the end, the case study will be concluded and main implications on the design support of the prescriptive study will be made.

7.2.1 Initial Situation and Boundary Conditions

The case study was conducted in cooperation with the technology consulting company Consulting4drive that works mainly in automotive industries. One of their customers is from truck industries. To identify innovative concepts for improving a truck model, Consulting4Drive started and ran a PSS planning process to check chances concerning potential

services and new technologies. This project focused on the driver's cabin of a truck model that should be in production line status in five years. The project included the identification and planning of new product and service elements. However, the connecting infrastructure that is an essential part of a PSS was not considered as an own domain but as a part of tangible product elements. For this case study, the connecting infrastructure of the vehicle is relevant for later phases of product development but less important for the planning phase. Since several technologies are currently in the planning stage, it is quite relevant which technology or innovation might be integrated into future vehicle concepts. The long-term vision included an autonomous driving and an office in the driver's cab. The truck model should be a first step into the direction of this vision. During this half-year project, the results of the method application were discussed several times with consultants of Consulting4Drive and with their customers.

7.2.2 Application and Adaption

To apply the process model developed in chapter 4, the initial situation and several issues of the truck were taken into account. Those issues were processed by the following methods: checklist for decision criteria (Schenkl et al., 2013c), block model for weighting decision criteria (Schenkl et al., 2013c), PSS model for analyzing the PSS architecture (Kammerl et al., 2014b), determination of uncertainties influencing the PSS (Kammerl et al., 2015), compatibility analysis of PSS elements (Schmidt et al., 2014c), technology road map (Kammerl et al., 2014a), quality analysis, and quality-cost portfolio (Schenkl et al., 2013b). This resulted into an adapted process consisting of the following six steps:

1. Decision Criteria and Requirements
2. PSS Elements
3. Dependencies
4. Uncertainties
5. PSS Concept
6. Quality Concept

Those steps are processed step-by-step and they are based on each other. The three review points are included in this process: R1-review at the end of step 1, R2-review at the end of step 3, and the R3-review at the end of step 6. A scheme of steps 1 and 2 is shown in Figure 7-1.

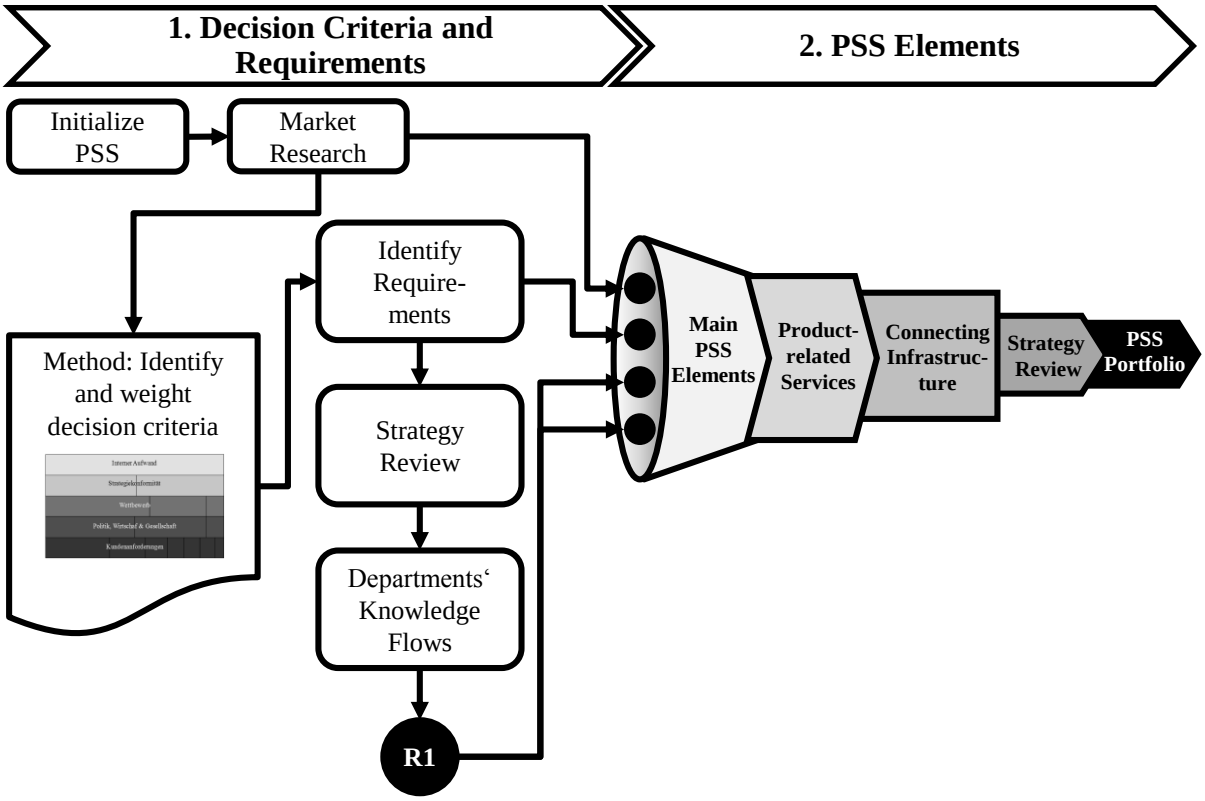

Figure 7-1 Stages and methods of step 1 (decision criteria and requirements) and step 2 (PSS elements)

The first activity of step 1 is to define the product idea (initialize PSS) that was the driver's cab of a truck. The following market research was based on data collected by the marketing department of the truck company. The product management identified and weighted the decision criteria (Schenkl et al., 2013c). Those decision criteria mainly stem from company's environment, e.g. the customer or statutory requirements. These weightings can be used as a basis for budget allocation. The decision criteria can serve as categories for identifying requirements. After checking the requirements to the strategy, the knowledge flows between departments were investigated. This consideration revealed that the departments Homologation, Rental, Styling, and Development should be earlier integrated into the planning process to enable a better relation between product elements and service elements. The R1-review concluded step 1. In contrast to the actual process model, the relations between requirements were not checked in step 1, because they are analyzed in step 3. Step 2 includes the identification of PSS elements which was done by an interdisciplinary workshop with participants from After Sales, Innovation management, Market research, and Product Management. This workshop resulted in a list of product and service elements (previous vehicle generation). Another list was created that included new product and service elements that should be integrated into the following model generations. Those two lists represented the PSS portfolio (Kammerl et al., 2014b). During this workshop, the product management checked the strategy-fitness of the PSS elements.

Step 3 considered the dependencies between requirements, functions, product, and service elements, also described as the PSS architecture. Figure 7-2 shows steps 3 and 4 on a schematic level.

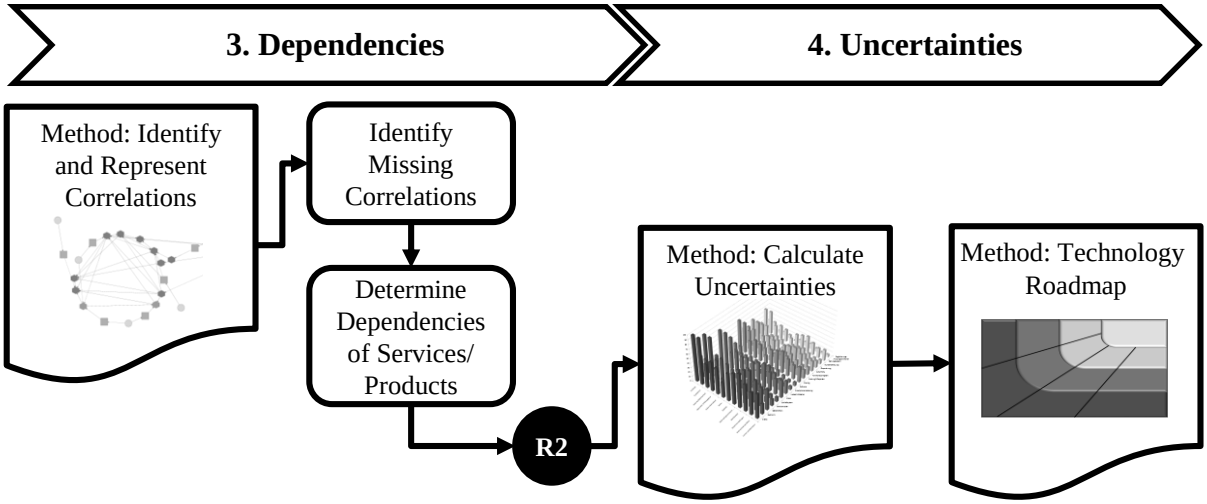

Figure 7-2 Stages and methods of step 3 (dependencies) and step 4 (uncertainties)

The PSS architecture was modeled in the software tool Soley Modeler (Kissel, 2016). Rules of the PSS architecture were defined addressing the relations between requirements, functions, and elements. Based on those rules, missing correlations were identified and processed. After that, the PSS architecture was analyzed, e.g. concerning elements that are critical concerning the number of interfaces to other elements. Furthermore, the dependencies between product elements and service elements were quantified. This quantification was used in step 5 to support the decisions which product or service element should be earlier integrated into the vehicle. This analysis of the PSS architecture and the correlations served as the R2-review. After that, step 4 checked the uncertainties of product and service elements based on the decision criteria defined in step 1. This uncertainties evaluation was done by the method (Kammerl et al., 2015) and it showed that service elements have lower uncertainties than product elements because most of service elements are software-based and created by agile processes which means lower costs and efforts for changes. The time-dependent maturity of innovations is based on those uncertainties and the relation between uncertainties and the time. A technology roadmap presents successively the periods for realizing product and service innovations. Figure 7-3 shows the stages and methods of steps 5 and 6.

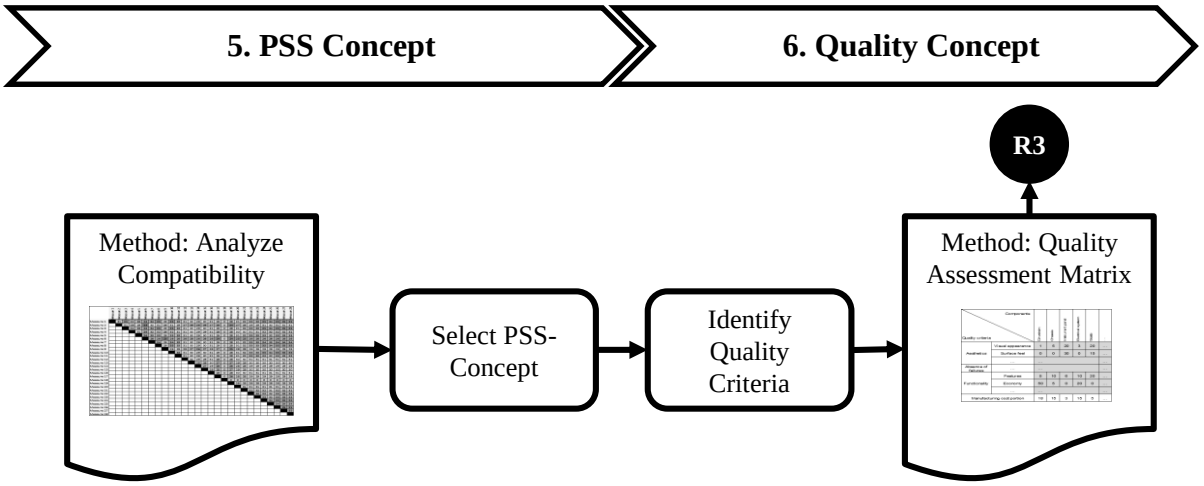

Figure 7-3 Stages and methods of step 5 (PSS concept) and step 6 (quality concept)

Step 5 includes the selection and combination of PSS elements identified in step 2 to a consistent PSS concept. A support method for this step is the compatibility analysis (Schmidt

et al., 2014c). Since the compatibility between PSS elements was not important for this case study, another measure was applied: product elements were evaluated concerning the necessity of realization. Product elements can be required for implementing services or for implementing product innovations. The number of possible service innovations and the number of possible product innovations that a product element is required for quantified the necessity of a product element.

Before the embodied design phase starts, step 6 has to ensure the quality of the PSS concept. Based on quality criteria according to Garvin (1996), a market research was conducted to compare the PSS concept to competing products (Schenkl et al., 2013b). After that, a quality-cost matrix was created to check if the budget is adequately allocated to product elements.

7.2.3 Conclusions and Implications for Design Support

In this case study, the several planning methods were integrated into the PSS planning process for creating the PSS concept of a truck. The process model turned out to be a suitable framework for the planning process. The real procedure in the case study did not exactly reflect the procedure defined at the beginning of the project: Step 3 (dependencies) was processed after step 4 (uncertainties) because the PSS elements' uncertainties were earlier needed in this project. This underlines the iterative character of the process model and it shows that the sequence of the steps and reviews of the planning process is not fixed. The sequence depends on the current development situation.

This case study was not a New Development Project (NPD) but a next generation development project including innovative product and service elements. This case study shows that the process model cannot be the only support for the planning phase, further models and methods are necessary to support PSS planners. In this project many PSS-related methods to support decisions were used, other projects under different conditions might need different methods, e.g. stakeholder analysis or market research methods.

In a subsequent expert interview (see section 8.2), this case study was presented and discussed to an expert from automotive industries. He pointed out the importance of those methods and processes for long-term projects to structure the work and results. The expert evaluated the methodology as applicable and beneficial if it is capable of generating new and innovative solutions. However, the complexity of processes and methods might hinder employees to apply them: the way of presentation and the ease of understand are essential for a sustainable success of those processes and methods.

7.3 Case Study II: Analyzing Customer Acceptance of Robotic Lawn Mowers

This case study applies the model of customer acceptance to robotic lawn mowers and to their integration into smart home. The study was located in the product management of the smart home system providing company, that also offers products for the household (e.g. smoke detectors, thermostats). The product management currently dealt with the question if robotic lawn mowers should be integrated into the smart home environment or not. After that,

innovative use cases should be identified (not part of this case study). The aim of the case study was to identify issues of customer acceptance about this integration.

First, a guidance for a semi-structured interview was prepared based on the model of customer acceptance. This guidance checked the aspects of customer acceptance of the lawn mower. Since the aim of the case study changed after the preparation of this guidance, the interviews were conducted more open and not based on the guidance only. The actual aim was to identify aspects of customer acceptance of the lawn mower and it changed to consider those aspects of integrating the lawn mower into the smart home environment. In total, four people were interviewed within three interviews. Those employees dealt with smart home (service, support, training, product management, security software development) and the lawn mower (service and support). These interviews consists of three parts: first, the introduction and general questions, then the selection of relevant categories of customer acceptance, and at the end more detailed questions concerning the selected categories were asked. Over all interviewees, interoperability, unawareness of needs, trust, reliability and availability, and perceived complexity were considered as relevant categories. The interviews were recorded and partly transcript. The statements of interviewees were evaluated concerning their importance and concerning the number of mentioning for the lawn mower, for smart home in general, and for integrating the lawn mower into smart home. The result of this evaluation is shown in Figure 7-4. E.g. one aspect of interoperability is the *compatibility between products of different companies* that is not given for all aspects of the lawn mower.

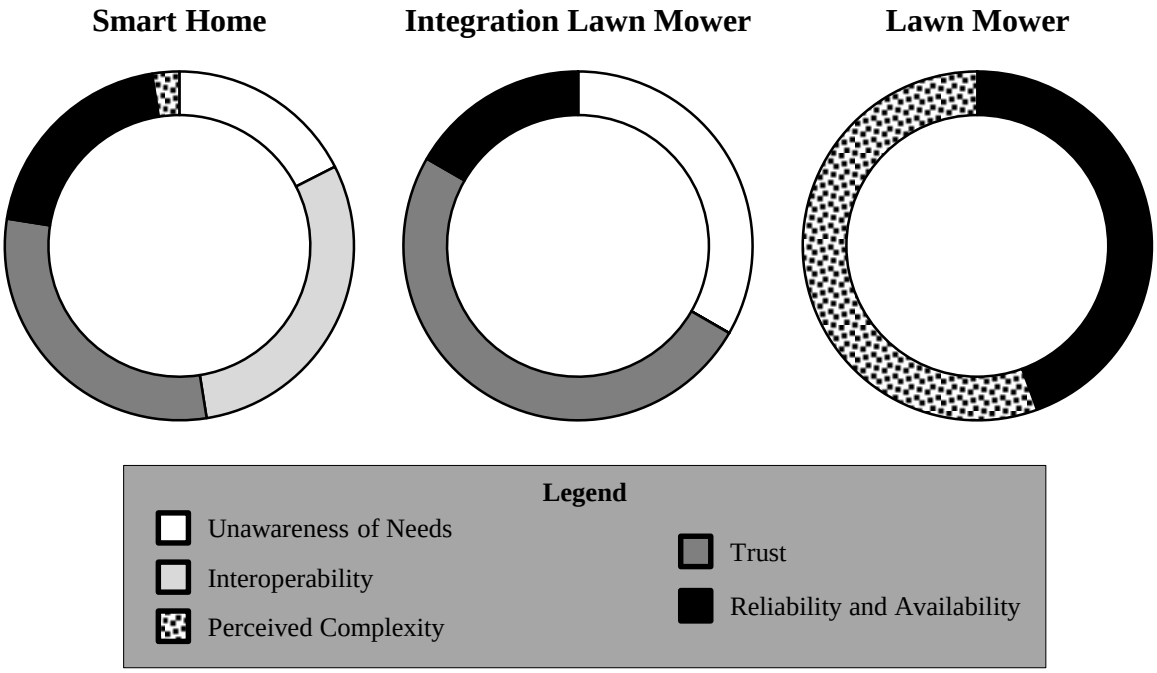

Figure 7-4 Evaluation of aspects of customer acceptance for smart home, integration lawn mower, and lawn mower

Furthermore, a literature research about aspects of customer acceptance of smart home solutions resulted in a broad collection of customer aspects (Balta-Ozkan et al., 2013; Paetz et al., 2012). These theoretical aspects were compared to the aspects mentioned by interviewees. This comparison revealed that interviewees are not aware of all aspects (since it is a quite large list),

however, they have a strong focus on aspects addressing the privacy and security. Based on those results, several options for future steps were identified, e.g. to provide a better definition of the target customer group or to identify innovative use cases from robotic vacuums.

Conclusions

The concluding presentation of the results to the responsible product manager turned out that the results were beneficial for the company. The structured procedure by interviews was considered as helpful and beneficial as well as the model of customer acceptance that provides a rough structure of aspects of customer acceptance. The case study also showed that the aim of applying the model of customer acceptance has to be clearly defined. A better visualization of aspects of customer acceptance (at that time) would support the interviewer and interviewee in their work. Since all interviewees' statements could be allocated to one category of the model of customer acceptance, the model is considered to cover a broad variety of aspects. The model of customer acceptance was successfully and beneficially applied and adapted to the area of lawn mowers and smart home. The model covers most aspects, however, this broad coverage requires many aspects that must be understand and processed by the applier. This high number of aspects might confuse practitioners and make them to neglect important aspects.

7.4 Case Study III: Increasing Customer Acceptance of Construction Machines

This case study focused on the application of the decision-making process, the model of customer acceptance, and the service catalogue. This case shows the consistency between the three design supports: the model of customer acceptance and the service catalogue can be easily integrated into the decision-making process. Connecting the model of customer acceptance with the service catalogue provides a decision support for selecting suitable services. This section starts with the initial situation and the boundary conditions. After that, the application and adaption of methods and models will be presented and a short conclusion shows the main findings of this study. A more detailed description is provided in (Brüderle, 2016).

7.4.1 Initial Situation and Boundary Conditions

The case study was conducted in a company of construction machines that overtakes the planning, developing, producing, and marketing phases of their PSS. The tangible product part of the PSS this case study is focused on is a rotary drilling rig. The company offers different kinds of PSS for this rig: construction operators can buy the tangible product including services (product-oriented PSS). Construction operators can rent the rig (use-oriented PSS). Customers can also order auger piles (the result of the rig) for their construction sites and the company sends their own employees and rigs to the customers' construction sites to produce the auger piles (result-oriented PSS). Since different customers buy or use different kinds of those offers, the company wants to keep all three offers in its PSS portfolio. This case study focused on the product-oriented PSS only. The aim from the perspective of the company was to create an advanced PSS concept, mainly focusing on the service elements of the PSS. In the past, the services were offered additionally to the tangible product, i.e. the product was the starting point

to identify services. This case study started from the customers' wishes to identify suitable services. Based on those services, product elements might have to be adapted or changed. Instead of technical requirements, this case study referred the requirements to the service elements. This means that the elements of the service catalogue were used as requirements. Analyzing the current PSS offer yields the current fulfillment of services. This fulfillment of services shows if the current PSS is strong enough concerning those services, if services must be improved, or if new services have to be created. A master student who had 1.5 years professional experience as a product manager in this company processed the case study for his final master project.

7.4.2 Application and Adaption

In the first part of the decision-making process, the requirements were identified by interviews and workshops. The concept generation focused on the service concept and new services were identified and selected. In the last phase, the concept evaluation, two employees were interviewed to assess the service concepts. The finalization of the PSS concept was not a part of this case study. Figure 7-5 provides an overview of the adapted process.

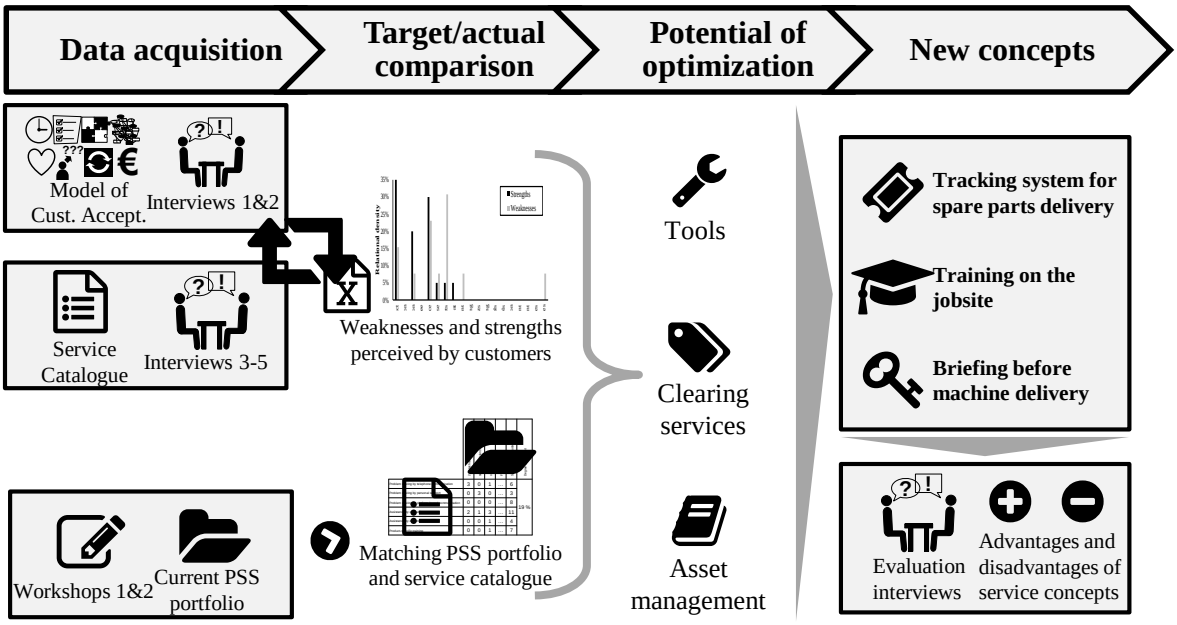

Figure 7-5 Procedure of the case study

To identify the customer-view, five employees of the departments product management, sales, assembly (at customers' sites), and aftersales service were interviewed. The interviews consisted of three main questions:

Q1. Why do customers decide for a drilling rig of this company?
Q2. What are the expectations/weaknesses of on those drilling rigs for customers?
Q3. How do the expectations match with the aspects of customer acceptance (model of customer acceptance) / with the services (service catalogue)?

The first question (Q1) focused on the strengths of the company's drilling rigs for customers. The second and the third question dealt with the potential for optimization perceived by

customers. The first two questions were asked as opened questions and the answers were referred to the service catalogue afterwards: the product manager sets the dependencies between interviewees' statements and service cluster based on the interviews separately for the question 1 and question 2. Those dependencies describe if the interviewees' statements address the service clusters or not. The model of customer acceptance and the service catalogue supported the third question: three interviewees received the aspects of customer acceptance (every category and its aspects), while two interviewees received the service catalogue (as a tree diagram). Again, the product manager transferred the answers of the three interviewees supported by aspects of customer acceptance into the service catalogue. Table 7-4 shows the data gathered in the interviews. The relations for Q1 show which interviewee (in columns) considers which service cluster (in rows) as relevant for customers and their purchase decisions. The relations for Q2 demonstrate where interviewees see weaknesses and expectations of service clusters for customers. The relations of Q3 describe where interviewees see weaknesses and expectations of service clusters for customers, like the relations for Q2. However, the relations of Q3 were identified in different ways, not as open questions:

- Interviewees 1 and 2 received the model of customer acceptance and selected relevant aspects. After that, the product manager transferred those answers to the service catalogue.
- Interviewees 3-5 received the service catalogue directly and selected relevant service clusters.

Table 7-4 Data gathered in interviews (excerpt)

Legend:
- ● mentioned by interviewee
- ○ not mentioned by interviewee

Superclust	Service clusters	Q1: Strengths – Open questions, referred to service catalogue					Q2: Weaknesses – Open questions, referred to service catalogue					Q3: Weaknesses – Based on service catalogue or model of customer acceptance				
		Interviewee 1	Interviewee 2	Interviewee 3	Interviewee 4	Interviewee 5	Interviewee 1	Interviewee 2	Interviewee 3	Interviewee 4	Interviewee 5	Interviewee 1	Interviewee 2	Interviewee 3	Interviewee 4	Interviewee 5
Assistance for using the product	Problem solving by telephone communication	○	●	●	○	●	●	○	○	○	○	○	●	○	○	○
	Problem solving by personal support	○	●	○	○	●	●	○	○	○	○	○	○	○	○	○
	Pr. sv. by platform-based communic.	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	Assistance by consulting	●	○	○	○	●	○	○	○	○	○	●	○	○	○	○
	Assistance by documentation	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	Product-specific training	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
…	…	…					…					…				

To next step was to process the data. The results of the interviews referred to the strengths and to the weaknesses of the drilling rig. To process those data, the strengths and weaknesses are quantified. This quantification is conducted by calculating the relational densities of superclusters (Vanderfeesten et al., 2007). One supercluster consists of several service cluster and the density of a supercluster is the number existing relations divided by the maximum number of possible dependencies. To give an example the supercluster "assistance for using the product", shown in Table 7-4 consists of six service clusters. To calculate the strengths of this supercluster, the number of relations regarding Q1 of all five interviews is divided by the maximal possible number of relations, i.e. 30 (six services multiplied with five interviews). The degree of strength for the supercluster "assistance for using the product" is 7/30 = 0,233. The calculation of two types of degree of weakness (one for Q2 and one for Q3) is analogue to calculating the degree of strength that is shown in equation (1).

$$RD_{SP} = \frac{R_{i,SC}}{N_i \cdot N_{sc}} \tag{1}$$

while RD_{SP} is the relational density of the supercluster, $R_{i,SC}$ is the number existing relations between the service clusters mentioned in interviews, N_i is the number of interviews, and N_{sc} is the number of service clusters for the supercluster.

Since the interviews resulted in two values for weaknesses, the final relational density for the weaknesses is the average of both values: the relational density for the weaknesses based on

Q2 is calculated and the relational density for the weaknesses based on Q3 is calculated. The average of those values for the relational densities serves as the total value for weaknesses. The relational densities, showing strengths and weaknesses of the current PSS, are calculated for all superclusters and they are shown in Figure 7-6.

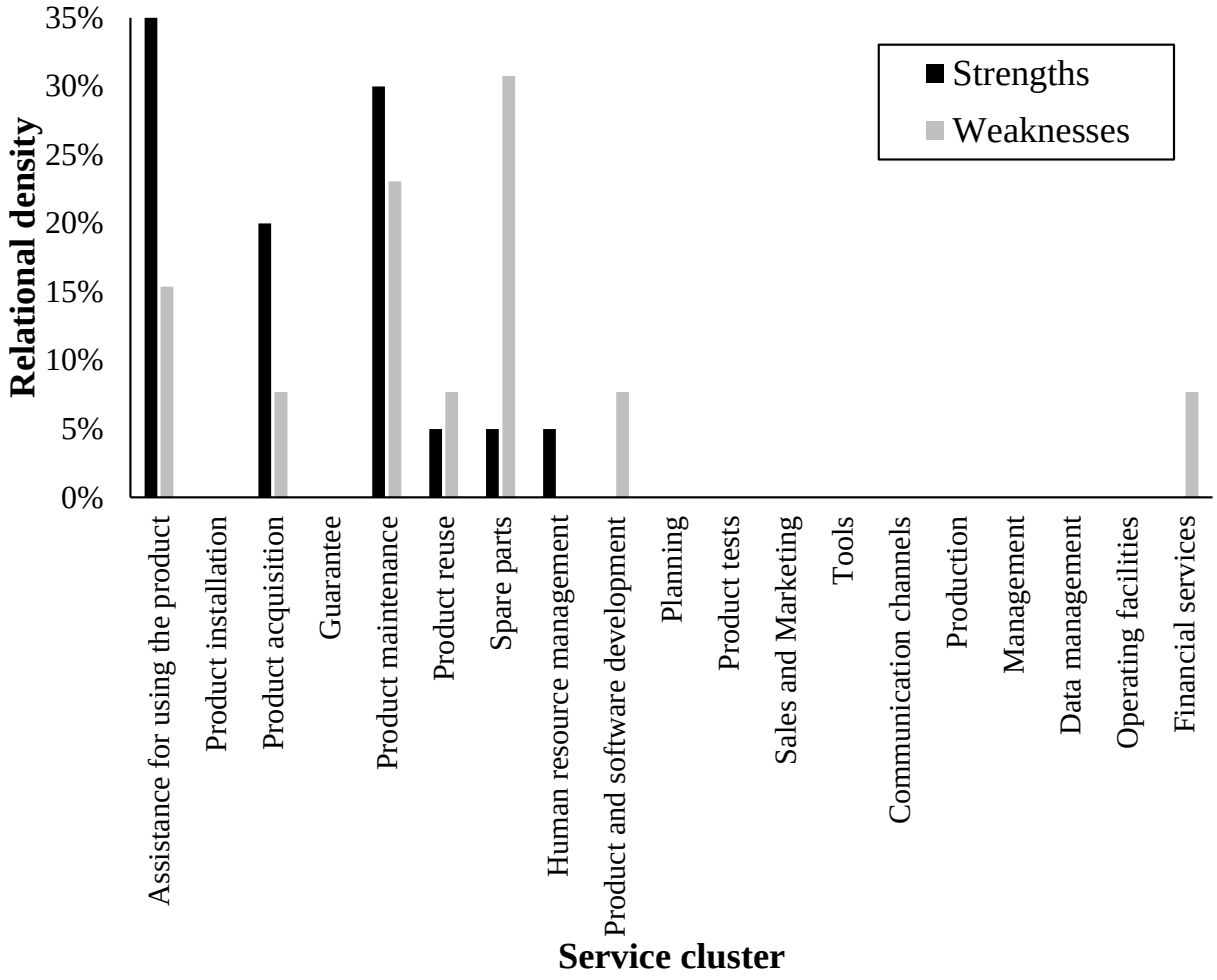

Figure 7-6 Strengths and weaknesses of current PSS from customer perspective

Deducting the degree of strengths out of the degree of weaknesses results in the deficits of superclusters. If this deficit is negative, the strengths dominate the weaknesses. If the deficit is positive, the weaknesses dominate the strengths. The superclusters *spare parts* (14 %), *product and software development* (i.e. *tools*, see Table 7-7) (16 %), and *financial services* (12 %) have the highest deficits.

The process step *state of the art* of the process model focused on the identification of the current PSS offer. A first workshop with eight employees (manager of business unit, product managers, repairmen, service consultants) of the department *Parts & Service* identified the currently offered services (only of the Parts & Service department):

24/7 technical hotline (for free), service technicians, world-wide service network, maintenance, training center, training on the jobsite, service box, service catalogue, customer center, operation care, platform for pre-owned machines, renting, on site repair, overhaul, all-round care in case of damage, and reliable logistics partners.

In a second workshop with the same participants, the services of the current service portfolio (Service A) were matched to the service clusters of the catalogue (Service B). The scale shown in Table 7-5 was used for this matching.

Table 7-5 Scale for matching real services with services from the catalogue

Value	Description
0	No correlation between service A and service B
1	Service A influences service B
2	Service A is a sub-part of service B
3	Service A is the main part of service B

Calculating the degree of fulfillment for all superclusters (analogue to the degree of strengths/weaknesses) showed which superclusters of the service catalogue are fulfilled by the current PSS offer. Figure 7-7 shows an excerpt of matching the service catalogue with the services of the existing PSS offer. This Domain Mapping Matrix (DMM) shows the matching based on the scale defined in Table 7-5 for the service cluster "assistance for using the product" (as it is included in the services catalogue) and the services 24/7 technical hotline, service technicians, and operation care that are services of the current PSS portfolio. By adding the relation belonging to one particular service cluster and all services of current PSS portfolio results in the sum per service cluster that is shown in equation (2).

$$S_{SC} = \sum_{k=1}^{m} R_k \tag{2}$$

while S_{SC} is the sum per service cluster, k is the particular service of the current PSS portfolio, m is the number of services of the current PSS portfolio, and R_k is the matching between a service cluster and the service k using the scale that is shown in Table 7-5.

This sum per service cluster describes if the particular service cluster is already implemented in the current PSS portfolio: if this value is high, the current PSS portfolio already includes this service cluster, if this value is low, the current PSS portfolio does not offer this kind of service cluster. To calculate an analogue measure for each supercluster, those sums of service clusters are added and divided by the maximum possible value. This maximum possible value is the sum of all relations between elements of the service catalogue and elements of the current PSS portfolio based on the scale in Table 7-5. In this case study, this maximum possible value was 209. This is called the degree of fulfillment and is shown in equation (3).

$$DF_{SP} = {\sum_{p=1}^{N_{sc}} S_{SC,p}} \Big/ {S_{PSS}} \tag{3}$$

while DF_{SP} is the degree of fulfillment of a supercluster, p is the particular service cluster, S_{SC} is the sum per service cluster, N_{sc} is the number of service clusters for the supercluster, and S_{PSS} is the maximum possible value (209).

For the exemplary supercluster "assistance for using the product" in Figure 7-7, this degree of fulfillment is 19 % (= [6+3+8+11+4+7] / 209).

			Services of current PSS-portfolio					
			24/7 technical hotline	service technicians	operation care	Further services	**Sum per service cluster**	**Degree of fulfillment**
Service clusters and superclusters of service catalogue	Assistance for using the product	Problem solving by telephone communication	3	0	1	…	**6**	**19 %**
		Problem solving by personal support	0	3	0	…	**3**	
		Problem solving by platform-based communication	0	0	0	…	**8**	
		Assistance by consulting	2	1	3	…	**11**	
		Assistance by documentation	0	0	1	…	**4**	
		Product-specific training	0	0	1	…	**7**	
…	…	…	…			…	…	…

Figure 7-7 Degree of fulfillment of supercluster between current PSS and service catalogue (excerpt)

To better identify potential for improving, the degree of fulfillment (based on the current PSS-portfolio) was compared to the deficits (based on customers' perception) on the level of service clusters. For this comparison, three categories of service clusters were identified describing different levels of the need for improving. The definitions of those three categories and the services allocated are shown in Table 7-6.

Table 7-6 Categories of service clusters describing the need for improving

Category 1	**Category 2**	**Category 3**
Service clusters with a high deficit and a degree of fulfillment that is almost zero	Service clusters with a low degree of fulfillment and a high deficit	Services with a high deficit and an average level of the degree of fulfillment
• Tools • Clearing services • Asset management	• Product implementation and integration • Overdraft services • Discounts • Tax consulting	• Pre-/Dis-/Reassembly • Installation support • Supply organization • Spare parts delivery • Credit • Transaction management

All service clusters mentioned in Table 7-6 were discussed with product managers. This discussion meeting was the R1-review point to select the services (requirements) on which the concepts generation should focus. Some of the service clusters were excluded because other departments are responsible for those services (e.g. finance department is responsible for

overdraft services, clearing services etc.). In other cases, product managers evaluated the current situation as sufficient (e.g. tools, installation support etc.). The product managers evaluated the service clusters *pre-/dis-/reassembly* and *supply organization* as relevant for the next planning stages. In this case study, the services from the service catalogue were used as analogous artefacts for requirements, so those two service clusters are the starting point for the second part of the planning process, the concepts generation.

The first two steps of the concepts generation, *main PSS elements* and *product-related services*, were conducted together, because the project focused on the service concept only. In the concept generation, the two service clusters identified before were analyzed based on the service catalogue. This analysis dealt with the identification of deficits and problems arising in those two service clusters. Deficits in the supply organization were long waiting periods for spare parts. Employees of Parts & Service considered the prioritization system for spare parts as one reason for these long waiting periods. The prioritization system has been started recently and was not established yet. The prioritization status of spare parts is manually set and most ordered parts were declared on the most urgent stage because employees were hoping for a faster delivery for all of the spare parts ordered. By looking at the concrete services of the service cluster supply organization, the *service check of delivery times online* seems to be a promising approach to increase acceptance for waiting periods. Based on these considerations the new service concept *tracking system for spare parts delivery* was identified. Another way could be to create incentives for employees to a proper use of the prioritization system. Analyzing the service cluster *pre-/dis-/reassembly* resulted in the new service concepts *training on the jobsite* (further trainings than one training after the first installation) and *briefing before the machine delivery* (short training before the final release of the product at the provider's production site).

The next step checked if the connecting infrastructure of those three concepts is already existent. The service *tracking system for spare parts delivery* requires the development of a tool that can be integrated into the existent customer management center. The service *training on the jobsite* needs more employees that work as trainers and an adapted business model to ensure the revenue stream for this service. The service *briefing before the machine delivery* would require more working time by employees, however, product managers estimated the additional working time required by *briefing before the machine delivery* as lower than the working time required by *training on the jobsite*. In checking the service concepts concerning the corporate strategy, no contradictive issues were identified. The service concepts did not radically change the current business model or the business. Therefore, the check between service concepts and the corporate strategy did not turn out any critical issues.

An interview focusing on those three service concepts accomplished the R2-review. The interviewees were an executive manager and a sales man. They were asked for the customer perception of those service concepts. One interviewee considered the *tracking system for spare parts delivery* as a promising approach for increasing customer acceptance of long waiting periods for spare parts, while the other interviewee negates a positive effect of transparency on the acceptance to longer waiting periods. *Training on the jobsite* was evaluated as beneficial for sales regions with a lower level of education. The interviewees saw *briefing before the machine delivery* as a successful approach for European markets to increase customer acceptance. While the service concepts *training on the jobsite* and *briefing before the machine delivery* passed this R2-review, the concept *tracking system for spare parts delivery* was put on hold. This project was not a new product development project but focused on creating new service concepts. The third phase, the concepts evaluation, dealt with a concretization of the

two service concepts and did not consider the whole PSS concept. The service concepts were detailed and processes were defined that are necessary for providing those services. This point was the end of this case study, a further development or implementation was not considered within this study.

7.4.3 Conclusions and Implications for the Design Support

This case focused on the service part of the PSS. Customer wishes and requirements were formulated as weaknesses of strengths concerning services of the service catalogue. This planning process was not a classic PSS planning project but an advancement project to improve the existing PSS concept. The usage of the service catalogue instead of the concrete customer requirements made all participants thinking on an abstract level and generated a more generic perspective for them. In this project, the service catalogue had various use cases: it was used to identify the weaknesses customer see in the PSS, to identify the strengths of the current PSS offer for customers. It was also used as a checklist to analyze the current PSS offer and to create new service concepts. The different layers of this service catalogue were applied for the different use cases: while the layer of superclusters gives an overview of the whole service spectrum, the layer of concrete services was beneficial for finding new service concepts. This case study revealed that some services of the service catalogue might be misunderstood. Mostly this misunderstanding was based on the differences between services from B2B and from B2C markets. Table 7-7 shows example of services mentioned by the applying product manager and what he actually meant by that.

Table 7-7 Misunderstood services in the service catalogue

Mentioned service	**Actual service or benefit**
product and software development	tools
product development and design	customer-specific design, individualized product (not a service)
product advancement	upgrading

To overcome those misunderstandings, the service descriptions were detailed and the categorization of the service catalogue was changed to better distinguish between B2B and B2C services.

The model of customer acceptance was used as a minor aspect of this project but it turned out to be beneficial to support interviewees in identifying relevant aspects of customer acceptance. Especially the connection to the service catalogue was helpful to include the consideration of customer aspects into the service analysis.

The decision-making process supported the product manager to plan the whole process from the beginning. He was able to define meetings for the review points at the beginning of this process. This project revealed one weak point of the process' illustration, that the iterative character is not highlighted enough. This case study showed that the model of customer acceptance and the service catalogue are compatible to each other and that they fit the decision-making process, i.e. the consistency between model of customer acceptance, service catalogue, and the decision-making process was shown.

7.5 Case Study IV: Increasing User Acceptance of Home Appliances

This case study focused on new service concepts for dishwashers based on aspects of user acceptance. It was located in the product management of a company that develops and produces home appliances and focused on both mature and emerging markets. Dishwashers for B2C markets from different brands were considered. In this case study, the model of customer acceptance and the service catalogue were used and connected to each other to identify relevant aspects of user acceptance and to find services and service concepts for increasing user acceptance.

7.5.1 Initial Situation and Overview of the Procedure

The mature markets (Romania, France and Belgium, East Adria, USA and Canada) and the emerging markets (China and Taiwan, Singapore and India and South-East Asia) differ in the market saturation: while most mature markets have a market saturation around 70%, emerging markets have a saturation around 10%. This might be caused in different aspects of customer acceptance. To cope with those differences between the markets, different service concepts should be identified. Figure 7-8 shows the overall procedure of this case study.

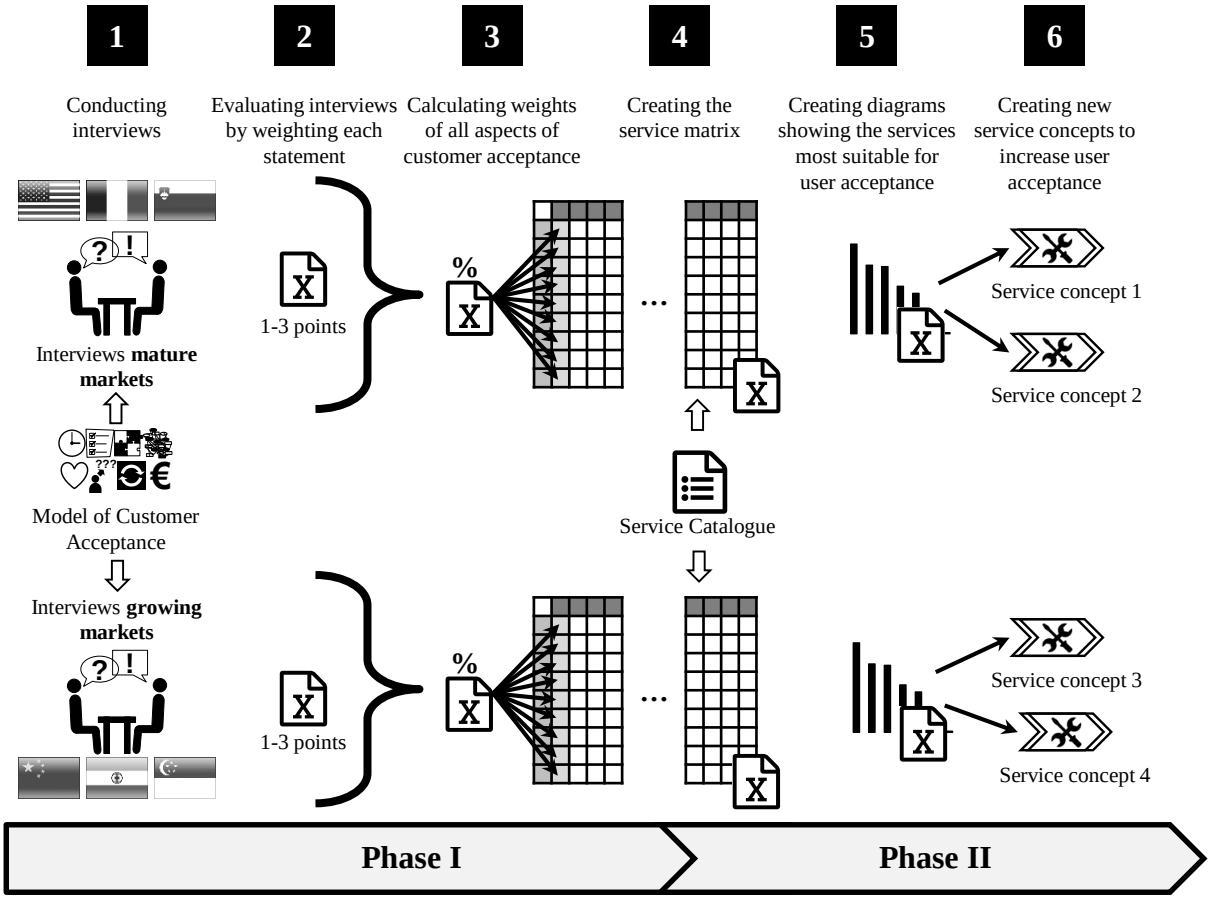

Figure 7-8 Procedure of the case study

This study was conducted in cooperation with the product management of the company's dishwasher sector. The final and intermediate results were presented to employees from the

product management on a regular basis to let them feedback and evaluate the results. The first step was to identify aspects of user acceptance for the different markets (emerging vs. mature markets). Semi-structured interviews with sales managers from different regions revealed the relevant aspects of customer acceptance. For conducting the interviews, it was necessary to create an interview guideline and adapt it to the product dishwasher. This guideline relies on the model of customer acceptance. The next step was to quantify the aspects of user acceptance identified in interviews. Market studies extended this quantification of user acceptance. After that, a matrix was built that describes the relations between aspects of user acceptance and the services from the service catalogue on a generic basis (a rough draft of the connecting matrix in section 6.5). Combining this matrix with the aspects of user acceptance quantified before results in an evaluation of services. This evaluation of services highlights those services that are recommendable for the markets considered to increase user acceptance. Based on this quantification of services, new service concepts were created and presented to the product management.

7.5.2 Identification and Quantification of Aspects of User Acceptance

The interview guideline for the interviews with sales managers consisted of three parts: the first part was to introduce the project and to ask general questions about the interviewee. Then, the eight categories of the model of customer acceptance were explained and the interviewee had to select three of the categories. Asking the sales managers questions from all eight categories would have been too time-consuming. The third part was to ask detailed questions concerning the categories selected by the interviewees. The interviews were recorded and transcript afterwards. In total, six interviews were conducted, two interviews with sales managers from emerging markets and four interviews with sales managers from mature markets.

Analyzing the transcripts of the interviews afterwards resulted in a quantification of the aspects of customer acceptance. In this analysis, the statements of sales managers were linked or allocated to detailed aspects of customer acceptance. A scale from 1 to 3 evaluated the relevance of the detailed aspects of customer acceptance. This evaluation relies on the number of statements per detailed aspect of user acceptance and on the emphasis sales managers put on their statements. Findings from market studies were also included in the analysis and quantification of aspects of user acceptance. The sum of those evaluation scores of detailed aspects results in the value of the aspects of user acceptance on a more abstract level. For emerging markets, the aspect categories *reliability and availability*, *unawareness of need* and *interoperability* were the most important ones. More detailed aspects are that detergents are difficult available (partly based on too low market penetration), people in those markets do not know the product dishwasher, or some households do not even have electricity or water. Figure 7-9 shows an overview of the quantification for all categories of user acceptance for emerging markets.

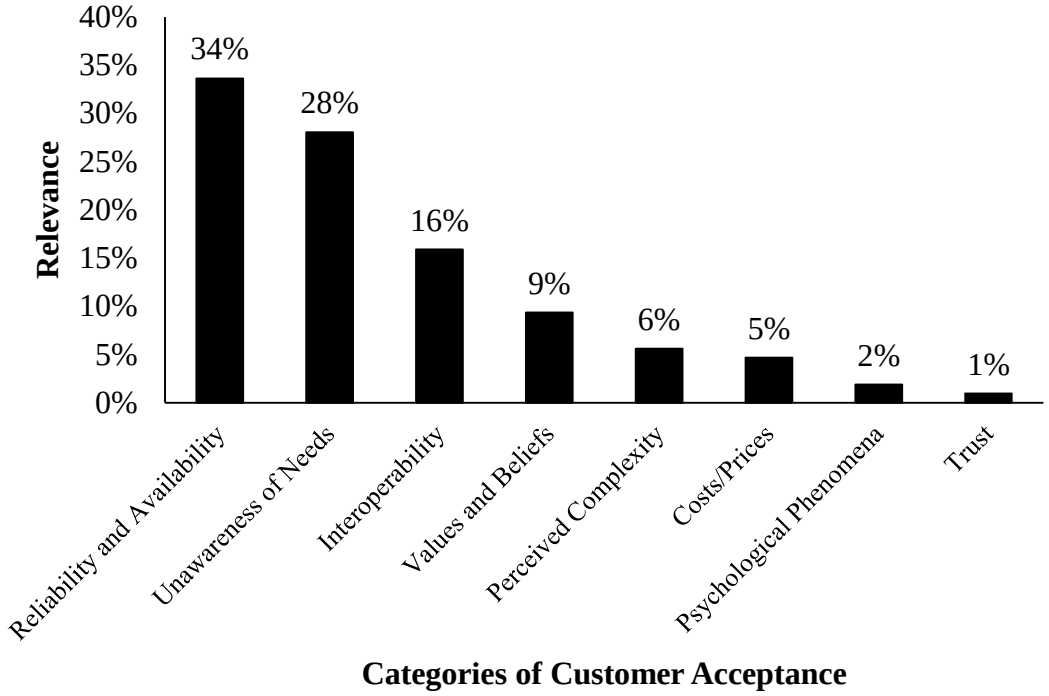

Figure 7-9 Quantification of the categories of user acceptance for emerging markets

In mature markets, *reliability and availability*, *unawareness of need* and *costs and prices* are the most relevant categories: customer expect clean and dry dishes, which is not always given, some customers evaluate handwashing as more efficient, or they perceive the costs of purchase as too high. Figure 7-10 provides an overview of the quantification for all categories of user acceptance for mature markets.

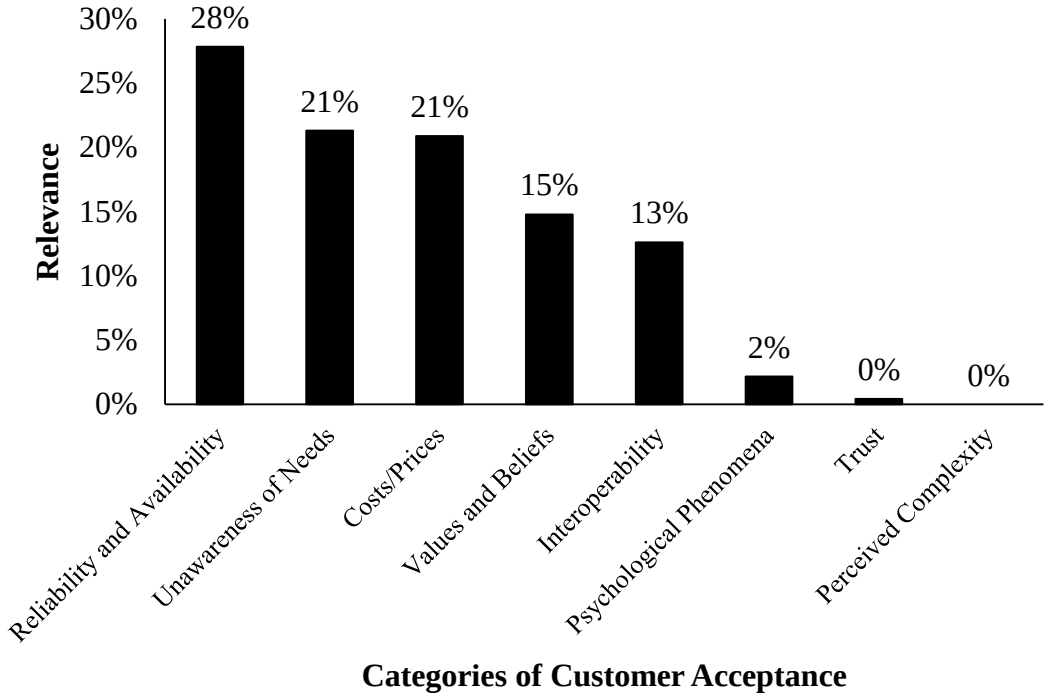

Figure 7-10 Quantification of the categories of user acceptance for mature markets

7.5.3 Finding new Service Concepts

To create new service concepts, the service catalogue was used to find possible services. To identify services fitting the aspects of user acceptance, a matrix was built to link aspects of user acceptance to the elements of the service catalogue. To link aspects of user acceptance to services, every cell in the matrix was set to -1, 0 or 1. These relations describe if a service has a positive effect on the aspect (1), if a service has a negative effect on the aspect (-1), or if a service has a vanishingly low effect on the aspect. Those relations between aspects of customer acceptance and services were the same for mature and emerging markets, while the quantifications of customer aspects were market-specific. Weighting those values with the quantifications of the aspects of user acceptance (see section 5.5) results in a value for every service describing the benefit this service might provide (for the specific market). Excerpts of these relations are shown in Figure 7-11 for mature markets and in Figure 7-12 for emerging markets. The figures for the different markets include different services and aspects of customer acceptance to show the elements relevant for the specific market. The quantifications of aspects of user acceptance were given in percentage. Since the relevance of services consists of adding the quantifications of customer aspects, the values describing the relevance of services do not have a unit but they are a linear measure describing the importance of services.

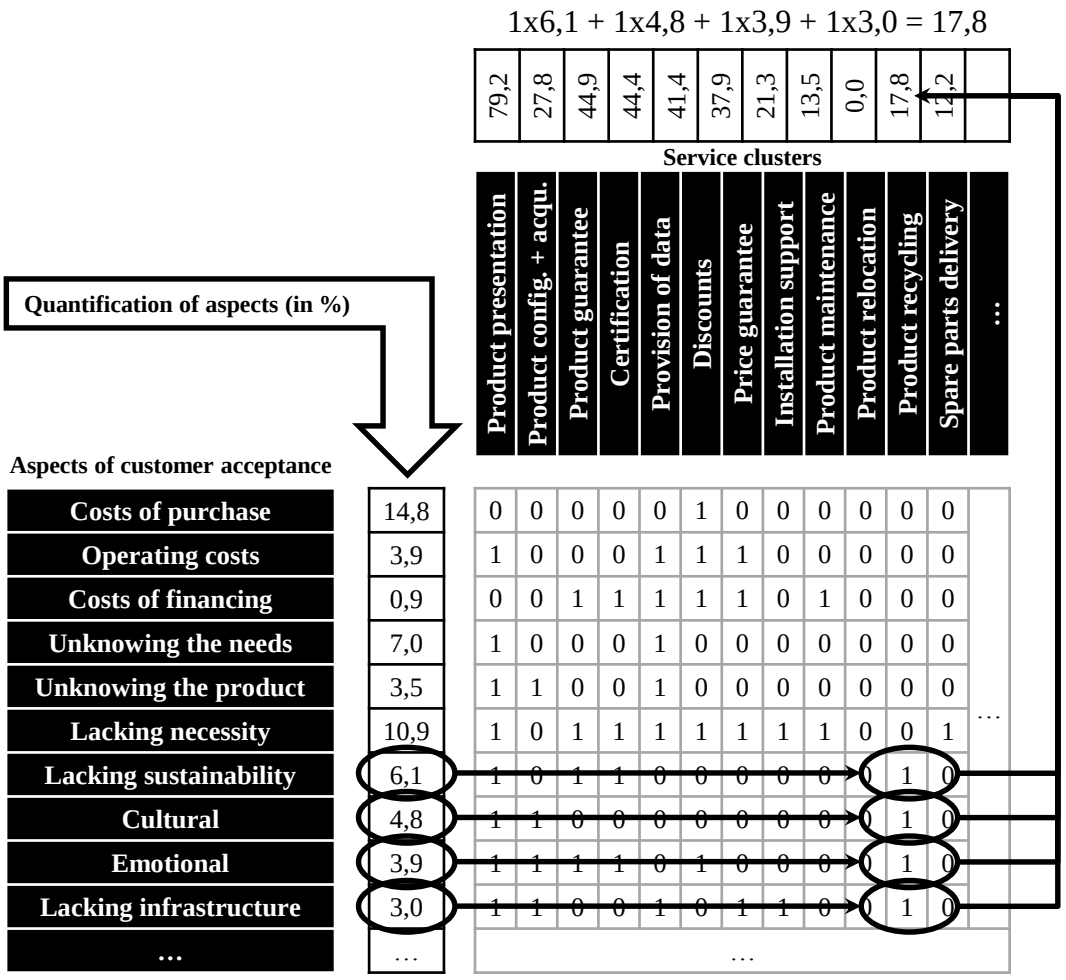

Figure 7-11 Matching between aspects of customer acceptance and service catalogue for mature markets (excerpt)

Figure 7-11 shows exemplary the calculation of the relevance of the service “recycling” for mature markets (this service was taken because the relevant values between customer aspects and services fit the small excerpt).

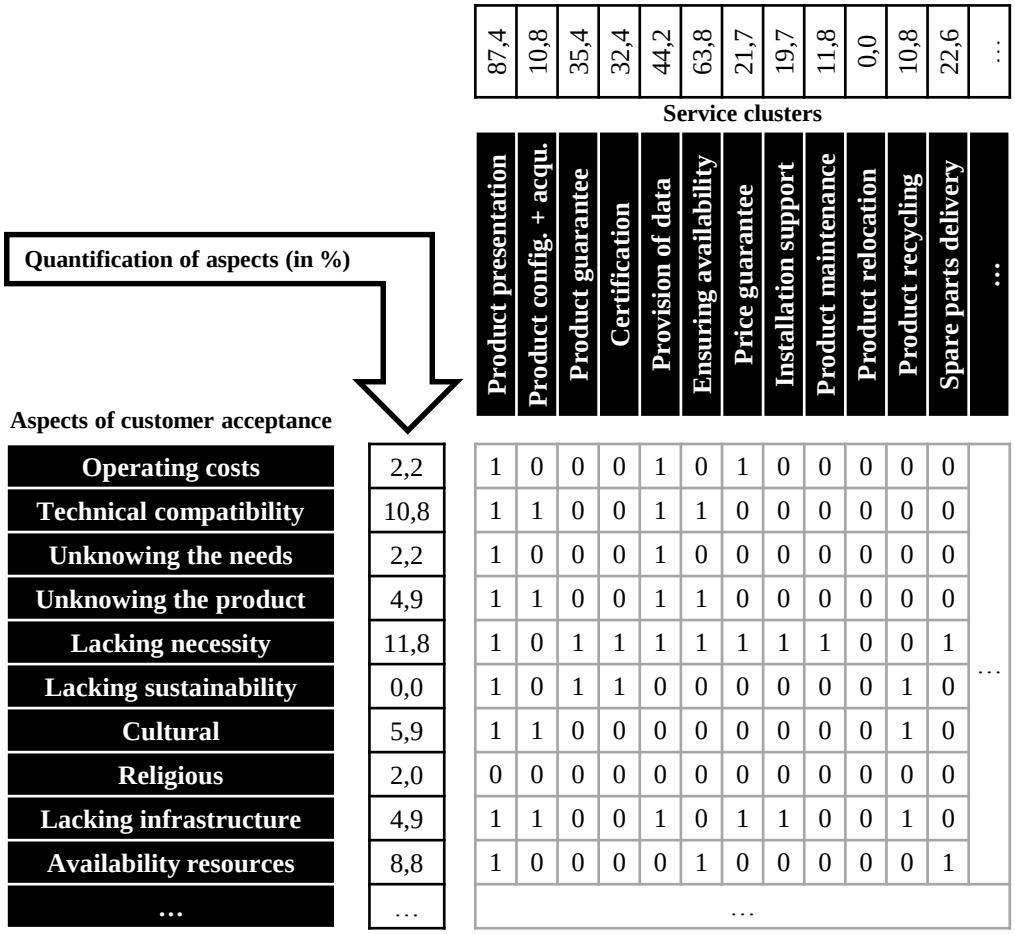

Figure 7-12 Matching between aspects of customer acceptance and service catalogue for emerging markets (excerpt)

The most relevant services for mature markets were *product presentation* and *product guarantee*, while emerging markets demand for *product presentation* and *ensuring the product availability*.

For emerging markets, the not-given availability of detergents could be a problem for users. This issue could be seen as a part of the aspect *availability of required resources*, that yields a relevance of 8,8% (see Figure 7-12). This aspect could be influenced by the services of a better *product presentation* (e.g. improved information about purchasing detergents), *ensuring the product availability*, or a *spare parts delivery*. Those connections between the aspects of customer acceptance and the services are described by the numbers in the cells of the matrix (see Figure 7-12). Based on *ensuring the product availability* and *spare parts delivery* that are elements of the service catalogue, the idea of supporting customers by handling detergents was identified. For this idea, two concepts of new PSS business models were created that are shown in the following as stakeholder maps (just for the presentation). The current situation is shown in Figure 7-13: the dishwasher company sells the dishwasher to the consumer via retailers. The

consumer buys the detergent from the detergent manufacturer (also via retailers), independent of the home appliances company.

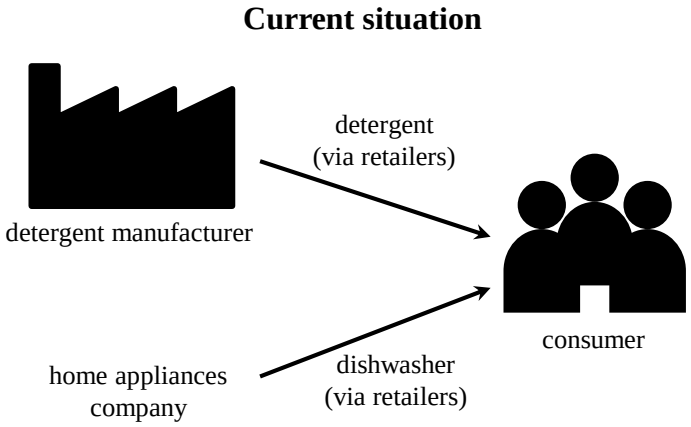

Figure 7-13 Current situation of relations between the home appliances company, the detergent manufacturer, and the consumer

Having a detergent provider as a key partner could enable the home appliances company and the detergent provider to start a common business in offering dishwashers and detergents. This kind of relation between the detergent manufacturer, the home appliances company, and the consumer is shown in Figure 7-14.

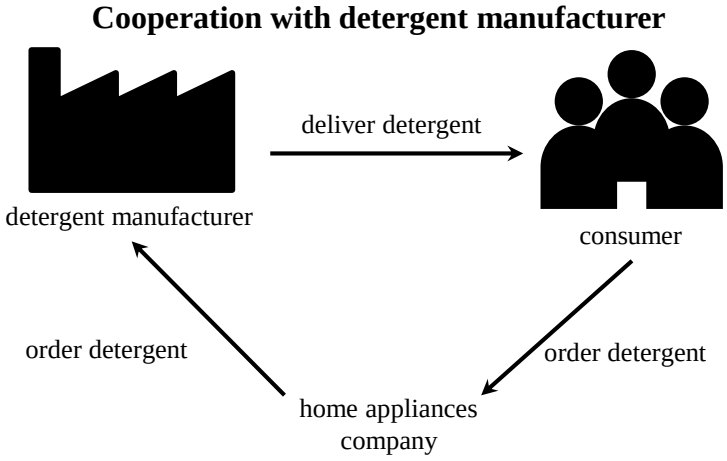

Figure 7-14 Cooperation between the detergent manufacturer and the home appliances company

Another option is that the detergent manufacturer is a supplier of the home appliances company and this company could offer and deliver detergent by itself and under an own brand. This option is shown in Figure 7-15.

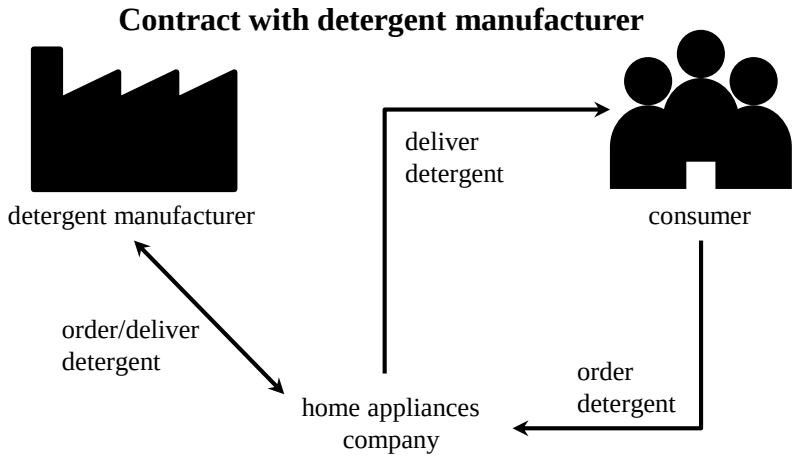

Figure 7-15 Contract with the detergent manufacturer

This PSS concept is capable of overcoming the low availability of detergents in those markets. Furthermore, the home appliances company makes the own product offer more difficult to copy, it can create a stronger connection to customers, and gain more profit from selling the detergents.

The service *product presentation* is considered as one of the most relevant services for mature markets. This is caused by several aspects of customer acceptance, e.g. customers do not exactly know about their specific requirements or they do not know the benefits of dishwashers compared to handwashing (see Figure 7-11). The company already offers different services for product presentation, e.g. a web-based dishwasher selector.

Because of the importance of *product presentation* for emerging markets, the dishwasher selector was analyzed resulting in a proposal for an advanced dishwasher selector. The current web-based dishwasher selector only focuses on technical details (e.g. energy class, size of the basket) instead of focusing on customer preferences (e.g. number of washes per day, number of persons living in the household). An operational cost calculator that shows the expected costs the customer has to pay in comparison to handwashing can extend this selector. An exemplary concept for this selector is shown in Figure 7-16.

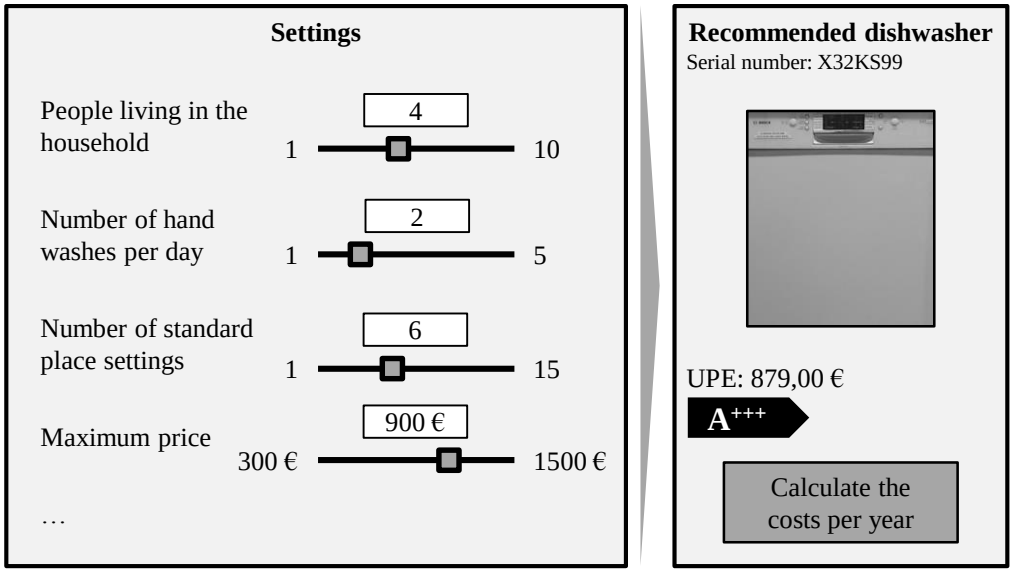

Figure 7-16 Dishwasher selector for mature markets

This selector supports customers in identifying their own and real needs for a dishwasher (*unawareness of needs*) and it helps them select a suitable dishwasher (*perceived complexity*). The operational cost calculator helps to evaluate the financial benefit a dishwasher provides compared to handwashing (*costs and prices*, *unawareness of needs*).

7.5.4 Conclusions and Implications for the Design Support

In this study, the service catalogue and the model of customer acceptance turned out to be helpful measures for identifying and quantifying relevant aspects of user acceptance and creating service concepts for increasing customer acceptance. The model of customer acceptance was applicable and beneficial for the interviews with sales managers. A new aspect was added to the model of customer acceptance, the healthy and hygienic aspect. In this case study, a preliminary version of the matrix connecting aspects of customer acceptance and services was created. Furthermore, this study revealed the need for a generic matrix linking aspects to services that is described in section 6.5. The quantification methods for evaluating the relevance of aspects of user acceptance was a reasonable measure in the study. Other researchers suggest more complex evaluation schemes that focus on more concrete customer issues, e.g. customer preferences or requirements that need detailed values. However, since aspects of customer acceptance are a quite abstract concept, a quantification scheme might not be suitable for customer acceptance issues. The benefit of those quantification schemes depends on the method of data acquisition (interviews, surveys etc.) and on the accuracy that is needed for determining the relevance of aspects of customer acceptance. This case study revealed weak spots of the service catalogue: like the case III in section 7.4, people misunderstood some services of the service catalogue based on the confusion between B2B and B2C services (e.g. marketing, product development and design). However, it was beneficial for the project to consider those services because the service catalogue was used to identify fields of action. The service concepts were created based on those fields of action instead of just taking and adapting the services of the service catalogue. Besides using the service catalogue, a detailed lifecycle model would be also helpful to identify fields of action. However, the service catalogue is more

focused on service offers and its structure is partly similar to a product's lifecycle. This case study showed that the service catalogue is also capable of identifying service-oriented fields of action for creating new and innovative services.

8. Interview Studies: Evaluation of the Results

Besides the case studies, the evaluation concept includes three interview studies (see section 7.1). The first interview study demonstrates the accuracy of the hypothesis that is the basis for research question RQ #1: "How can PSS planning increase customer acceptance?" (see section 8.1). Section 8.2 describes the evaluation interviews with representatives from different companies. The conclusion of this chapter summarizes if the design support is capable of fulfilling the requirements defined after the descriptive study I (see chapter 3). The third interview study mainly focused on the completeness of the model of customer acceptance and is more detailed described by Bauer (2014). The evaluation concept in section 7.1 provides an overview of all interview studies.

8.1 Interview Study #A: Electric vehicles in car-sharing systems

RQ #1 includes the main hypothesis and the underlying presumption of this work: PSS are capable of increasing customer acceptance. This research question is the foundation of the other three research questions. By answering research questions #2-#4, also this first research question was focused. To study this research question more specific, an interview study investigated the application of PSS for electric vehicles (EV). This study shows the mechanism of increasing customer acceptance using PSS as it is defined in the customer-oriented framework for PSS development (descriptive study I, see chapter 3). Since this interview study was conducted before the finalization of the model of customer acceptance, the attributes of customer acceptance concerning innovations were used in this study. Rogers (2003) proposed these attributes of acceptance that serve as a basis for this work's model of customer acceptance: *relative advantage*, *compatibility*, *complexity*, *trialability*, *observability*. This model was extended by the factor *risk* that was proposed by Herbig and Day (1992). Based on the example of EVs in carpools, interviews were held with four PSS providers and four PSS customers from Germany and Sweden. Analyzing those interviews resulted in the finding that PSS enable innovative products to increase customer acceptance by reducing performance gaps that exist between innovative and existing technologies. The main technology gaps of EVs are the limited range and the high purchase costs. Customers perceive those gaps as less considerable if they rent EVs as PSS in a carpool. A more detailed description of this study is provided in (Schmidt et al., 2016a) and in (Braun, 2014).

8.1.1 Design of Interviews: Car-sharing Providers

Four top-level car-sharing company managers were interviewed to investigate customer behavior. Those managers are familiar with main problems that customers experience in using the product. Interviewees came from different countries (Germany and Sweden) and different kinds of car-sharing companies (station-based and flee-floating). Car-sharing is a short-term model of car rental and a use-oriented PSS (Liu et al., 2014). There are different types of car-sharing: in station-based systems, cars are taken and returned at defined stations. Multi-nodal

shared-use vehicles rely on multiple stations (Barth & Shaheen, 2002). In free-floating car-sharing systems, cars are distributed throughout a certain area, the carpool business area. Cars can be taken from anywhere and parked everywhere, as far as allowed, throughout the entire business area. Table 8-1 shows the characteristics of the four managers and their companies.

Table 8-1 Characteristics of the four carpools examined

Company	**Comp#1**	**Comp#2**	**Comp#3**	**Comp#4**
Type of carpool	Station-based	Station-based	Free-floating	Free-floating
Country	Sweden	Sweden	Germany	Germany
Vehicles	Full EV	Mixed EV	Full EV	Mixed EV
Position	Top-level management	Top-level management	Top-level management	Top-level management

All interviews rely on the same interview guideline to ensure comparability. The first part of the interviews focused on the general use of EVs in car-sharing companies, with questions that involving the exact number of EVs included in the carpool as well as the reasons for integrating EVs in the carpools. The role of EVs as an innovation in car-sharing, the future perspectives of car-sharing as well as the effects of EVs in carpools on overall customer acceptance of this technology were investigated (sample question: What is your strategy for advertising the fact that you use only EVs in your carpool?). The second part of the interviews then focused on customer acceptance of the EVs integrated into carpools, in particular examining customers' reasons for using EVs instead of conventional gasoline cars. The interviews also looked more closely at user difficulties with the handling of EVs and the future development of EV user structure (sample question: Thinking of your customers' feedback, what are the reasons your customers mention for not using electric vehicles?). The first part of the interviews was analyzed based on the topics of EV user group characteristics, differences between the Swedish and German car-sharing markets, and future challenges and developments surrounding the use of EVs in carpools. The second part, focusing on customer acceptance of EVs, was analyzed based on the framework by Rogers (2003). The six factors of customer adoption were used to structure and categorize the replies given by car-sharing officials.

8.1.2 Design of Interviews: Car-sharing Customers

Since interviews with car-sharing companies' representatives might be biased, corresponding interviews were held with potential customers in order to deal with this matter and to double-check the findings of the company interviews. The focus of the customer interviews lies strongly on the risks of EVs in car-sharing and on reasons why customers have not yet used EVs in car-sharing. The people interviewed differed in their employment, age, background, and residence to ensure that a cross section of the most common types of people was represented. Table 8-2 presents the characteristics of the four persons that were interviewed.

Table 8-2 Characteristics of the four customers interviewed

Customer	**Cust#1**	**Cust#2**	**Cust#3**	**Cust#4**
Sex	Female	Female	Male	Male
Age	<30 years	>50 years	40-50 years	30-40 years
Job	Student	Housewife/ part-time work	Employee	Freelancer
Professional background	Other	Other	Technical	Economical
Residence	Small city (<250,000)	Large city (>1,000,000)	Small city (<250,000)	Medium city

The interviews are based on the company interviews including a similar interview guideline. The interviews start with a few statistical and personal questions to confirm that the selection criteria apply to the interviewee selected. The second and longer part of the interviews focused on reasons for and obstacles to the interviewees' willingness to use EVs in car-sharing, thus identifying their reasons for accepting this technology (sample question: Why would you use a conventional gasoline car rather than an EV in car-sharing?). Also, the factor of risk is evaluated in detail to find out whether the company interviews reveal insights, and to understand how EVs in car-sharing have to change in order to be attractive to a larger group of people (sample question: What difficulties do you anticipate with the handling of EVs in car-sharing?).

8.1.3 Analysis and Interpretation

The interviews have revealed that carpool providers have two main incentives for integrating EVs:

1. Environmental friendliness of EVs, especially the zero direct carbon dioxide emissions.
2. To learn technical aspects and details of EVs, learn how to integrate EVs into an existing carpool and learn about behavior and acceptance of customers that use EVs.

The providers' interviews were analyzed by quantifying the level of compliance of interviewees with Rogers' six factors (Herbig & Day, 1992; Rogers, 2003). Every factor includes several sub-dimensions. If an interviewee has mentioned a sub-dimension, the level of compliance has been increased by one. Since the factors differ in their number of sub-dimensions, the level of compliance was normalized to a maximum of ten (meaning that all sub-dimensions were mentioned) and a minimum of zero (meaning that no sub-dimensions were mentioned). Figure 8-1 shows the results for Comp#1 as a spider network.

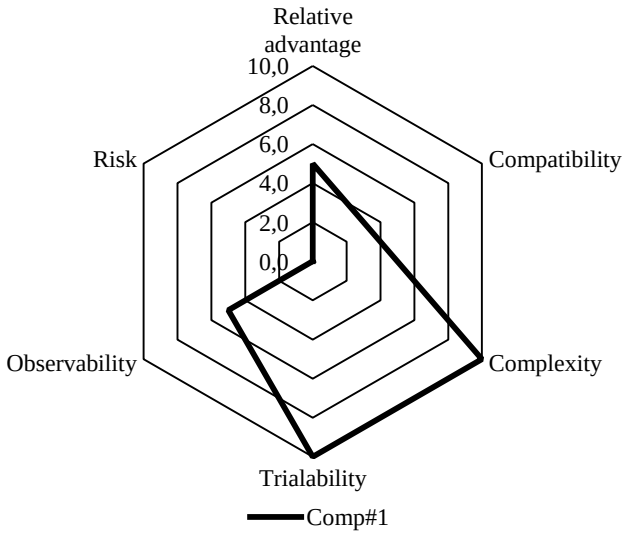

Figure 8-1 Customer acceptance factors identified in provider interview Comp#1

The provider interviewee of case #1 points out the importance of the trialability and the complexity. However, the risk and the compatibility are considered as less important. The results of Comp#2 are shown in Figure 8-2

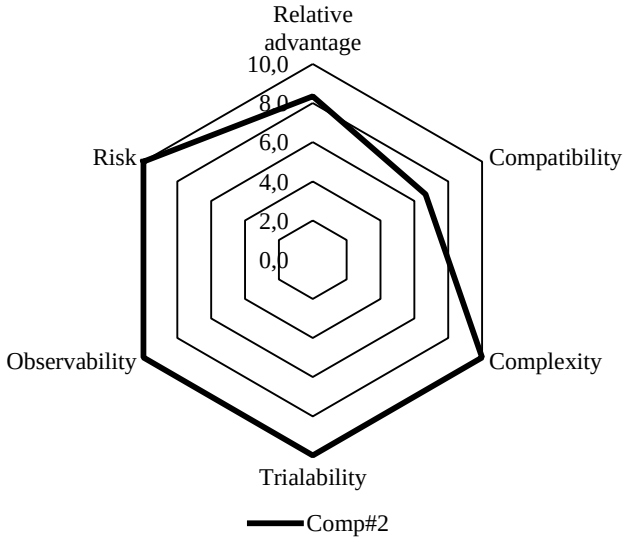

Figure 8-2 Customer acceptance factors identified in provider interview Comp#2

The manager of Comp#2 considered all factors as very relevant, while the compatibility got the lowest value. Figure 8-3 shows the results of the interview for Comp#3.

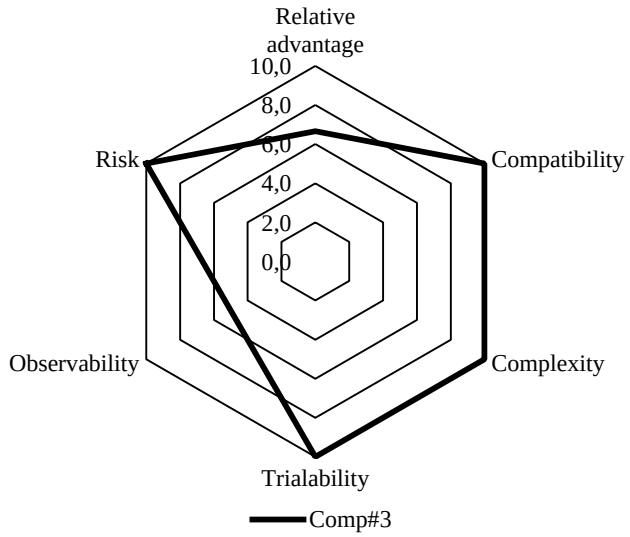

Figure 8-3 Customer acceptance factors identified in provider interview Comp#3

Besides the observability, the provider interview Comp#3 considers all factors as quite relevant. The relative advantage has a value that is a little bit lower than other factors. Figure 8-4 depicts the results of the provider interview Comp#4.

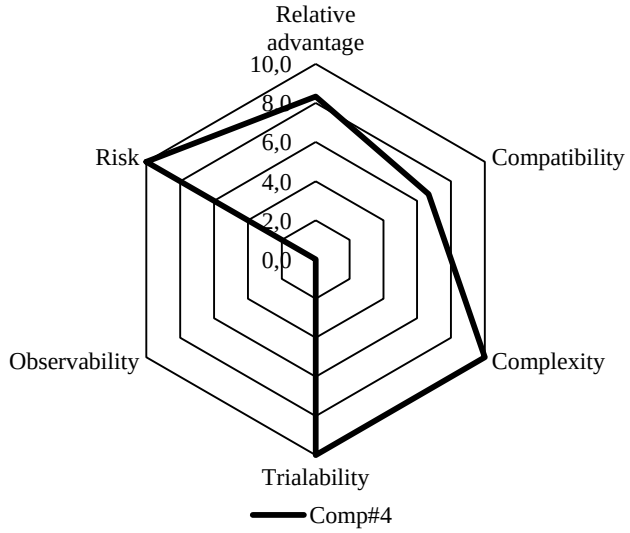

Figure 8-4 Customer acceptance factors identified in provider interview Comp#4

In Comp#4, the manager considers the observability a very unimportant, while other factors are considered as relevant. Analyzing the four customer interviews verified the statements made by providers and identified further issues not mentioned by providers. Figure 8-5 shows the factors brought up by customers in underlined font, factors by providers are in italic font and factors by both providers and customers are in bold font.

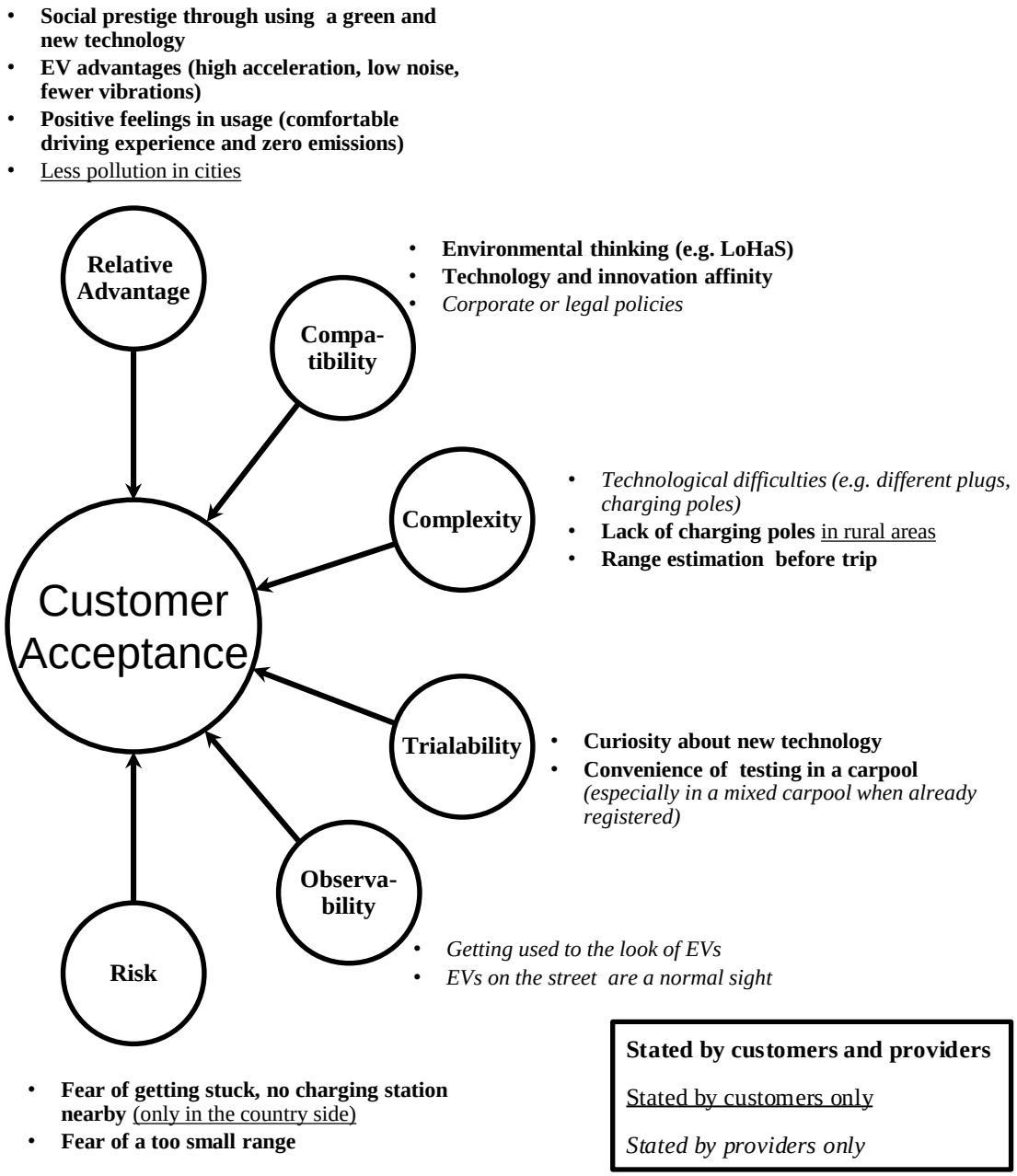

Figure 8-5 Customer acceptance factors in customer and provider interviews

EVs in carpools are attractive for the customer interviewees because of social prestige and advantages such as faster acceleration or fewer vibrations. The customers mentioned another point based on the environmental aspect: using EVs in cities might reduce fine dust emissions. Customers did not address the observability as a relevant factor for acceptance. With regard to relative advantage, customers confirmed the companies' statements. Customer interviews validate the findings of the company interviews. They mentioned similar arguments leading to the same conclusion: the customer acceptance factors by Rogers are a valid model for describing customer acceptance of PSS. Integrating the new EV technology into the car-sharing PSS reduces the typical disadvantages of EVs.

8.1.4 Conclusions: PSS for Increasing Customer Acceptance

The interview study showed that car-sharing increases customer acceptance of EVs, based on the six factors of customer acceptance. From a more abstract perspective, PSS supports to increase customer acceptance of innovative products. The PSS-shift is capable of bridging performance gaps of new technologies and increases relative advantages of them. Current performance gaps of EVs compared to combustion engines are high purchase costs and limited ranges. Car-sharing overcomes those weaknesses by offering cars for short distance trips and renting them instead of selling them. PSS may also reduce the complexity of innovative products by providing beneficial services (e.g. the carpool company is responsible for charging EVs, not the customer) that will diminish complex challenges for customers. PSS can also break down barriers preventing customers from trying out or testing a product to increase the product's trialibility. Since renting or leasing a product is easier for the customer than purchasing, PSS provide products that can be tested more easily. If the PSS provider owns a physical product and rents it to the customer, the provider is free to determine, and modify, the product's design. This enables the provider to increase the product's observability. EVs in carpools could be equipped with a distinctive logo or color to make the car conspicuous to other drivers or pedestrians. PSS can also increase customer acceptance of risks. By taking over the responsibility of uncertain activities for the customers, the provider reduces the risk to the customers. Potential EV customers might not know how to maintain an EV, therefore maintenance of EVs is an uncertain activity for them. In a carpool, providers are responsible for maintaining EVs, which reduces the risk to customers. Furthermore, back-up solutions can reduce risks. The conventional cars in mixed EVs carpools serve as a back-up solution for EVs.

The benefits of PSS for increasing customer acceptance of product innovations rely on the fact that PSS enable customers to try the product. Customers are not willing to buy a product innovation in the early phases of innovation diffusion. PSS do not force customers to purchase the innovation: they can try the product to verify the innovation's benefit. After testing the innovation, people talk to friends, relatives, or colleagues about their experiences. This accelerates the diffusion process and motivates other people to test the innovation. While testing the product, potential customers become familiar with the innovation and learn about its benefits and weaknesses. This study verified the underlying hypothesis of this work: PSS can increase customer acceptance. This study focused on innovative products that are not the only category of products on which this work focuses. Not all aspects of customer acceptance are relevant for innovative products, however, there are many factors that must be positively influenced to reach customer acceptance for them. Since there is no product and no market that includes all detailed aspects of the model of customer acceptance, innovative products are considered as sufficient to check the validity of research question #1.

8.2 Interview Study #B: Evaluation Interviews

To get feedback from industry about the benefits and the applicability of this work's results, evaluation interviews were conducted. In these interviews, experts from industry evaluated the approaches of this thesis and discussed the new findings proposed in this work.

8.2.1 Design of Interviews

The aim of the interviews was to get feedback from experts from industry. The main results of this work was presented to the interviewees and after every partial result, a short question session claimed their opinion about the results concerning the requirements defined in section 3.3. To get valuable feedback from those interviewees, they must be experts that are capable of understanding this work's results and their benefits for industry. To characterize experts for the evaluation interviews, several requirements were defined. Experts need to know how industrial organizations work (professional experience), they need to have a background in engineering, management, or economics to evaluate the results of this work. Furthermore, the branch they are working in has to fit this work's focus and they should have at least touching points with service engineering or the PSS approach. They should work in product management, management or service departments. Those departments can potentially take most advantages from using this work's results. To make sure that they are capable of seeing the bigger picture, they should also be at least a team leader. Table 8-3 summarizes the requirements that makes people to potential experts for evaluating the results of this work.

Table 8-3 Requirements on experts for evaluation interviews

Criterion	**Characteristic**
Professional experience	More than five years
Academic background	At least master degree in engineering, management, or economics
Branch/product/ market/company	Technical products (e.g. construction machines, cars, trucks, ships, trains, machine tools, manufacturing facilities, home appliances, mobile phones, laptops, or consumer electronics, see subsection 2.3.4)
Experiences with Services, PSS	At least touching points
Organizational unit	Service, product management, management
Hierarchical level	At least team leader

Based on this characterization, several experts were identified and four interviews were conducted. Table 2-2 presents the characteristics of those experts.

Table 8-4 Characteristics of the experts interviewed

Expert	Branch	Experience	Job/Position
B.1	Home appliances (B2C)	10 years	Group leader in product management for world wide markets
B.2	Automotive (B2B and B2C)	40 years	CEO of supplier company, head of development at an OEM
B.3	Home appliances, services (B2B and B2C)	10 years	COO of a startup company
B.4	Software and engineering services (B2B)	9 years	Product manager for software solutions

Interviews were semi-structured and guideline-based to give the participants enough freedom for expressing their own thoughts while being focused on the results of this work (Johnson & Christensen, 2012). The procedure of the interviews and the interview guideline are based on the work of Johnson and Christensen (2012) and Bogner et al. (2002). The procedure consisted of the following steps:

1. Introducing the dissertation project and the procedure of the interview
2. Questions about the person (e.g. academic background, experience in industry)
3. Introduction and motivation to PSS and an overview of the work (including research questions and customer-oriented framework)
4. Presenting the model of customer acceptance
5. Questions about the applicability, the benefit, and potential uses cases of the model of customer acceptance
6. Presenting the decision-making process for planning PSS
7. Questions about the applicability, the benefit, and potential uses cases of the decision-making process for planning PSS
8. Presenting the service catalogue
9. Questions about the applicability, the benefit, and potential uses cases of the service catalogue
10. Presenting one or two case studies
11. Questions about the benefit of methods and processes for the case studies
12. Questions about benefits, consistency, potential branches, chances, risks, strengths and weaknesses of the whole approach

The interviews consisted of alternating presenting parts of the results and asking the interviewee for feedback. The guideline for the semi-structured interviews is shown in the appendix 12.4. The interviews took between one and two hours and they were recorded for a more detailed analysis. This analysis derived the statements concerning the evaluation (applicability, added value, consistency, adaptability) criteria from the interviews. The analysis was documented in a template that is shown in the appendix 12.5. Weaknesses, strengths, chances and threats for

companies from using the models and methods were identified. This was the basis for an adapted SWOT analysis (see subsection 9.2.3).

8.2.2 Results of evaluation interviews

All interviewees understood the design support and its purpose and added value provided by this work. They consider the methods and models to be applicable in various application cases and for different users and departments. The model of customer acceptance can serve as quality criteria in every stage of PSS development, also after the market entry. The service catalogue can help marketing or sales departments to identify new ideas for services and for requirements definition. The decision-making process for PSS planning can be used as a reference process for PSS planning to measure current and real processes as they are actually implemented. The earlier all those methods are applied in the development process, the less expensive they are and the higher is the added value. Table 8-5 summarizes the statements of the **applicability** of the design support.

Table 8-5 Results from evaluation interviews (applicability)

	RQ #2: Model of customer acceptance	**RQ #3: Service catalogue**	**RQ #4: Decision-making process**
Applicability	• Broad variety of applications that is not limited, e.g. advance development, branding, as quality criteria, marketing and sales, and new product development • After market entry: for identifying weaknesses of the existing PSS, to optimize existing PSS, controlling of existing PSS • More reasonable in early phases of development • Easy to understand and use for practitioners • Requires detailed metrics for quantifying aspects • Some aspects cannot be identified in interviews/ surveys with customers/ sales managers • The temporal aspect might be underrepresented	• Usable for marketing, sales, aftersales services: defining requirements • For controlling existing PSS • As a measure to identify new services for short-term reactions on competitive products • Should be applied in early phases • Also applicable after market entry to optimize products • Usable for brand-marketing, regions • Purpose of the service catalogue might be misunderstood which might lead to misusing the catalogue • Filtering method required, because the catalogue is quite extensive	• Reference procedure for PSS planning to check current/actual processes • Marketing department, Sales department, and the development department are main appliers of this process • The earlier in the development process the better and easier applicable • Connecting infrastructure not clear enough (technical feasibility is missing) • Similar processes are already applied in many companies, different sequence (e.g. strategy fitness at the very beginning) • Granularity of processes is very reasonable • The overview of the process cannot represent the complexity of the process • Support methods are necessary • Sequence of process steps is potentially confusing

The most important statement concerning the added value for all three results is the structured way of identifying aspects of customer acceptance, finding new service concepts, and organizing the decisions within the PSS planning. The approaches were considered as holistic and comprehensive that support to consider all essential issues and prevent to forget important points. They make the company move into customer-orientation and trigger processes of new ideas. Table 8-6 shows the statements considering the **added value** of the design support.

Table 8-6 Results from evaluation interviews (added value)

	RQ #2: Model of customer acceptance	**RQ #3: Service catalogue**	**RQ #4: Decision-making process**
Added value	• Includes the levers of customer acceptance • Supports to focus on customers • Structured procedure • In early stages of development: low expenses for application, higher benefits • In later stages: more expenses for application, less benefits expectable • Different perspectives • Including obvious and non-obvious aspects • Provides consumer centricity • Eight categories are a reasonable tradeoff between detailed information and clear presentation	• Structured way for identifying service fields • Comprehensive collection of services, all relevant fields are considered • Supports to find reasons for new services, as a reasoning for implementing new services • Overview, holistic approach • Basis for brainstorming to identify new services	• Identify weaknesses of current/actual processes • Structured way for PSS planning • Requirements change: new iterations necessary, longer time to market • Including all necessary criteria • Unexperienced employees understand the whole process in short time • Integration of company's perspective into the methods and models • High efforts and time are necessary for a reasonable and sustainable implementation

The variety of companies and organizations that potentially adapt those models and methods is quite broad. All interviewees confirmed the relevance and adaptability for the branches and companies on which this work focuses. There is also no restriction concerning B2B and B2C markets. Interviewees consider even more branches as potential users of those methods and models. Almost every branch is considered as relevant (e.g. finance, services, online markets), however, other branches might need an adapted version of these models and methods. Mainly traditional small- and medium-sized enterprises are considered as taking advantage from using these models and methods. Startup companies need more agile processes and they do not have enough capacities to use those structured tools. Considering the **adaptability**, the following points were mentioned:

- Mainly focused on technical, tangible products
- Virtual products/services also thinkable (e.g. Facebook)
- No fixed restrictions for any market, product, company
- Applicable for both complex products and simple products/components
- Also thinkable for service providers
- Especially for saturated markets to extend existing markets
- Mainly for traditional companies that have not finished the process of servitization

- Basically for every kind of branches (services, product, home appliances, finance, medicine), companies, B2B, and B2C: different emphases and benefits, in principle the same
- Less advantageous for startups (methods are not agile enough), every kind of company should apply it, especially SME, the bigger the company, the higher the need for application

The interviewees considered the model of customer acceptance, the decision-making process, and the service catalogue as compatible to each other. These methods and models follow a logical structure and are a consistent procedure to increase customer acceptance. The interviewees stated the following points concerning the **consistency**:

- Methods and models are based on each other and follow a logical structure
- Methods and models can also be used individually
- Connection between service catalogue and model of customer acceptance essential, to define services' benefits, to define the focus/emphasis of a service; this can make the difference to competitors

8.3 Concluding Evaluation

The case studies (see chapter 7) and interview studies revealed potential for optimization of the design support to improve the models and methods proposed in this work. This section concludes the evaluation and discusses the requirements defined in section 3.3 in terms of the research questions RQ#2-RQ#4 defined in subsection 2.3.3. Section 8.2 provides the conclusion of RQ #1. This section deals with the question how the design support fulfills the requirements. Subsection 9.2.3 provides a more critical analysis focusing on weaknesses and threats of this work's results.

The requirement **applicability** was investigated in the case studies and the evaluation interviews. The model of customer acceptance (RQ #2) presents the aspects of customer acceptance clearly to potential users. The evaluation interviews revealed various cases of application in companies. The case studies II, III, IV, and VIII demonstrated the applicability of the categories and aspects for different companies and various application cases. The categorization of the model of customer acceptance made the broad variety of aspects easier to understand for potential users. Despite the complexity and broad range of aspects considered by this model, the categories provide a clear overview of the whole model. The categorization of the service catalogue (RQ #3) is helpful for users to get a comprehensive overview of the whole catalogue. Different cases of applications were identified, e.g. to identify new service concepts (case studies III, VI, and VIII) or to evaluate existing PSS offers (case study V). The connection to the model of customer acceptance, given by the connection matrix (see section 6.5), is also applicable for industry (case studies III and IV). The decision-making process for planning PSS supports companies to structure activities and decisions in the planning phase (case studies I, III, VI, VII). The presentation of this process is easy to understand for potential users and provides an overview of the activities and decisions that are necessary for planning PSS.

The main advantage concerning the requirement **added value** is the underlying structure that supports increasing customer acceptance using PSS. The model of customer acceptance includes relevant reasons of purchase decisions and helped companies to identify the essential aspects of customer acceptance (case studies II, III, IV, V, VIII). It enables companies to uncover unknown aspects and quantify existing aspects for different customer groups. The model of customer acceptance includes aspects known from the current state of research and is considered as a holistic model to identify all relevant aspects of customer acceptance, even on a detailed level. Furthermore, it enables companies to out-of-box thinking. Companies can identify aspects that have not considered yet. The service catalogue (RQ #3) provides an overview of services that might be offered additionally to a physical product. This catalogue is considered to be holistic and it triggers new ideas for service concepts (case studies III, IV, VI, VIII). In the case studies, the service catalogue helped product managers to find services that have not been considered before and they got an impression what kinds of services might be thinkable for their products. This catalogue is a structured way to identify service ideas that support to better argue the need for new services within companies on which this thesis is focused. The decision-making process (RQ #4) provides a structured procedure for planning PSS. Several case studies have shown (case studies I, III, VI, VII) that the process facilitates an intertwined planning of product and service elements. E.g. case study I identified problems in the communication between different departments, which is essential for a reasonable planning of PSS. The iterative character of this process makes it adaptable and beneficial to different cases of application. However, this process should include more concrete methods and models to support PSS planning in detail. Another weakness was the integration of technical feasibility that is an essential criterion for PSS planning.

The methods and models created in this work were applied in several industries and different companies (requirement **adaptability**). Essential industries this work is focused on gain benefits from using those results. The case studies showed the applicability and added value for truck industries, power tools, home appliances, construction tools, automotive industries, and skateboards. Those industries are from both B2B and B2C markets. The only part of this work that might be different for B2B and B2C markets is the top-level categorization of the service catalogue. Section 6.3 proposes two options of this categorization, while experiments result in the finding that the option *target* is beneficial for B2C markets and the option *literature* is beneficial for B2B markets. Especially the evaluation interviews have shown that the potential users of these methods and models are not limited to the potential users proposed in subsection 2.3.4. The methods and models need to be adapted to the requirements and conditions of other companies and markets. The interviewees considered other companies as potential users, too. Even though the methods and models were not tested for all branches and different companies, they are beneficial for companies on which this thesis is focused. As defined in subsection 2.3.4, this work's results mainly help small- and medium-sized companies. Smaller companies, especially startups, need more agile processes and methods for starting and improving the own businesses. Larger cooperates usually have processes implemented, the decision-making process might be less useful for them. However, the model of customer acceptance and the service catalogue also support larger companies to better focus on customers.

The **consistency** of the model of customer acceptance, the service catalogue, and the decision-making process was tested in case study III, while the consistency between the service catalogue

and the model of customer acceptance was tested in case studies IV and VIII. Case study VI showed that the service catalogue and other methods can be integrated into the decision-making process. The mechanism for increasing customer acceptance using PSS, proposed in the customer-oriented framework (see chapter 3), is the logical procedure that connects those three methods and models. The connecting matrix (see section 6.5) matched service catalogue and the model of customer acceptance. The evaluation interviews pointed out that this connection between services and customer acceptance is essential for PSS planning and this work proposes this connection. This whole procedure can be seen as an integrated way of increasing customer acceptance using PSS.

Even though several case studies and evaluation interviews have shown the applicability and added value of tools provided by this thesis, not all parts have been evaluated in detail. Some parts were created based on findings of the case studies and have not been evaluated in new case studies yet. The principle idea of the connection matrix (see section 6.5) has been evaluated in evaluation interviews and in case studies III and IV, however, the current version and all links were not part of those studies. The final version of the generic catalogue of questions for interviews and surveys is based on interview guidelines used in the case studies. However, the last version was not applied in real cases. Since the single parts of the design support focus on different cases in a company, it was difficult to find a real case from industry that requires all results from the design support on a detailed level. Case study III was the only case that was capable of testing the consistency between all parts. However, not all aspects of the model of customer acceptance were relevant for this study, neither all services of the service catalogue. This work cannot provide a long-term evaluation of the design support. To evaluate a sustainable success of applying these results, a long-term study is necessary. This long-term study must be capable of describing the success of application separated from other factors like market trends or other external factors. This success would be the long-term success of the applying company that cannot decoupled from other external factors, because the current market situation or new technologies have stronger effects on the company’s success.

9. Reflection and Discussion

This chapter reflects the procedure and the results of this work. Section 9.1 deals with the procedure of this work that is an application of the Design Research Methodology (DRM). Research methods applied in this work and alternative methods are discussed and evaluated. To discuss the results, the contribution for research and for industry will be presented. Adapting the SWOT analysis to evaluating the results of the prescriptive study reveals strengths, weaknesses, opportunities, and threats of this approach. The SWOT analyses result in measures for improving the approach and for future research.

9.1 Discussing the Procedure

The whole procedure and documentation of this work is based on the Design Research Methodology (Blessing & Chakrabarti, 2009). Applying the DRM turned out to be a structured procedure that enabled a logical reasoning throughout the whole thesis. The stages were not sequentially processed, many stages overlap with others and the procedure was characterized by many iterations between the prescriptive study (PS) and the descriptive study II (DS II). The work itself did not follow the initial sequence. The sequence was applied for creating the documentation and supported to structuring the work for the documentation.

Before discussing the single stages of the DRM, the two different work strategies are reflected: top-down vs. bottom-up. In the context of this research, the top-down approach means to define the overall goal first and going more into detail afterwards. The bottom-up approach means to start with more detailed working packages and to synthetize the detailed results to an comprehensive approach afterwards. In this work, both strategies were used: the overall target was defined and elaborated based on a top-down strategy (RQ #1: how can PSS increase customer acceptance). In contrast, the three parts of the design support (model of customer acceptance, decision-making process, and service catalogue) were created based on the bottom-up strategy. Those measures were developed independently from each other. The later stages stressed the linkages between them. This late consideration of the linkages was expensive and required many iterations, an earlier investigation of the linkage would have been more efficient.

Research Clarification

The research clarification is based on a literature review. Searching for research gaps and defining research questions was helpful for the course of the work. Furthermore, it enables to have a scientific contribution and foundation. However, this literature review is focused on approaches from the PSS research field. At this point, involving more sources from service science and marketing would have been helpful to include more ideas from different disciplines.

Descriptive Study I

The result of the DS I is the customer-oriented framework that describes the mechanism of increasing customer acceptance using PSS. Another beneficial option for creating this

framework could have been interviews with practitioners from industry. Those interviews could focus on requirements and needs from industry for PSS approaches. The interviews' results would be beneficial for creating tools and for the PS to specifically meet requirements of practitioners. This could increase the contribution for industry. Furthermore, many ideas in the PS stem from case studies and discussions with representatives from companies. However, at this stage of research, it might be too difficult to define interview questions that are capable of demanding suitable answers. Preuß (2015) conducted such an interview study. The results of this study were quite abstract and generic, e.g. that many companies have not successfully completed the PSS transition or that PSS planning requires intertwined processes and integration of more stakeholders. Those results are not helpful to identify specific industry-related requirements and ideas for the PS.

Prescriptive Study

The prescriptive study consisted of three parts, the model of customer acceptance, the decision-making process, and the service catalogue. All three parts described a recursion of the DRM even though not all detailed steps of the DRM were applied in those recursions. To ensure the scientific relevance for all three parts a review-based research clarification was conducted for all of them. Those research clarifications are not documented in this thesis, however, they are documented in other publications (Schmidt et al., 2014a; Schmidt et al., 2015c; Schmidt et al., 2015d).

Creating the **model of customer acceptance** was to identify and analyze literature that describes aspects of customer acceptance. There might be other methods than a literature review (e.g. expert interviews, customer interviews, surveys…), however, this literature-based procedure enabled a broad view on those aspects of customer acceptance. Furthermore, many ideas and results from other disciplines could be included into this work. There are also other methods for classifying the aspects, however, a workshop with the included researchers seemed to be the most efficient way, because the number of aspects was low enough for humans to handle. Automatic categorization algorithms were not considered as capable of dealing with elements that are as vague as aspects of customer acceptance.

The research clarification for the **decision-making process** turned out that there already exists a high number of approaches dealing with PSS planning processes. Since some of those approaches are already evaluated and tested in industry, it was a reasonable procedure to create a decision-making process based on other processes' elements. On the one hand, it makes the creation easier, on the other hand some parts of the process are already evaluated. Even though this process is not significantly different to existing approaches, the decision-making process has advantages compared to existing approaches concerning decision-related criteria.

The first label for the **service catalogue** was service classification because the need for a catalogue was not known at the beginning of creating the service catalogue. The service catalogue is a service classification scheme. The label service catalogue was defined after recognizing the need in industry for a catalogue. Practitioners from industry might better understand the label service catalogue and the benefit of this tool than the label service classification scheme. The Structural Complexity Management (StCM) was a beneficial approach for structuring the catalogue. Even though StCM focuses on other typical application

cases, e.g. modularization of product architecture, it was also applicable for this case. The first version of the service catalogue was created by summarizing and clustering the services by hand, which is described as pre-clustering in section 6.2. The evaluation of this first version of the service catalogue turned out that the services must be clustered based on a more systematic way. Using StCM made the reasons for clustering replicable. Another issue why manual clustering, even in a workshop with more participants and experts, is less promising is caused on the size of the service catalogue: in total 265 services had to be clustered. This number of elements was even for some software tools too high (see section 6.2). Manual clustering of 265 elements is a task that humans are not able to handle without methodical and software support.

Descriptive Study II

The DS II consisted of several case and interview studies. The case studies were partly conducted in parallel to the PS that was beneficial for including insights from cases into the PS. After every case study, some parts of the PS were changed based on new information acquired in the cases. The cases have shown that users of the models and methods need experience and knowledge in product management and/or knowledge about services for properly using the methods and models. The case and interview studies have shown that practitioners from industry do not know the term PSS. After a short explanation, they understand the concept of PSS, however, the usage of other terms than PSS would have been more successful. There are terms like added value service, service solution, or servitization. Those terms might not be the same from the scientific perspective, however, they make the concept of PSS easier to understand for practitioners from industry and increases the acceptance of practitioners to use PSS approaches. Time pressure influenced the way of working within the case studies and the application of the design support. A longer lead time would have been beneficial for structuring the case studies. The interviews #B were conducted at the very end of this work. It was very helpful to prepare a structured presentation of all results and to get feedback from different perspectives. This feedback helped the author to better reflect the work's results and get inspirations for defining the contribution of this work.

One critical point of the descriptive study II is that most case studies or interview studies has not integrated customers directly. Even though customer acceptance is a central topic of this work, the DS II has asked some of them personally (case VI and interview study #A). This work proposes fundamentals of customer acceptance: direct integrating of customers would be beneficial for evaluating this work's results. However, this step from fundamentals to direct customer integration would be another extensive work package that exceeds the limits of this dissertation. New methods and measures have to be developed that are based on the fundamental results of this work. This work mainly focuses on the company-view on customer acceptance. This work supports employees that are working with customers (e.g. sales or marketing departments), therefore, case studies supporting those employees without direct customer integration are sufficient for an evaluation. Since direct customer integration is based on individual customer preferences and needs, companies need to have an overview about all customers or about the average of customers and this is what this work is looking at: instead of satisfying needs of individual customers, this work supports companies in increasing customer acceptance for their target group. The reason why just one of the case studies integrated customers directly relies on the fact that companies are not allowed transferring data of

customers to third persons. For this reason, only case study VI (university project) and interview study #A (potential customers were asked independent of the companies) were the only studies of DS II that have directly integrated customers.

9.2 Discussing the Results

After discussing the application of the DRM as a procedure of this work, the results of the work are reflected. This section first deals with the contributions from scientific and practical perspectives. To provide a comprehensive discussion of the design support, an adapted SWOT analysis considers the strengths, weaknesses, opportunities, and threats of the approach. At the end, potential for future research and measures for improving the approach are proposed.

9.2.1 Contribution from the Scientific Perspective

There are some approaches in literature dealing with PSS and the customer-view (see subsection 2.2.3), because the approach PSS is capable of providing benefits for customers. However, just a few approaches deal with the specific topic customer acceptance. Most existing approaches investigate the weaknesses of PSS concerning customer acceptance. This work first provides concrete measures how PSS should be planned to increase customer acceptance.

Customer-oriented Framework for PSS development

The customer-oriented framework for PSS development describes the principle mechanism this work is based on: starting from the target customer groups, relevant aspects of customer acceptance are identified. Those aspects are quantified and considered in planning PSS. This framework outlines this mechanism and includes the surrounding context (strategy space) as well as the relevant fields of action (customer layer, customer aspects layer, and solution layer). Besides describing this mechanism, the framework helps to locate support methods. To define the purpose and the aim of methods that support this mechanism, the framework is capable of clarifying the fields those methods support.

Model of Customer Acceptance

The novelties of the model of customer acceptance compared to other approaches are the branches focused by the model, the PSS relevance, the broad coverage, and the way of categorization. This work does not provide any new aspects of customer acceptance; it is a collection of existing aspects. It is as broad collection of various aspects that are structured and summarized to one model. This model might be beneficial for other approaches or methodologies dealing with product or PSS design that focuses on customer acceptance. The kind of categorizing and summarizing the aspects to one model is new. The main purpose in structuring the aspects was to make them easy to understand. While other approaches categorize aspects according to Rogers (2003) or without any systematic, this work's categorization is beneficial for practitioners. Since research about customer acceptance is mainly located in other disciplines than engineering (e.g. service science, computer science, marketing), this model represents a novelty for complex technical products and for engineering branches. Especially the abstract level of aspects of customer acceptance (not focused on one specific product) and

the relevance for B2B and B2C markets makes this model unique. Since the branches and products this model is focused on overlap with typical products and branches of PSS research (see subsection 2.3.4), this model is particularly suitable for integration into PSS approaches.

Decision-making Process for Planning PSS

The difference of the decision-making process for planning PSS to existing approaches is not as significant as other results of this work because it is based on existing approaches.

In contrast to other approaches, this process considers decision-related issues. The planning phase consists of many decisions and a planning process has to suit those decisions. Decisions in planning PSS deal with various issues (e.g. requirements, PSS concepts) and they require various information (e.g. state of the art) at different stages in the planning process (e.g. after creating the first version of the requirements list). The decision-making process structures the decisions concerning the decision object, the information required for decisions, and the stage in the planning process. This is included in the structure of the decision-making process that consists of three main parts and three decision points. This structure is the main difference to existing approaches for planning PSS, while the activities covered by the decision-making process are also included in existing approaches. In total, the process depicts an improvement of existing planning processes concerning decision-related issues. However, the total contribution of this decision-making process is smaller in comparison to other methods and models of this work, because it is only a small step forward compared to existing approaches.

Service Catalogue

The service catalogue is a collection of existing service offers that are documented in literature and industry. It can also seen as a classification scheme for services that classifies services concerning their performance range and the customer functions. There are none approaches that classify services according to the customer functions. The service catalogue can support PSS approaches dealing with customer-orientation. Other approaches that classify services or that provide a collection of services are on a more abstract level. The high number of services considered by this service catalogue provides a broad and detailed coverage of possible services. Structuring the service catalogue using StCM created a structure that is easy to understand. This catalogue can also be seen as a library for PSS design. The catalogue was integrated into other scientific projects as a design library. Kruse and Shea (2016) have implemented the catalogue as a library for model-based mechatronic concept design in SysML (Kruse & Shea, 2016).

Case Studies

The main contribution from the case studies refers to the results of the PS. They helped to make the methods and models more compatible for industry and easier to understand and use for practitioners. Based on the case studies, more possibilities for applying the methods and models were identified. Furthermore, the case studies revealed practical issues that are relevant for a scientific investigation (see subsection 9.2.4).

Interview Studies

While the interview studies #B and #C focus on evaluating the results of the PS, the interview study #A deals with the research question (RQ #1) if PSS are capable of increasing customer acceptance, especially for product innovations. Based on the attributes defined by Rogers (2003), the interview study comes to the conclusion that PSS can increase customer acceptance concerning five of those attributes. The attribute compatibility is considered to be critical concerning PSS and its effects on customer acceptance of product innovations.

9.2.2 Contribution from the Practical Perspective

This subsection presents the benefits for applying companies and potential users and propose use cases. It focuses on the results that are relevant for industry, i.e. the model of customer acceptance, the decision-making process, and the service catalogue.

Model of Customer Acceptance

The model of customer acceptance helps companies to understand underlying reasons for purchase decisions. The model supports several cases in the company. In early phases of new product development, it serves as a target to declare the important aspects the PSS should aim to. During the whole planning and development process, the aspects of customer acceptance can be used as quality criteria to control the customer-centric of the PSS. After market entry, the model of customer acceptance supports to find out why a product or PSS has failed. Since the flexible service part of PSS can be easily changed, adapting the PSS can increase market acceptance after market entry. Product managers, sales managers, employees of marketing or quality are potential users of the model of customer acceptance. The detailed description of the aspects, the generic interview guideline and the generic survey are tools that are easy to use to identify relevant aspects of customer acceptance. The quantification method supports companies in evaluating the relevance of aspects of customer acceptance.

Decision-making Process for Planning PSS

The decision-making process helps companies to structure their activities and decisions for planning PSS. Companies can use this process to plan the decisions that have to be made during the planning phase. While the capacities of decision-makers in companies is limited, this process proposes three main decisions points that can be organized at the starting point of the planning phase. This enables users to plan the integration of decision-makers from the beginning and to make sure that relevant decision-makers are aware of important decisions that have to be made. The process also helps them to define information that is necessary for decision-making. It provides a kind of a checklist for every decision point and helps users to not forget important information in preparing the decisions. Larger companies already have implemented planning processes, however, those are usually only fixed to tangible products or services only. Those product or service planning processes are similar to the process proposed by this work. Using the decision-making process for planning PSS can help those companies to better connect product and service elements to each other and to enable cooperations between departments that are responsible for both product and service elements. Especially smaller and

traditional companies that have not defined a planning process gain benefits from using this process. Potential users are product managers, product planners (e.g. from strategy department), process managers, or sales managers.

Service Catalogue

The initial purpose of the service catalogue is to support companies in identifying new services. By providing a broad collection of services that might be offered additionally to products, users get an overview of the solution space. However, the service catalogue is more than just a checklist to identify new services. It proposes areas that might be promising for new services. Since the catalogue is structured into different levels of abstraction, the elements in the more abstract layers suggest service fields. These service fields can trigger the development of new services. The service catalogue can also serve as an evaluation measure to check a PSS concerning its service broadness. This reveals potential for optimizing PSS. The connecting matrix matches the model of customer acceptance and the service catalogue. This matching is a selection support to choose services with higher potential to increase customer acceptance. It also helps companies to find the customer-related target of services. The services implemented in PSS should focus on certain aspects of customer acceptance. Analyzing the target of real services enables customers to identify weaknesses of those real services. Users of this catalogue can be product managers, PSS planners (e.g. from strategy department) sales managers, or employees from marketing, controlling, development, or quality.

9.2.3 Strengths, Weaknesses, Opportunities, and Threats

This subsection provides the overall reflection of the design support. The SWOT analysis (strengths, weaknesses, opportunities, threats) is a strategic measure to connect external factors and internal factors by defining strengths (internal), weaknesses (internal), opportunities (external), and threats (external) (Robson, 1994). This method is adapted to reflect this work's results in order to identify potential for optimization: instead of analyzing the strengths and weaknesses of a company, this work's SWOT investigates the strengths and weaknesses of the design support. A classic SWOT acquires opportunities and threats a company might have emerging from external settings. The adapted SWOT looks at opportunities and threats a company might have because of applying the design support of this work. Those differences between the classic SWOT and the SWOT adapted to this work are shown in Table 9-1.

Table 9-1 Comparison of a classic SWOT with the adapted version

Classic SWOT	**Adapted SWOT**
Strengths of an organization (internal factors)	Strengths of the design support
Weaknesses of an organization (internal factors)	Weaknesses of the design support
Opportunities for an organization (external factors)	Opportunities a company has because of applying the design support
Threats for an organization (external factors)	Threats a company has because of applying the design support

The SWOT analysis includes the helpful drivers of the design support (strengths) and of applying the design support (opportunities). The harmful points of the design support are given by the weaknesses and the threats describe the harmful issues of the application. The SWOT is based on the results of the interview study #B, the case studies and further analyses.

SWOT Analysis of the Model of Customer Acceptance

The model of customer acceptance is considered as a holistic approach that covers all relevant aspects of customer acceptance. This enables companies to identify unknown reasons or causes why customer do not buy a product. However, the detailed granularity might confuse users in applying the model. Wrong evaluations of the importance of aspects might bias the targets of PSS planning. Figure 9-1 shows the results of the SWOT analysis of the model of customer acceptance.

	Helpful	**Harmful**
Approach	**Strengths** • Enables out-of-box thinking • Holistic approach, provides a broad variety of aspects • Easy to understand and easy to use	**Weaknesses** • Very detailed granularity • Detailed analysis might be too complicated for practitioners • Rough quantification scheme
Application	**Opportunities** • Identify unknown reasons and causes of insufficient customer acceptance • Defining the customer as the target • Analyzing aspects leads to new service ideas	**Threats** • Misunderstanding aspects • Some aspects might be difficult to understand • False quantification leads to defining false targets for PSS planning

Figure 9-1 Adapted SWOT analysis of the model of customer acceptance

SWOT Analysis of the Decision-making Process

The decision-making process includes all relevant steps and activities that are necessary for planning robust PSS concept. This facilitates companies' more reliable and more customer-oriented decision-making. The technical feasibility should be more considered in the process and the application of the process might become too expensive if companies increase the customer integration. Figure 9-2 shows the results of the SWOT analysis of the decision-making process.

	Helpful	Harmful
Approach	**Strengths** • Iterative character • Recurring reflection in each decision point increases the reliability of decisions • Suitable measure for engineers and unexperienced designers • Includes relevant steps and activities • Sequence is based on a logical order • Easy to understand and easy to use	**Weaknesses** • Technical feasibility and communication to production not sufficiently considered • Process model not sufficient: further methodical support required • Communication between different stakeholders and departments not sufficiently considered • Implementation needs further support than just an overview
Application	**Opportunities** • Managing great quantity of information that is necessary for reliable decisions • Decisions are more reliable and more customer-oriented • Revealing uncertain requirements • Planning the planning process and decisions	**Threats** • Extended integration of customers might increase efforts for communication and the amount of information • Implementation is the actual challenge that can easily go wrong • Too early feedback from customers might destroy promising ideas

Figure 9-2 Adapted SWOT analysis of the decision-making process

SWOT Analysis of the Service Catalogue

The service catalogue provides a broad view of potential services and it helps companies to identify relevant fields for identifying innovative services. The service catalogue is just a snapshot of current markets: changing market conditions require updating the service catalogue. Applying the service catalogue can restrict the creativity because concrete services are determined that might prevent applying practitioners in thinking about innovative service concepts. Figure 9-3 shows the results of the SWOT analysis of the service catalogue.

	Helpful	Harmful
Approach	**Strengths** • Holistic overview of possible services • Support in selecting suitable services • Easy generation of service ideas • Easy to understand and easy to use	**Weaknesses** • Service catalogue is not a detailed step-by-step procedure but a support for identifying fields of services as a creativity method • Specified industries focused, not applicable to other • Temporal limitation: changing market conditions make it necessary to update the catalogue
Application	**Opportunities** • Optimizing services and PSS • Adapting services and PSS to aspects of customer acceptance • Identifying relevant fields of service innovations	**Threats** • Restricting the creativity in designing new services • Misunderstanding services (especially distinguishing between B2B and B2C services) • Wrong application • Purpose of service catalogue must clear for appliers to enable a correct application

Figure 9-3 Adapted SWOT analysis of the service catalogue

SWOT Analysis of the Comprehensive Design Support

The overall approach provides a logical procedure and assists practitioners in structured working. It facilitates companies' including various perspectives and to focusing on customers. Companies might identify new aspects that have not considered before. The design support enables companies to better distinguish themselves from competitors. Users who are from non-engineering background might have problems in understanding the procedure because it is made by and for engineers. There are other aspects, e.g. emerging from organizational aspects (e.g. mindset of, employees) that might hinder the implementation of a PSS that was developed using the design support. Furthermore, the mostly theoretical considerations might decrease the relevance of practice for employees in companies. Figure 9-4 shows the results of the SWOT analysis of the comprehensive design support.

	Helpful	Harmful
Approach	**Strengths** • Useful assistance for structuring processes • Providing a structured procedure, a guideline • Following a logical structure of identifying and analyzing weaknesses to reveal potential for improving and creating concepts to overcome those weaknesses • Procedure is logical for people from engineering background • Transferability to other companies/branches • Granularity is reasonable and makes the methods and models easy to understand and use for practitioners • Consideration of all relevant domains: customer, product/service, company	**Weaknesses** • For non-engineering background (marketing, sales) potentially difficult to understand • Consideration and evaluation of the whole PSS concept should be more focused • Neglecting other aspects than customer acceptance and services that are potentially important for product's success
Application	**Opportunities** • Identifying new aspects/issues/potential that have not considered before • Including more perspectives • Provide and ensure customer centricity • Distinguish from competitors • Trigger processes for optimizing and focusing on customers • Trigger creativity processes • Companies that are not focused by this work (e.g. service companies, organizations providing services, online market) might also use this approach • Accelerate processes • Continuous improving processes and methods based on experiences from industry can increase the benefit of this approach • Setting the focus on early stages of PSS development, improving the PSS concept • Diverging from technical aspects, more focusing on customers	**Threats** • Getting lost in details • Too much theory might reduce the relevance of practice • Too theoretical implementation might fail • Acceptance of stakeholders (especially internal) involved in PSS development • Methods support on a second step in the servitization process: before applying these methods, the mindset of employees must fit the PSS ideas and employees from different departments must be motivated to work together • For other companies that are not focused by this work: application and benefit not clear • Structure might influence and limit the creativity, because fixed solutions are suggested

Figure 9-4 Adapted SWOT analysis of the comprehensive design support

9.2.4 Measures for Optimization

Since the SWOT analyses have revealed potential for optimization, this section proposes measures to improve the design support. Based on the threats and weaknesses of the SWOT

analysis measures and ideas for improving the methods and models and for future research are suggested.

Model of Customer Acceptance

The categorization of the model of customer acceptance is helpful for potential appliers and makes the model easy to use and easy to understand. However, it includes many detailed aspects from various disciplines and research fields. The way of presentation in the detailed descriptions might be too abstract to understand all aspects in detail. There might be other and more detailed descriptions that makes those aspects easier to understand. The case studies have shown that more than one aspect is relevant for a product or a market. Thus, quantifying the relevance of aspects of customer acceptance is essential to define a reasonable target for PSS planning. This work proposes a rough quantification method to evaluate this relevance of aspects. This quantification scheme was beneficial for the case studies. However, the literature provides other methods for quantification that might be more exact (see section 6.6). Even though those approaches are not focused on weighing the relevance of aspects of customer acceptance, they might be applicable for this evaluation. To improve the accuracy of quantifying the aspects of customer acceptance, existing methods from literature should be adapted or a new method should be developed for quantifying those aspects.

Since the categories of the model overlap, similar aspects are mentioned in different categories (from different perspectives). There are many interdependencies between aspects from different categories that have not identified and analyzed yet. To give an example, the sunk-cost-effect can be seen as a psychological phenomenon but also as an aspect of change costs emerging from planning a purchase. Investigating those interdependencies might help to better understand the aspects of customer acceptance. Furthermore, the process of identifying and quantifying the aspects for a real case can benefit from those findings. Analyzing those interdependencies can be conducted by comparing all aspects or by analyzing the matrix created in section 6.5; if aspects are positively influenced by similar services, there might be a connection.

Decision-making Process for PSS Planning

The technical feasibility of the PSS is not on a prominent position in the decision-making process. It is partly considered in the step *connecting infrastructure* and it is a decision criterion for the decisions within the planning phase (Schenkl et al., 2013c). However, instead of the step *product-related services*, a further investigation of the technical feasibility might be beneficial. However, this depends on the applying company because some might use the technical feasibility as one of the decision criterion at every decision, while other companies need an extra meeting or decision point to evaluate the technical feasibility. Based on the technical feasibility, the communication to the production is not highlighted in the process. The process does not include the communication and information flow between involved departments. Since the integration of all relevant stakeholders and the communication between departments is one of the challenges of PSS transition (Hou & Neely, 2013; White et al., 1999), this issue should be further studied. A rough study is provided in the case study I, that came to the conclusion to integrate departments like development, rental, or styling earlier in the PSS planning. Another

measure for optimization would be to find practical methods for customer integration. The process model keeps the issue of customer integration quite abstract, there is still need for research. The process models just activities and decisions of the planning phase. However, further methods are necessary to support PSS planners. This work has shown that the decision-making process is adaptable to other methods and models, e.g. to the evaluation of uncertainties (Schmidt et al., 2015a) or the business model canvas (Osterwalder & Pigneur, 2010) that was applied in two case studies (Felber, 2016; Hofbauer, 2016; Nguyen, 2016; Schmidt et al., 2016b). Since the PSS planning needs a consistent information management, there is also a need for a comprehensive PSS model including relevant information from the planning phase. Based on current market trends, like big data or industry 4.0, those PSS models need to be adaptable to new market conditions, e.g. to cloud solutions.

Service Catalogue

The main purpose of the service catalogue is to identify potential fields of new services, however, it could be misunderstood as a concrete checklist that proposes services. This concrete checklist would mean that the services identified should be implemented as they are described in the catalogue. To prevent this misunderstanding, the presentation and the conception of the service catalogue might highlight the actual purpose. To improve the categorization can also help in this issue, because the categories are the first layer the user comes in touch while using the catalogue. The validity of the service catalogue is temporally limited because companies might offer different and new services in ten years. This issue can be overcome by updating the service catalogue to a current collection of services. Since this work also describes the procedure to create a service catalogue, this update is not expensive (see section 6.2). This service catalogue is focused on companies, products, and markets as they are described in subsection 2.3.4. The evaluation interviews turned out that this concept of a service catalogue might be applicable for other companies. There is need of research to create such an adapted service catalogue and to investigate its benefit. Since the service catalogue includes a limited number of existing services, it can serve as a barrier for creativity. If users only take the services mentioned in the catalogue into account, they are not able to find new and innovative services. This requires measures to create innovative services. A promising approach for identifying innovative services is currently developed at the chair of product development: the results of an FMEA (Failure Modes and Effects Analysis) include problems and issues user might have in using the product. Based on those issues, new and innovative services can be identified and developed to support users and to provide benefits additional to the product.

Overall Approach

The approaches proposed by this work are made for engineering companies, however, they might be applicable for different companies from other industry branches. One option for future research would be to investigate the fitness to other branches. This can happen by conducting case studies in those businesses and adapt the approaches to those businesses. Those case studies should reveal the benefits and costs for applying the measures for those companies. Besides industrial businesses, other organizations providing services are potential users of these results, e.g. hospitals or public authorities. Even though they do not focus on selling products or PSS, they are interested in providing services that are convenient for their customers.

The methods and models proposed by this work focus on companies that are willing to perform the PSS transition. Before companies can successfully apply those measures, they need to change their mindsets and strategies for the PSS transition. There might be still need to support companies in motivating their employees for overcoming challenges arising from the PSS transition. Especially the cooperation between different departments must be improved and methods to increasing the cooperation need to be created.

This work mainly focuses on the product and service parts of PSS to increase customer acceptance. The business models and the corporate strategy are essential levers for increasing customer acceptance. To support companies in increasing customer acceptance, the development of business models and the definition of the corporate strategy could be connected to the model of customer acceptance. Matching the model of customer acceptance to the morphological chart of business models proposed by Lee et al. (2011) could be a measure to support companies in identifying suitable elements for the business model. This approach was preliminary implemented by Curraj (2016). Matching strategic options (Gausemeier & Plass, 2014) with the model of customer acceptance supports the definition of a corporate strategy and helps companies to focus on customer acceptance on a strategic level. This procedure is further described by Huthmacher (2016) and Wibowo (2016).

Another issue that should be further investigated is the acceptance of company's employees. To adapt the measures proposed by this work and to perform the PSS transition they need to change their work and their behavior. Especially employees of traditional companies might not be motivated to change their daily routine. There is a challenge to persuade those employees to support the PSS transition. Future research can focus on potential obstacles of employees using PSS methods and supporting the PSS transition. Based on those obstacles, measure and strategies must be defined to overcome those barriers.

The design support is based on the current market context of engineering companies. This market context will change in the future. The Federal Ministry of Education and Research of Germany created the term "Industrie 4.0" that describes the strategic trend to cross-linked production systems. This strategy has strong influences on PSS planning and the context of PSS. In a world of Industry 4.0, PSS must meet the requirements of networked systems and individualized products. The methods and models supporting PSS development and planning need to get along with these changing conditions. This is a broad field for future research dealing with PSS. A further investigation of opportunities and risks of Industry 4.0 in product development is given by Novak (2015).

10. Summary and Outlook

This chapter provides a summary of this work's results. The outlook proposes recommendations for future research by prioritizing the measures for optimization (see subsection 9.2.4).

10.1 Summary

Aspects of customer acceptance affect the purchase decisions of customers. The approach of Product-Service Systems (PSS) is capable of influencing those aspects of customer acceptance. This work provides a framework and three tools to enable companies to plan PSS on order to increase customer acceptance: the model of customer acceptance describes and presents aspects of customer acceptance, the decision-making process includes and structures the activities and decisions of the PSS planning phase, and the service catalogue supports PSS planners in identifying suitable services.

The **customer-oriented framework** consists of three layers and describes the fundamental mechanism on which this work is focused. Based on the target customer groups (customer layer), relevant aspects of customer acceptance have to be identified and quantified (customer aspects layer). PSS planning considers the relevant aspects of customer acceptance to increase customer acceptance (solution layer). The model of customer acceptance supports the customer aspects layer, while the decision-making process and the service catalogue operate in the solution layer.

The **model of customer acceptance** structures a broad variety of aspects of customer acceptance into eight categories: values and beliefs, unawareness of needs, trust, psychological phenomena, perceived complexity, costs and prices, interoperability, and reliability and availability. The aspects stem from literature and describe drivers and barriers influencing customers' purchase decisions. This model supports sales managers, product managers, or the marketing department in identifying and quantifying relevant aspects of customer acceptance. The aspects included in this model also serve as quality criteria ensuring that the PSS development orients itself towards customer acceptance.

The **decision-making process** structures the activities and decisions needed for PSS planning. It consists of three stages: requirements clarification, concepts generation, and concepts evaluation. The decision points after each stage summarize the decision objects and the information that is needed to make reasonable decisions. The process has a strong iterative character and the sequence of activities proposed by this work varies based on the application case. The process includes activities from the first idea to the final PSS concept that is the input for the embodied design. The process supports product managers or process managers in structuring the planning phases or the processes of advanced development.

The **service catalogue** is a collection of services identified from literature and real offers from industry. Since a list of those 265 concrete services is not easy for practitioners to understand, a clustering algorithm was used to show a hierarchical structure of the catalogue consisting of four layers. The concrete services are summarized to 65 service clusters, 19 superclusters, and

four categories: Services Supporting Consumer Customer (SSC), Services Supporting Business Customer (SSB), Services Supporting Product (SSP), and Services Supporting Outcome (SSO). Matching the model of customer acceptance with the service catalogue is a decision guide for selecting customer-oriented services. The service catalogue supports product managers or service engineers in identifying suitable service ideas or fields of action for finding new services.

For the **evaluation** of the results, eight case studies and three interview studies checked the design support for applicability, added value, consistency, and adaptability. The case studies dealt with products like automobiles, trucks, home appliances, lawn mowers, and construction tools. In those cases, the model of customer acceptance, the decision-making process, and the service catalogue were adapted to the underlying situation and applied to create new PSS concepts for increasing customer acceptance. Final evaluation interviews with experts from industry and science analyzed the strengths, weaknesses, opportunities, and threats posed by this work's results (SWOT). The interview came to the conclusion that the methods and models are beneficial for a broad range of industries and are capable of supporting product management especially. Another interview study with representatives of car-sharing companies and potential users of car-sharing systems confirmed the underlying hypothesis of this work: PSS can increase customer acceptance.

10.2 Outlook

To support companies in increasing customer acceptance, this approach should be extended to business models and corporate strategy. The business model and the corporate strategy are powerful levers for performing the PSS switch and for increasing customer acceptance. Delineating implications for the business model development and the strategy definition, based on the model of customer acceptance, can help companies to orient their business and strategy towards customer acceptance. PSS transition is considered to be a strategic approach (Manzini & Vezzoli, 2003); therefore the strategy definition is essential for companies that want to evolve from a product seller to a PSS provider. Basic ideas for connecting the strategy and business model to customer acceptance are proposed within this work (see subsection 9.2.4), in (Huthmacher, 2016), and in (Wibowo, 2016).

This work proposes methods and models to support companies in planning PSS. This PSS switch also requires changes in the organizational structure of the companies applying the methods (Vandermerwe, 1990; White et al., 1999). Those changes refer to information flows, communication, and cooperation between different departments. Furthermore, it might be necessary to merge departments or create new divisions. There is still a need for research to support companies in this organizational PSS switch. Changing employees' mindsets to enable the PSS switch at their level is strongly connected with this organizational switch. Employees must be motivated and convinced of the advantages and benefits of the PSS transition (Vandermerwe & Rada, 1988).

Industry 4.0 describes the trend towards more automatization in manufacturing. Cyber-physical systems are interlinked with each other, with people, and with processes. The effects are not limited to manufacturing industries only; they also influence their customers and suppliers. In this context, PSS need to fulfill changing requirements. Industry 4.0 includes new technologies,

e.g. cloud-solutions, RFID, or embedded systems. Models and processes of PSS development need to promote those technologies. There is a need for research to provide the tools, models, and processes of supporting technologies for the changing requirements of Industry 4.0.

This approach was developed for engineering companies. Companies from other industries might also benefit from adapting and applying those methods and models. Future research can focus on adapting these approaches to make them applicable for organizations from other fields. Case studies in other fields can reveal the requirements for adapting these approaches. The procedure for creating the service catalogue could be applied to services of those organizations to provide a catalogue that includes a broader area of services. This service catalogue would be a more generic catalogue that could be also beneficial for engineering companies.

The model of customer acceptance, the decision-making process, and the service catalogue are measures that companies can use for short-term projects. They can also embed those measures into the company's organizational structure to enable the PSS switch focusing on customer acceptance on a long-term basis. The duration of the case studies presented in this work were between half a year to one year. Embedding those measures into company's structure could mean defining the aspects of customer acceptance as quality criteria which every product or service idea has to pass before further development or implementation. They could be used as long-term controlling measures to enable long-term company success. Future research can deal with the issue of making those measures fit for long-term embedding into companies. Long-term case studies need to evaluate the efforts and success of these measures.

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12. Appendix

12.1 Abbreviations

CA	Customer acceptance
DMM	Domain-mapping matrix
DRM	Design research methodology
DS I	Descriptive study I
DS II	Descriptive study II
DSM	Design structure matrix
EV	Electric vehicle
HP	Hewlett Packard
MDM	Multiple-domain matrix
NPD	New development project
POS	Point of sales
PS	Prescriptive study
PSS	Product-service system
RC	Research clarification
RQ	Research question
RSP	Receiver state parameter
SME	Small and medium-sized enterprises
SSB	Services supporting business customer
SSC	Services supporting consumer customer
SSO	Services supporting outcome
SSP	Services supporting product
StCM	Structural complexity management
SWOT	Strengths, weaknesses, opportunities, and threats

12.2 Detailed Description of the Categories of Customer Acceptance

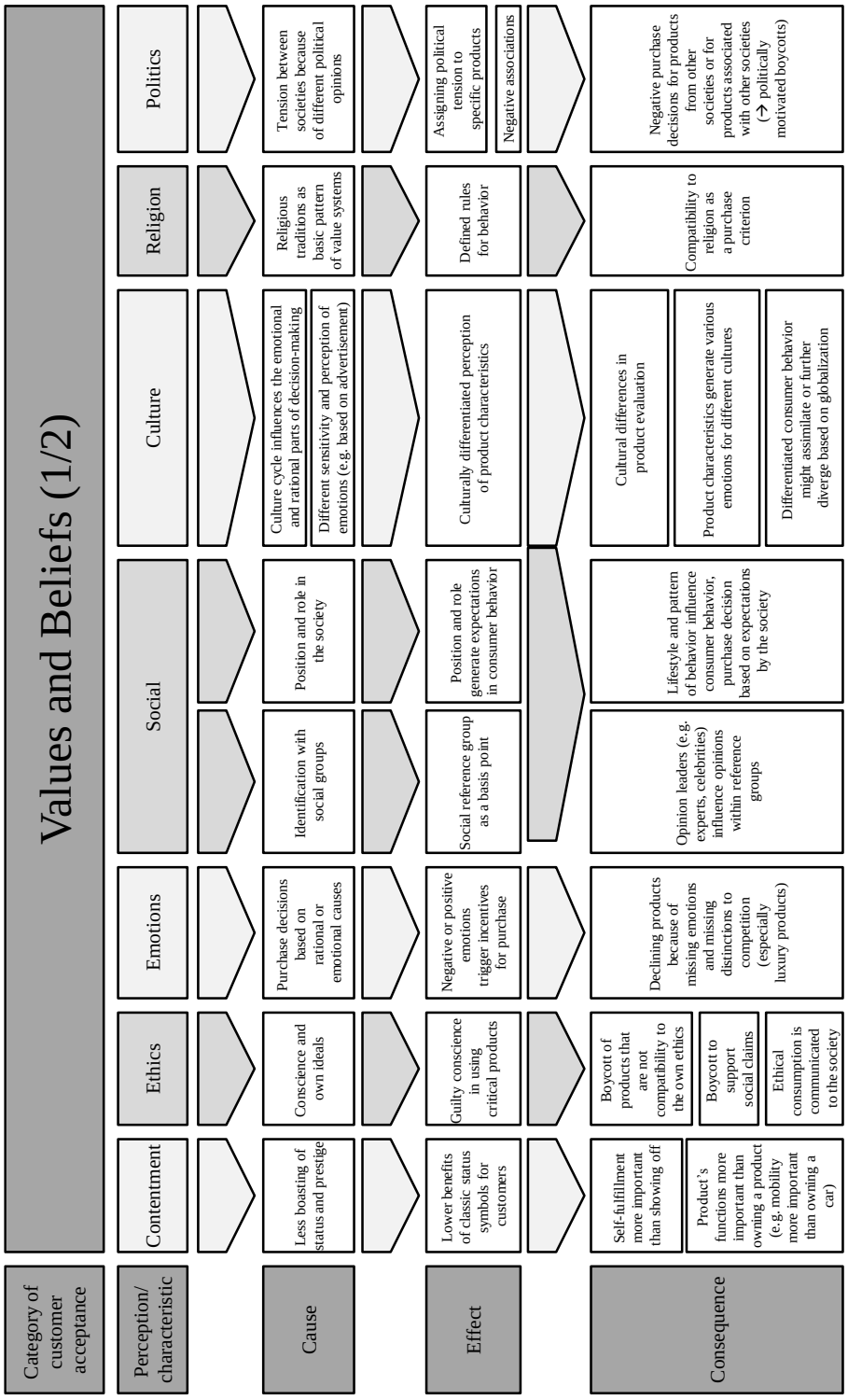

Figure 12-1 Aspects of values and beliefs (part 1 of 2)

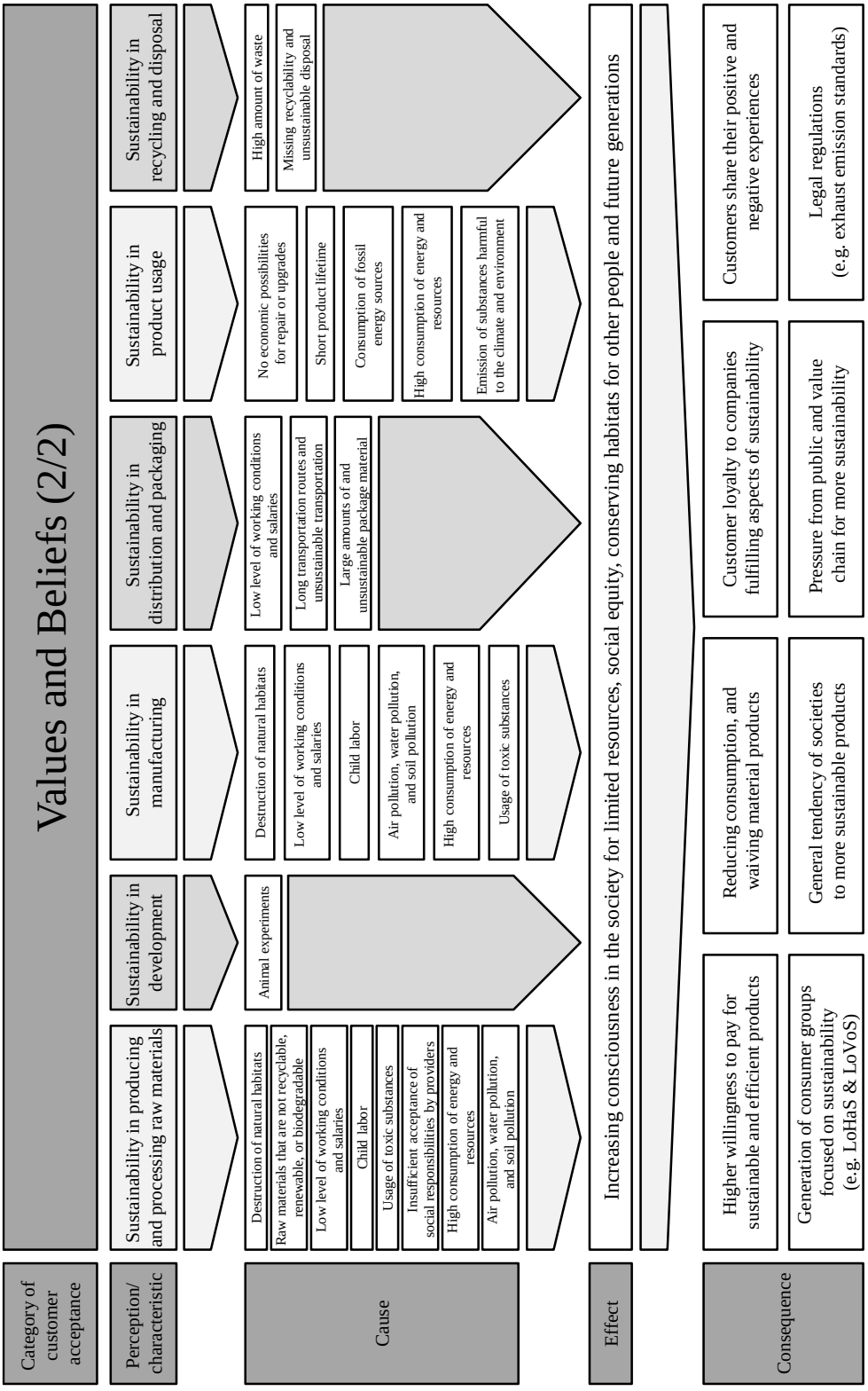

Figure 12-2 Aspects of values and beliefs (part 2 of 2)

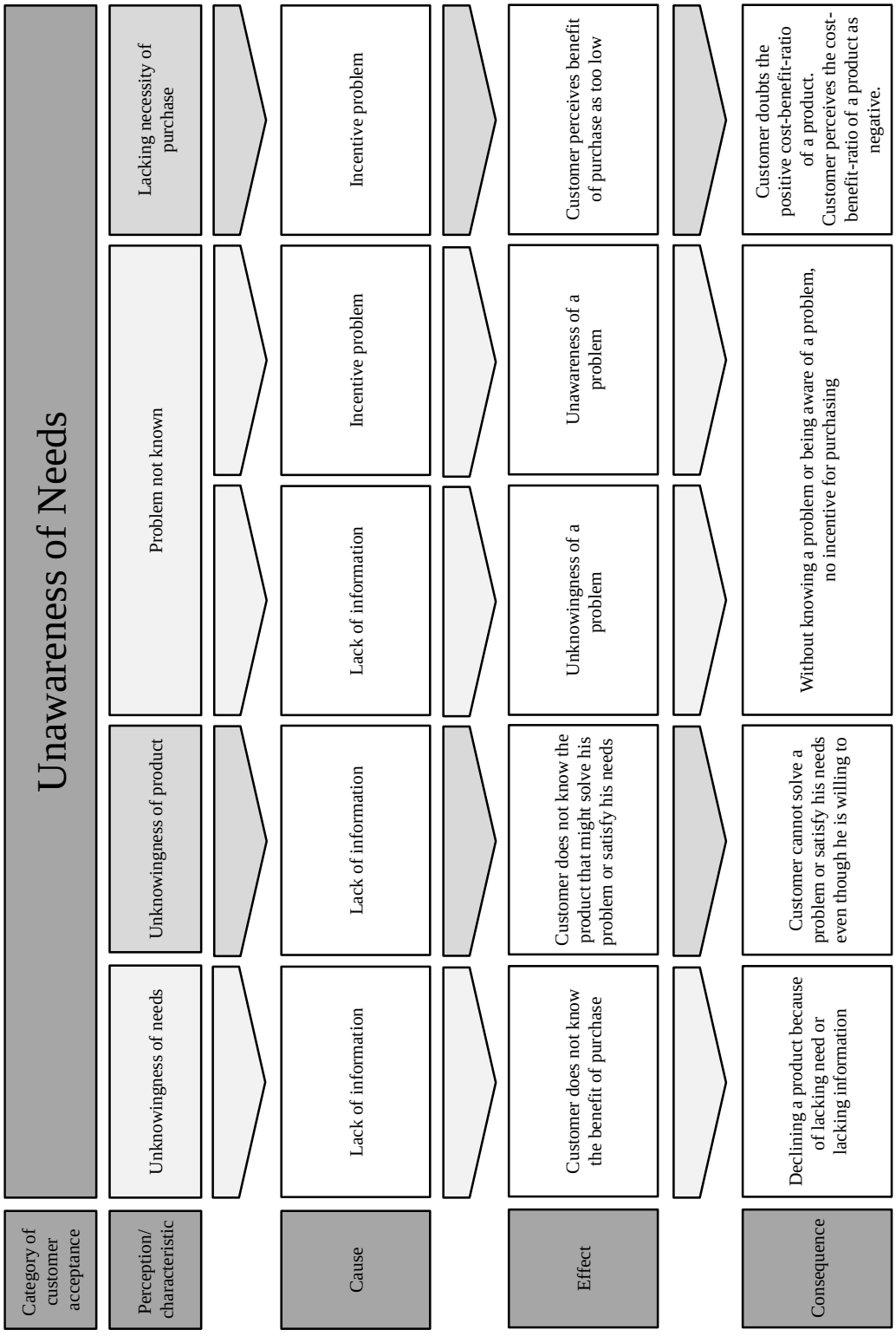

Figure 12-3 Aspects of unawareness of needs

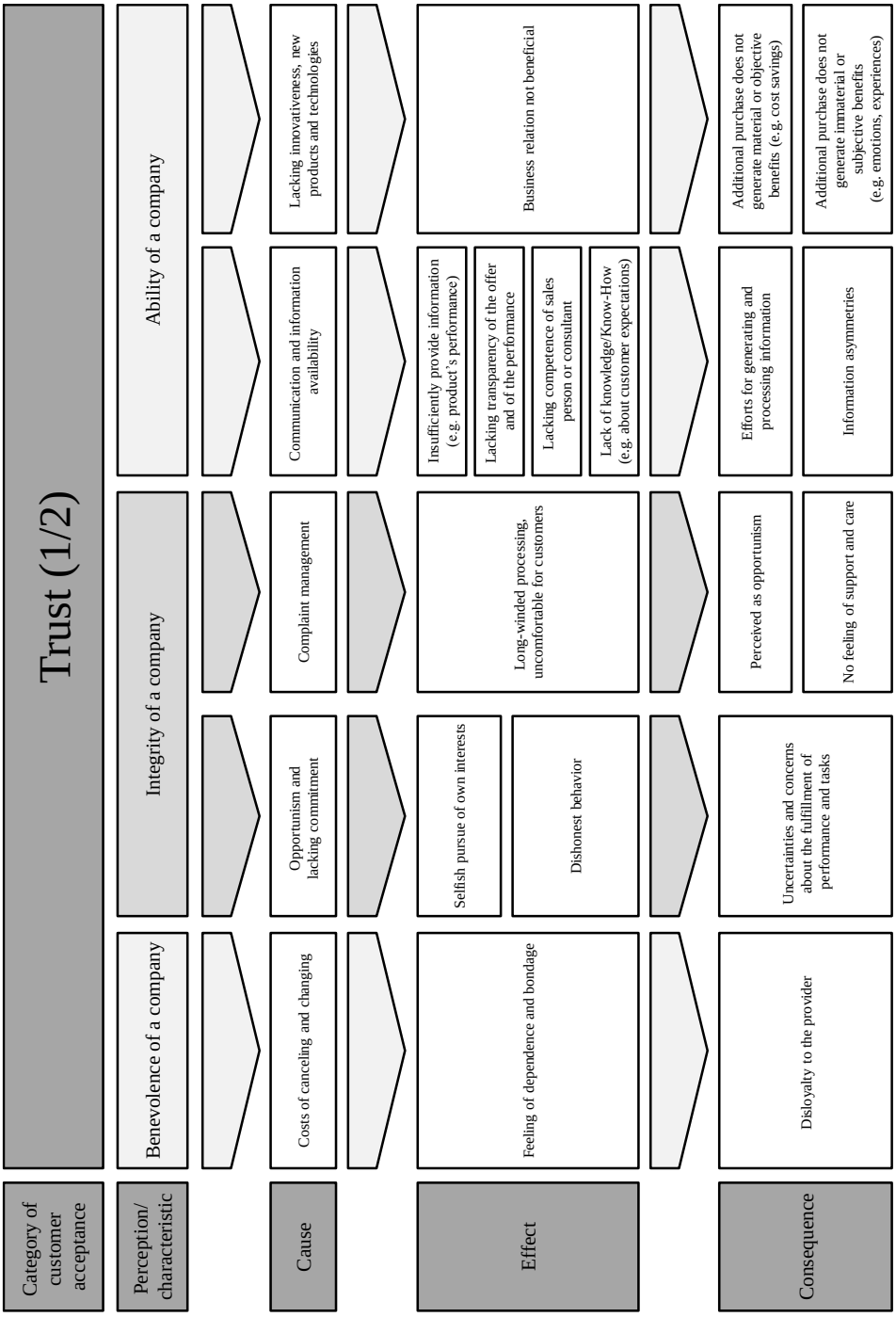

Figure 12-4 Aspects of trust (part 1 of 2)

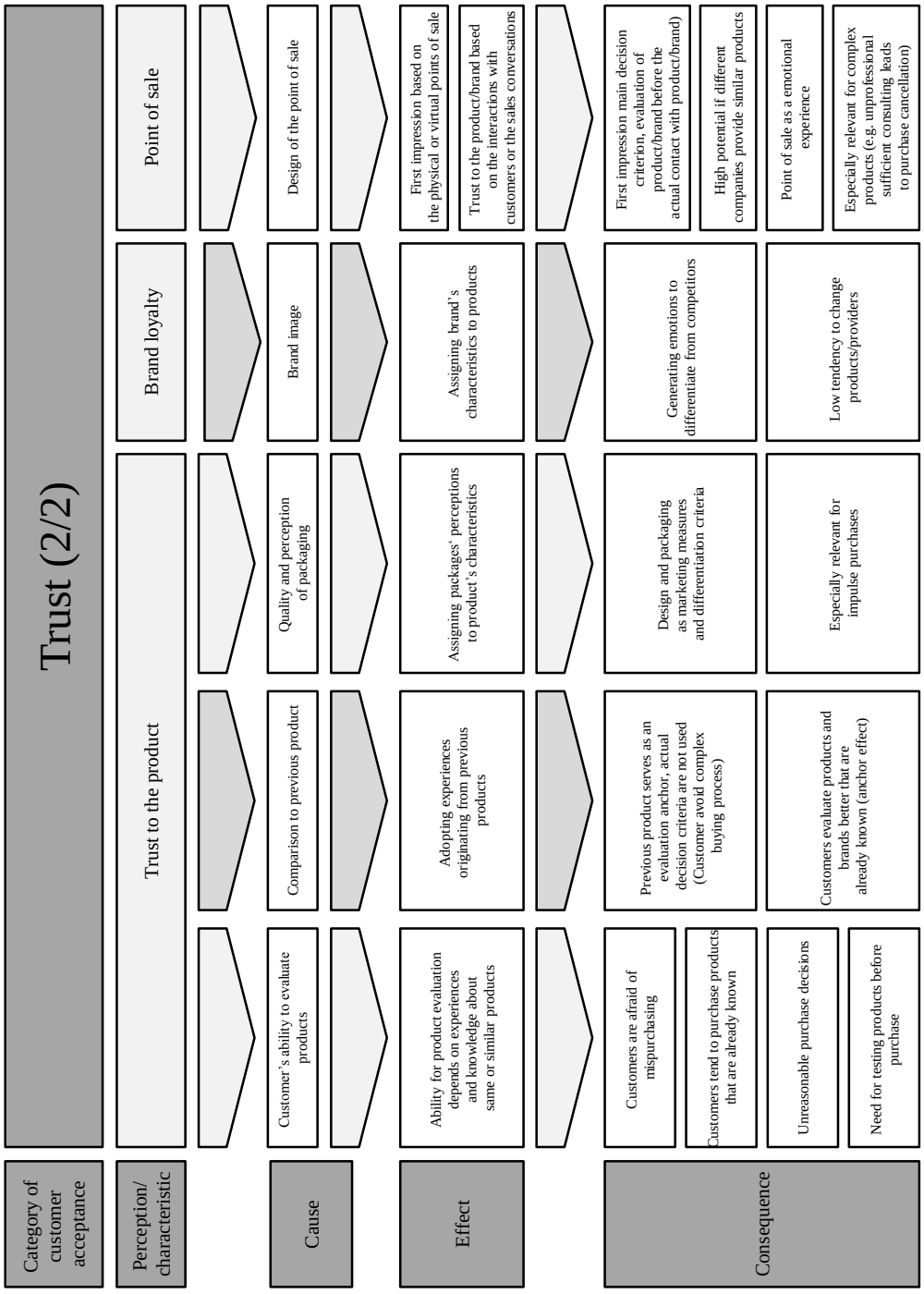

Figure 12-5 Aspects of trust (part 2 of 2)

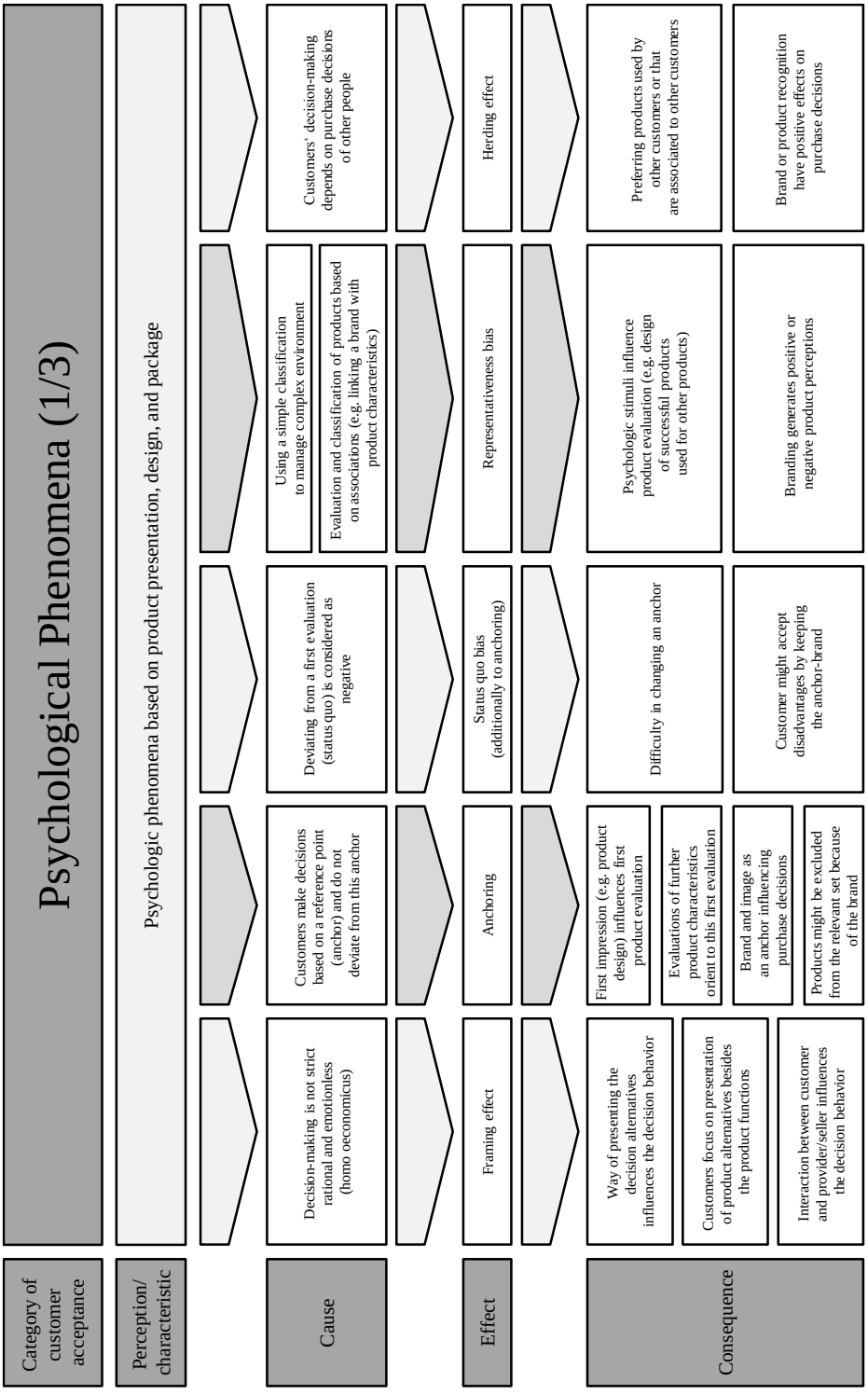

Figure 12-6 Aspects of psychological phenomena (part 1 of 3)

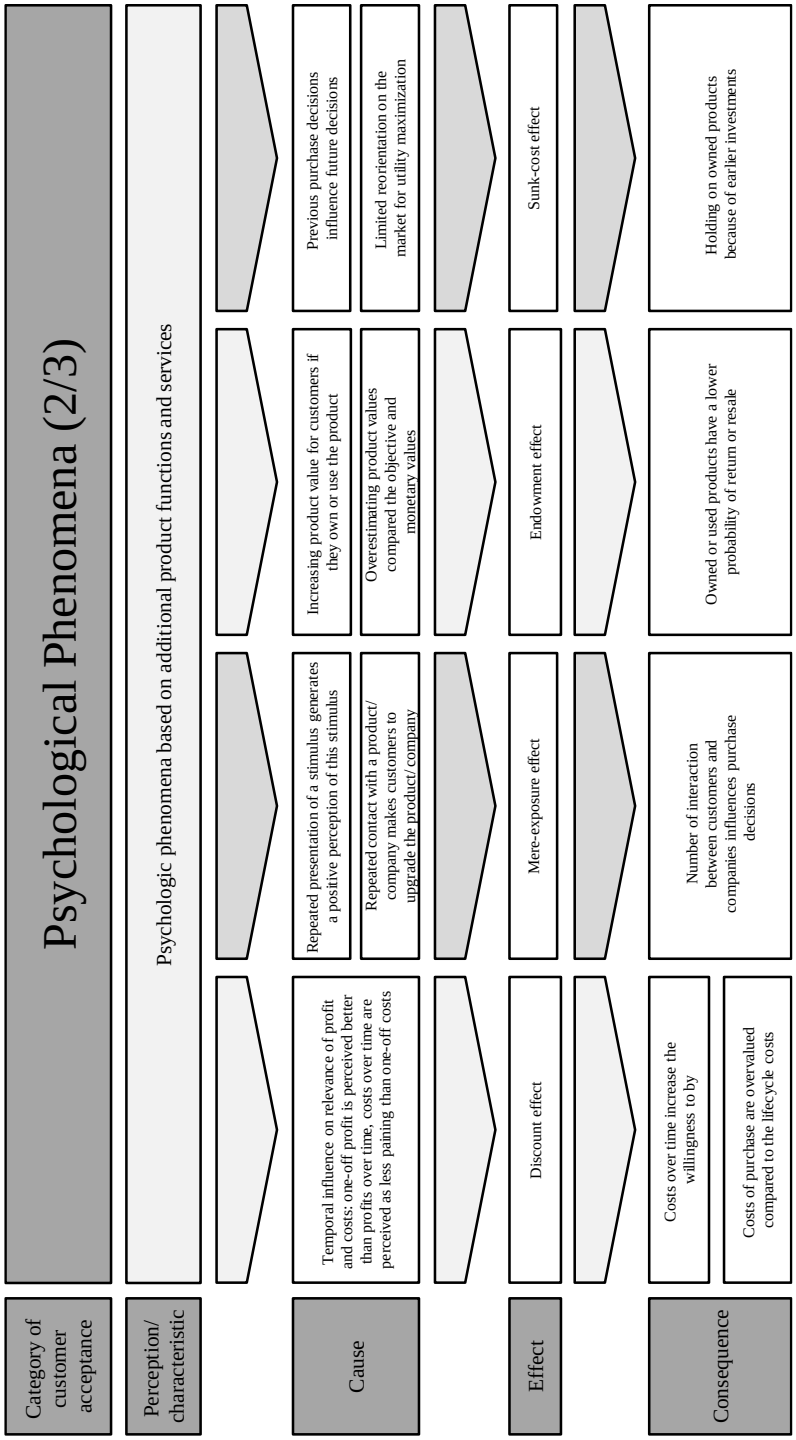

Figure 12-7 Aspects of psychological phenomena (part 2 of 3)

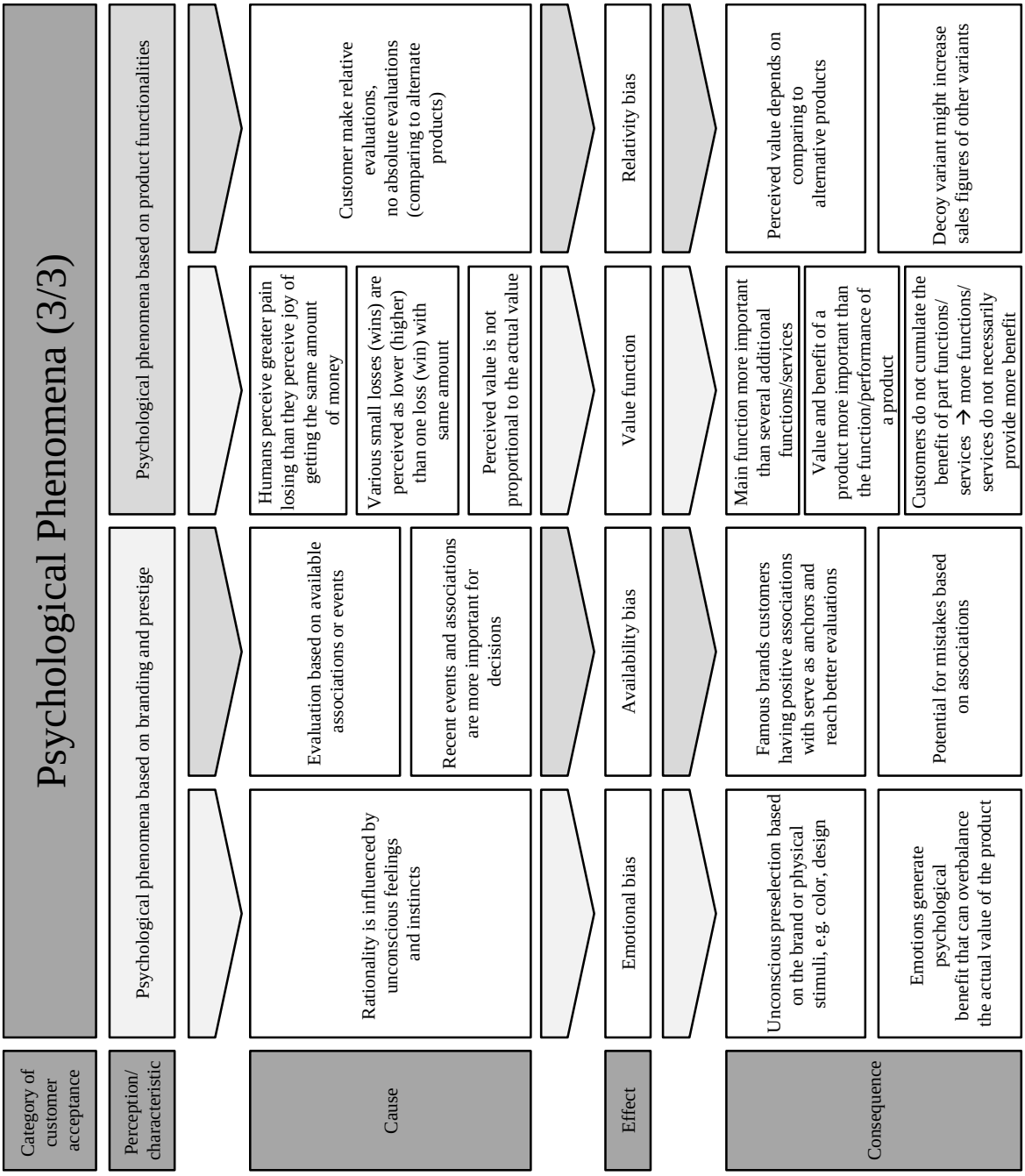

Figure 12-8 Aspects of psychological phenomena (part 3 of 3)

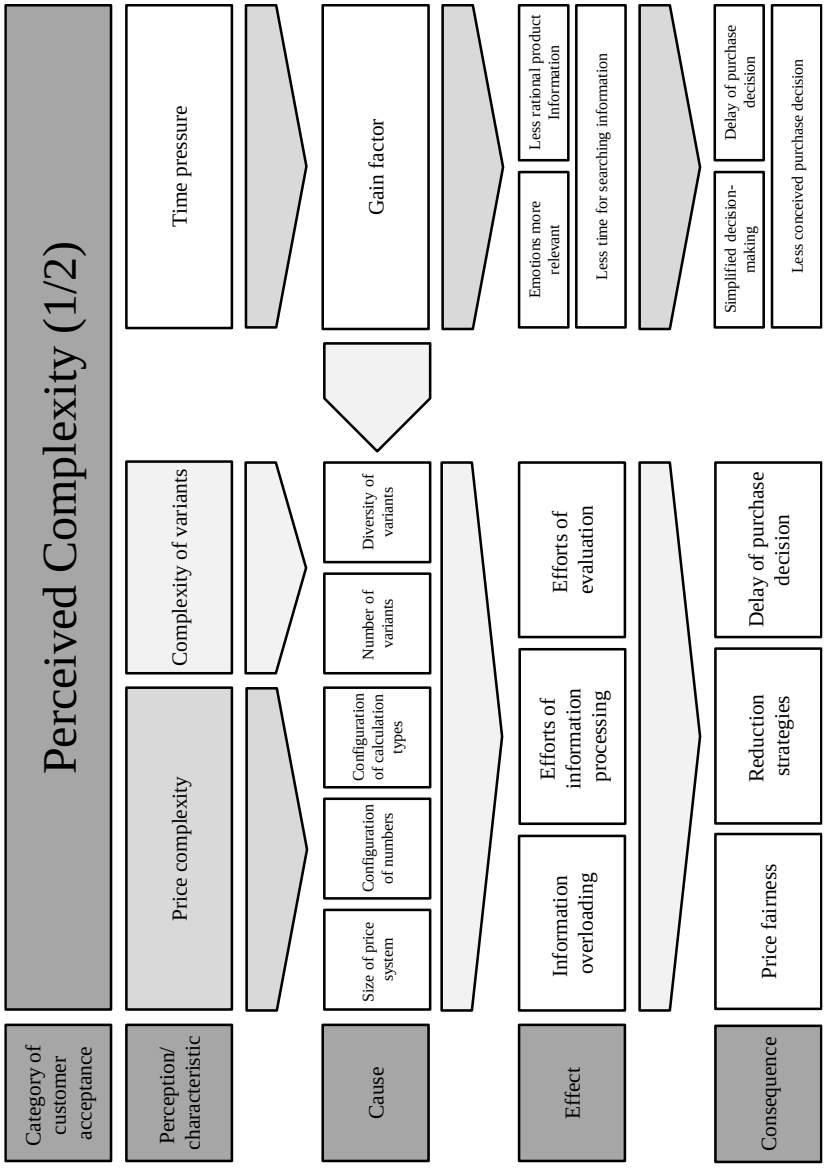

Figure 12-9 Aspects of perceived complexity (part 1 of 2)

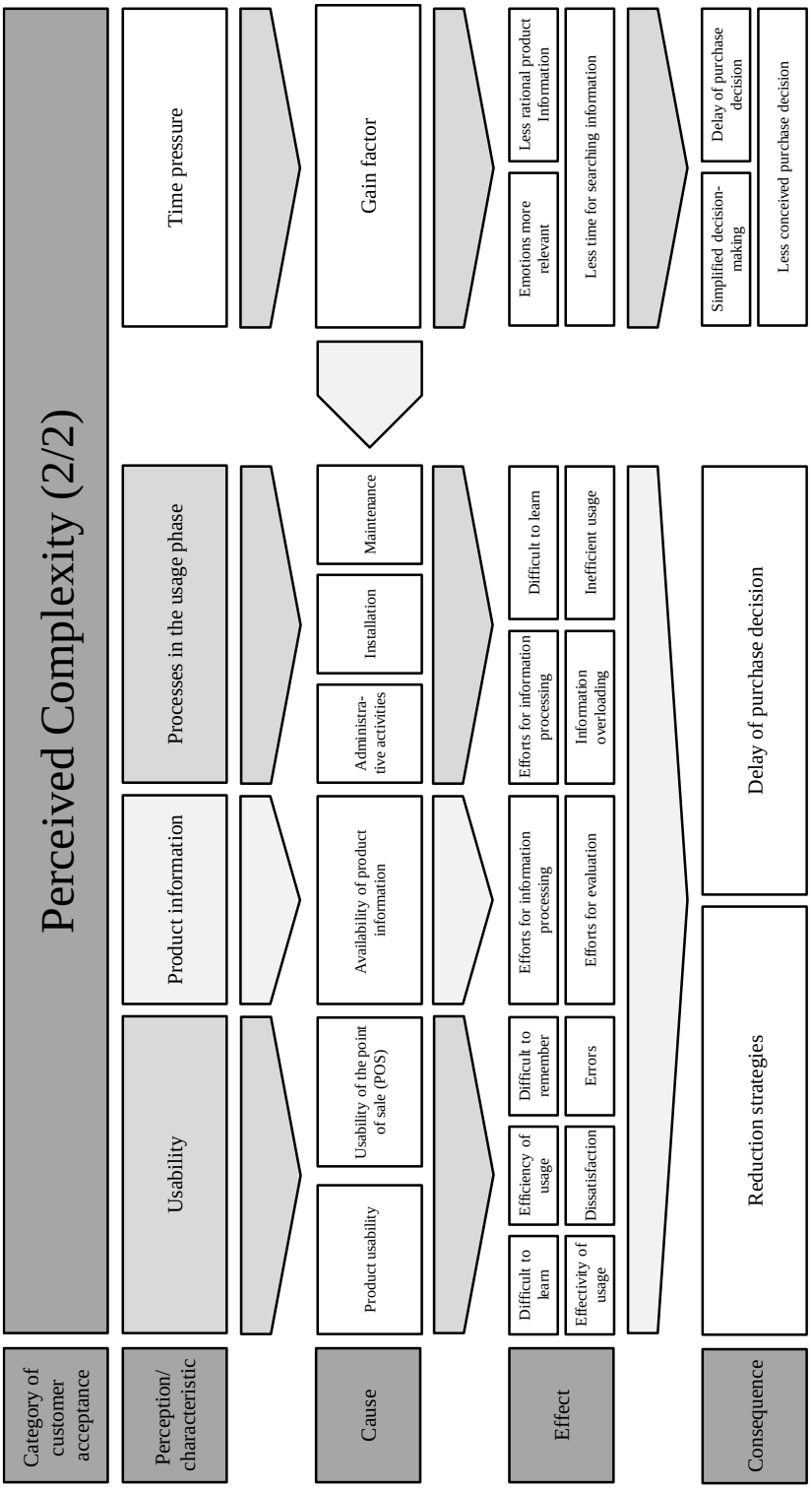

Figure 12-10 Aspects of perceived complexity (part 2 of 2)

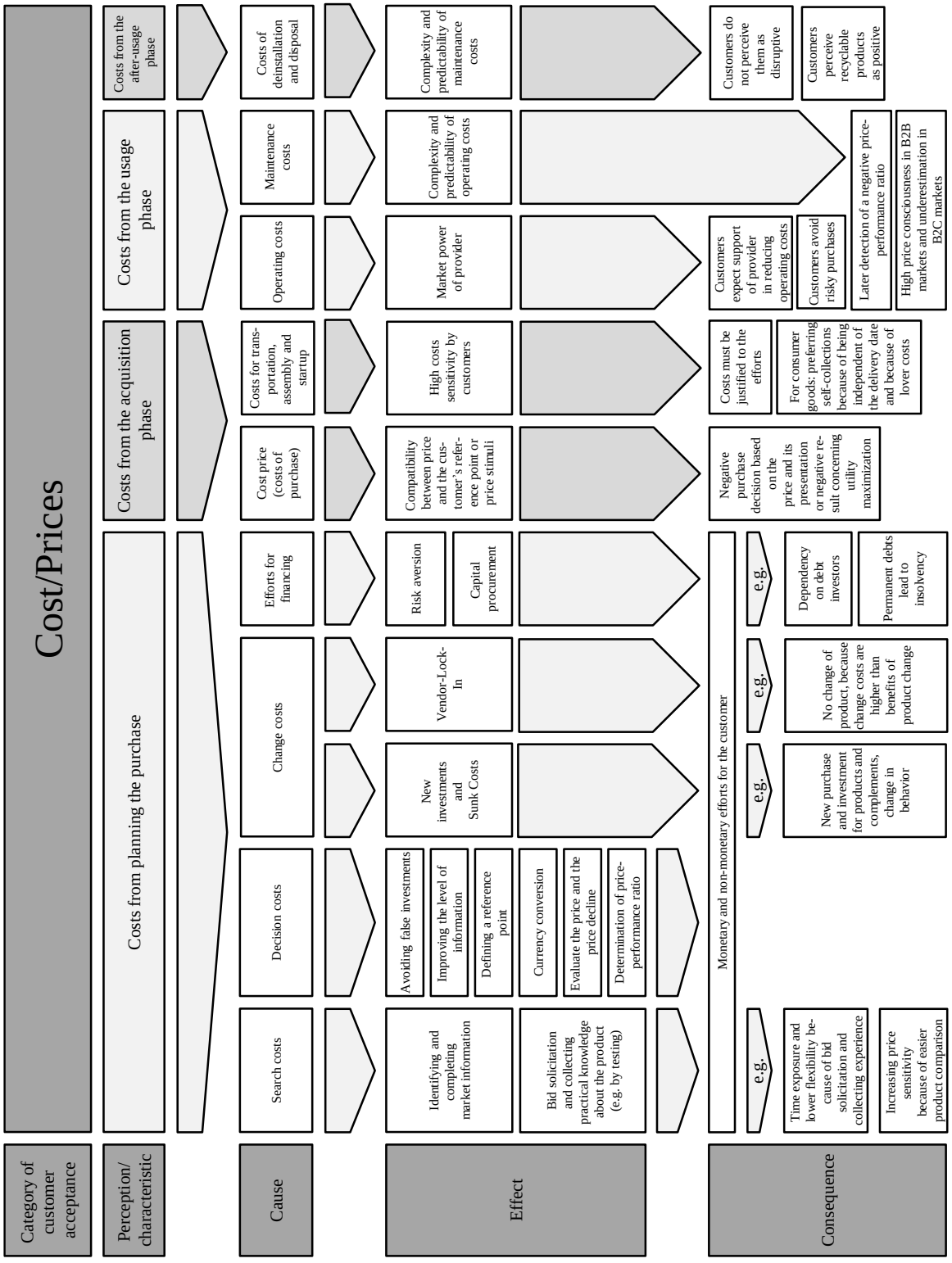

Figure 12-11 Aspects of costs and prices

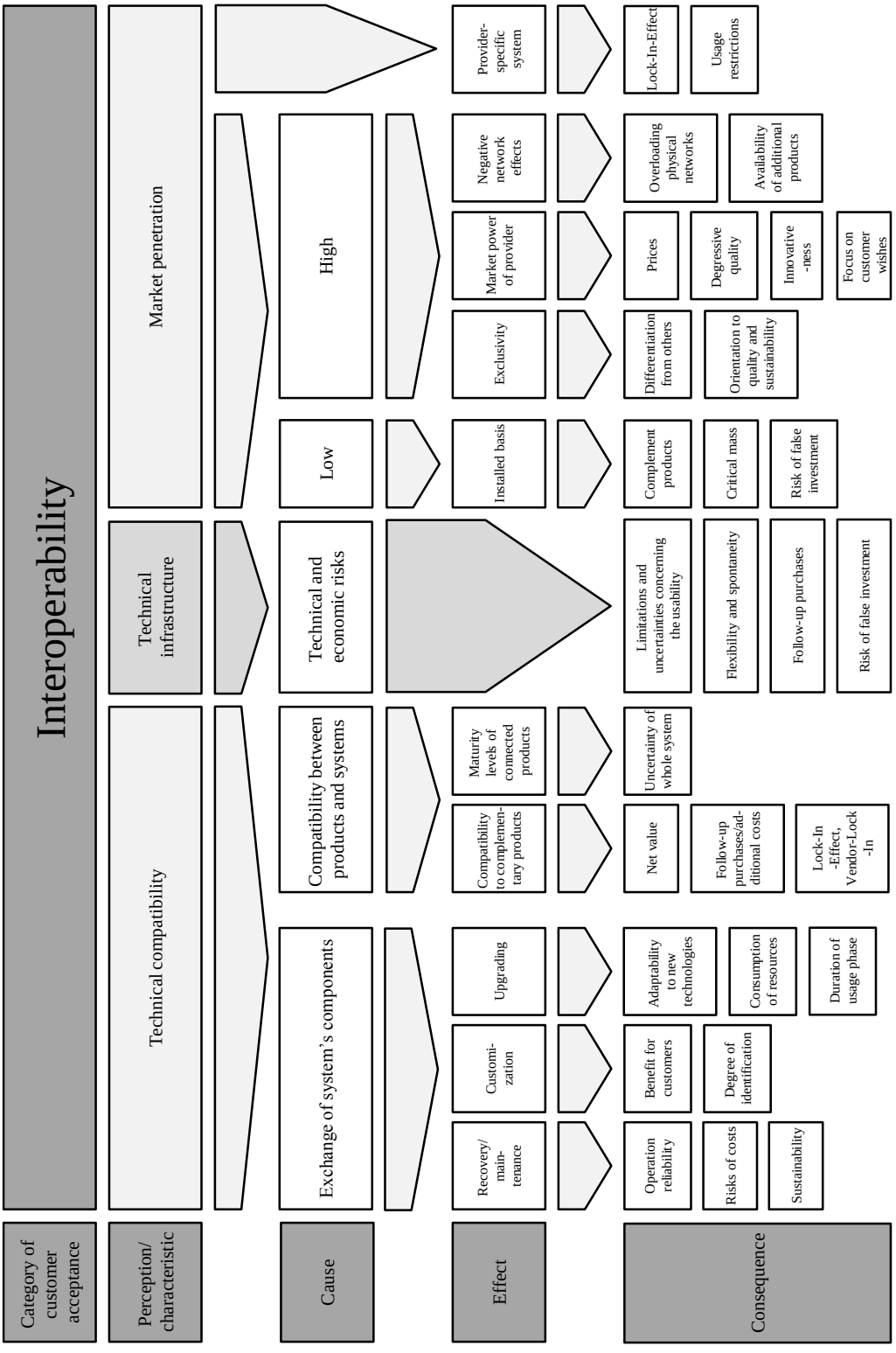

Figure 12-12 Aspects of interoperability

Figure 12-13 Aspects of reliability

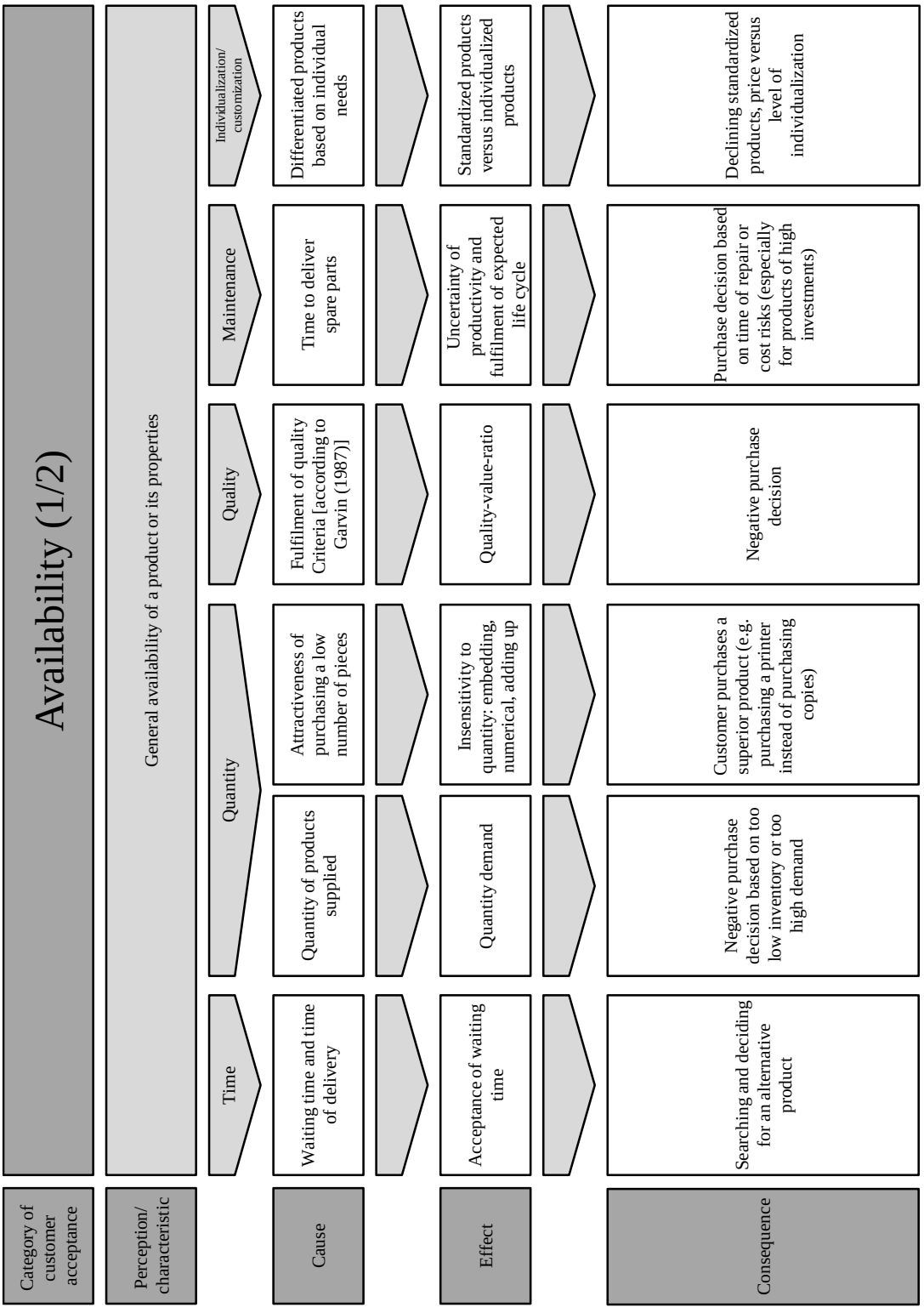

Figure 12-14 Aspects of availability (part 1 of 2)

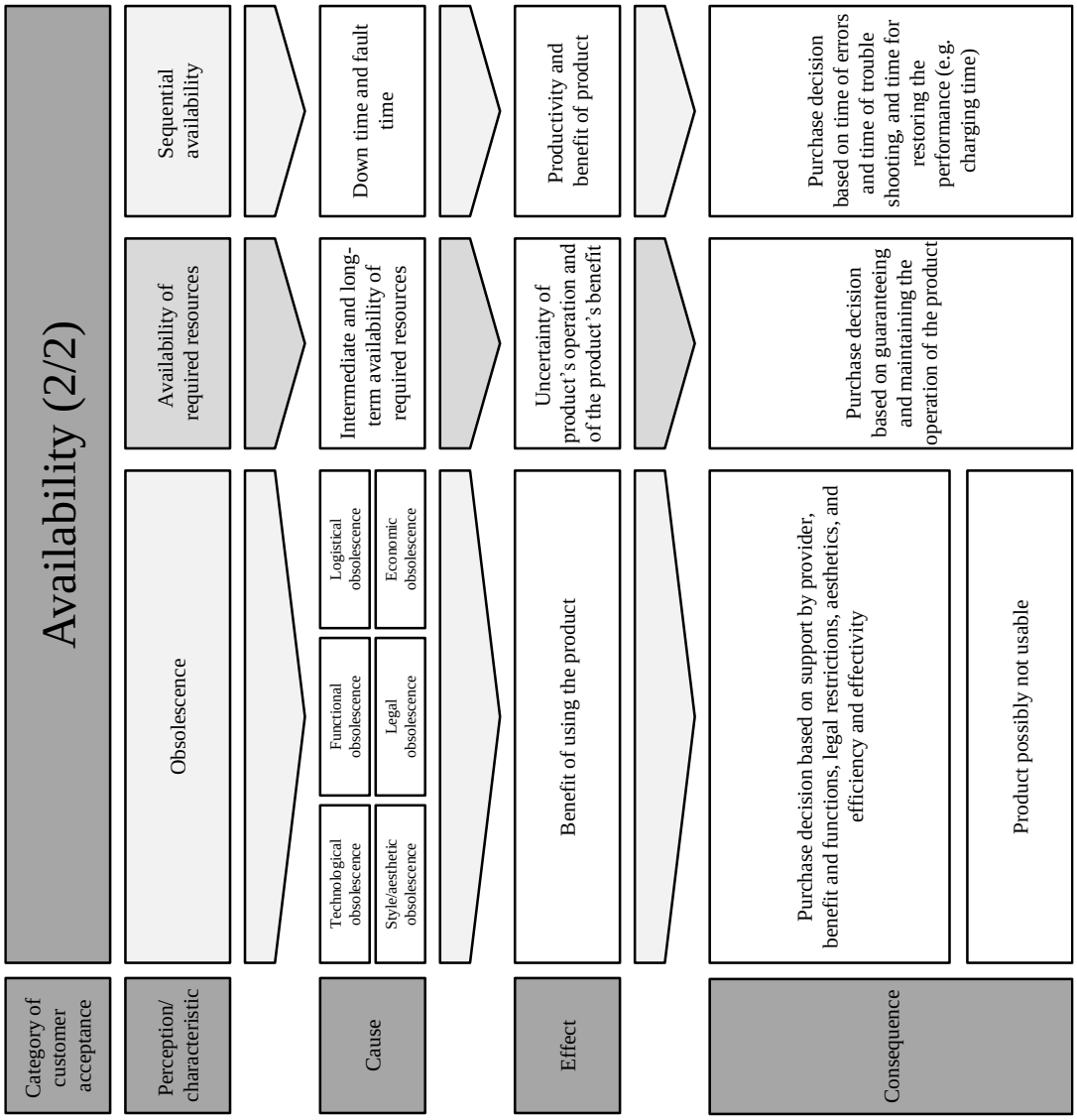

Figure 12-15 Aspects of availability (part 2 of 2)

12.3 Service Catalogue

12.3.1 Services Identified From Literature

(Goedkoop et al., 1999): Advisory in need, Agricultural & horticultural advice, Availability, Call-center, Cleaning, Consumables, Control, Credits & financing, Development, Distribution, Exchange, Fixed prices, Insurance, Leasing, Maintenance, Needed accessories, Production, Refurbishing, Repairs, Sharing, Surprise, Take back of leftovers, Trainings, Transparency, Upgrades, (Roy, 2000): Advisory, Collecting, Consultancy, Control, Copying, Credits (bonuses), Delivery, "Duplication" service, Functional results (carpet tiles), Leasing, Maintenance, Pooling, Recycling, Re-manufacturing, Repairing out-of-guarantee, Replacement, Selling results (clean clothes, heat), Sharing, Supplying, Take back, Trainings, Transportation, Upgrades

(Mont, 2002c): Communication campaigns, Consultancy, Maintenance, Promoting, Take back, Teaching, Upgrades

(Morelli, 2003): Coffee services, Financial services, Full office services, Functional results (working PCs), Technical assistance

(Oliva & Kallenberg, 2003): Business-oriented consulting, Business-oriented Training, Commissioning, Documentation, Engineering, Hotline/help desk, Inspections/diagnosis, Installation, Maintenance, Managing maintenance functions, Managing operations, Monitoring, Optimization, Process-oriented consulting, Process-oriented training, R&D, Recycling, Refurbishing, Repairs, Simulations, Spare parts, Spare parts management, Tests, Trainings, Transportation, Upgrades/updates

(Besch, 2004): Assistance, Consultancy, Furniture inventory analysis, Leasing, Maintenance, Remanufacturing, Renting, Repairs, Spare-planning , Spare parts, Supplying, Upgrade

(Aurich et al., 2006; Aurich et al., 2007; Aurich et al., 2009): Assistance, Communication channels, Contracting, Customer order taking, Description, Information exchange, Inspections, Liability Maintenance, Repairs, Service staff, Servicing, Spare parts supply, Support, Tele-services

(Oliveira & von Hippel, 2009): Additional account, Adjustable rate mortgages, Advisory, Aggregating information, Alerts, notifications, reminders, Automatic clearing house, Automatic paying, Automatic savings account, Budget planner, Business risk assessment, Cash management account, Consultancy, Consumer forums and communities, Dynamic password system, Home equity credit line, Microcredits & microfinances, Mobile banking, Online banking, Overdraft protection, Tax preparations, Telephone banking, Text messages services, Trainings

(Gaiardelli et al., 2014): Cleaning, Consultancy, Consumables, Delivery, Documentation, Extended warranty, Financial services, Help desk, Inspections/diagnosis, Installation/Start-up/commissioning, Leasing, Maintenance, Outsourcing, Pay-per result, Pay-per use, Pooling, Recycling, Refurbishing, Remanufacturing, Renting, Repairs, Safe keeping, Sharing, Spare parts , Take-back, Trainings, Update/upgrade

12.3.2 Service Identified From Industry

Alzmetall Werkzeugmaschinenfabrik und Gießerei Friedrich GmbH & Co. KG: Acceptance tests, Advisory, Axes measuring, Calibration, Construction, Consultancy, Control, Delivery/transportation, Development, Financing services, Functions tests, Installation, Leasing, Maintenance, Renovation & retrofits, Replacement of wear parts, Software updates, Spare parts availability for at least 20 years, Trainings

Atlas Copco Holding GmbH: Adjusted supply, Advisory, Availability, Back-up tools/equipment, Calibration, Commissioning, Consultancy, Consumables, Control, Delivery, Documentation, Extended warranty, Inspections, Installation, Maintenance, Outsourcing, Programming, Qualified technicians, Rent of certain products, Repairs, Security, Spare parts, Start-up, Tool management, Trainings, Upgrading, Workshops

AVENTICS GmbH: Rexroth Pneumatics: Assembly, Assistance, AVENTICS eShop, B2B special discount rates, Bench test, Check of delivery times online, Cleaning, Consultancy, Control, Commissioning, Diagnosis, Disassembly, Engineering tools, Exchange of defective components, Information, Inspections, Installation, Maintenance, Online ordering, On site services, Phone/e-mail support, Repairs, Risk assessment, Spare parts, Troubleshooting, Weekend services

Benteler Engineering Services GmbH: Advisory, Calculations, Capability studies, Concept design, Consultancy, Control, Cost estimation, Data management, Design studies, Diagnosis, Digital mock-ups, Feasibility analysis, Information, Maintenance , Mechanical design, Patent research, Planning, Product development, Production support, Project management, Quality assurance, Quality management, Recommendations, Risk assessment, Simulations, Supplier evaluation, Testing, Validation

BHS Corrugated Maschinen- und Anlagenbau GmbH: Agreed performance, Courses, trainings and workshops, Maintenance, Spare parts, Supporting personal, Technical availability, Transparent maintenance costs, Upgrade parts

Robert Bosch GmbH Elektrowerkzeuge: Advisory, Availability, Catalogs, Consultancy, Delivery, Easy access to new products, Full-service, Guarantee even on wear parts, Innovation portal, Learning campus, Maintenance, Manuals, Online shop, Recycling, Repairs, Sizing, Spare parts, Transportation

Canon Deutschland GmbH: Automatic creation of forms and templates, Billing, Consultancy, Consumables, Digital mail-administrating center, Document converting, compression and editing, Document creating and storing, Document management, Driver, software, Information, Installation, Maintenance , Managed print services, Management, Manuals, Outsourcing, Print as a service, Recycling, Repairs, Replacement, Service help desk, Service technicians, Support, Take-back, Trainings

Dematic GmbH: Analysis, Certification, Cloud services, Consultancy, Consumables, Control, Delivery, Documentation, Extended warranty, Hotline, Implementation, Inspections, Investment planning, Maintenance, On-site customer service, Optimization, Project management, Remote control, Remote diagnosis, Repairs, Replacement, Retrofits, Service technicians, Software development, Spare parts, Trainings, Updates, Upgrades, Workshops

FRIEDRICH DUSS Maschinenfabrik GmbH & Co. KG: Bohr- und Meisseltechnik, Diamantbohrtechnik: Engineering, Extended warranty, On site demonstrations, Phone/e-mail support, Repairs, Spare parts, Technical advice

Eaton Corporation plc: Analysis, Application engineering, E-mail service, Extended warranty, Maintenance, Online documentation, Online FAQs, Online library, Online platform, Online product search, Repairs, Software, Spare parts, Tests, Toll-free hotline, Tools, Trainings

Gebr. Eickhoff Maschinenfabrik u. Eisengießerei GmbH: Assembly, Coaching, Commissioning, Condition Monitoring, Consultancy, Inspections , Maintenance, Repairs, Spare parts, Trainings, Trouble shooting, Workshops

Fibro GmbH: Advisory, CAD parts online, Construction support, Consultancy, Delivery, Manufacturing, Online configuration assistants, Part availability, Pre-assembly, Repairs, Synchronized construction, Technical support, Trainings, Web-shop

FRIMO Group GmbH: Condition monitoring, Consultancy, Delivery, Inspections, Integration of used products, Maintenance, On-site technicians as back-up, Reconstruction, Reuse, Spare parts, Trainings, Transportation, Updates, Upgrades, Workshops

GEA Refrigeration Technologies GmbH: Administration, Advisory, Analysis, Control, Development, Diagnosis, Engineering, Inspections, Installation, Maintenance, Online documentation database, Online shop, On-site services, R&D, Remote monitoring, Repairs, Retrofits, Service engineers, Spare parts, Technical support, Trainings

BASF Coatings GmbH: Glasurit Automotive Refinish Solutions: Accessories, Auditing, BASF colour mixing formulas, Colour data bases, Colour identification, Colour mixing, Consultancy, Trainings, Painting, Workshops

Gleason-Pfauter Maschinenfabrik GmbH: Commissioning, Consultancy, Delivery, Development of customer-tailored results, Engineering, Exchange, Heat treat, Machine relocation, Maintenance, On-site services, Rebuilding/, Remanufacturing, Reinstallation, Remote diagnosis, Remote services, Removal, Repairs, Retrofits, Service Hotline, Spare parts, Technical support, Trainings, Transportation, Upgrades, Webinars, Workshops

HAINZL INDUSTRIE-SYSTEME GmbH: Analysis, Assembly, Commissioning, Condition monitoring, Consultancy, Customer services, Diagnosis, Documentation, Engineering, Installation, Maintenance, Project management, Repairs, Start-up, Technology consulting, Tests, Trainings, Updates, Workshops

HSM GmbH + Co. KG: Accessories, Advisory, Certification, Commerce connector, Consultancy, Development, Engineering, Extended warranty, Financing, Money-back guarantee, Online checklists, Online FAQs, Online manuals, Online service portal, Online tools, Project management, Recycling, Remote control, Remote diagnosis, Repairs, Replacement, Service hotline, Trainings, Workshops

IMA Klessmann GmbH: Advisory, Analysis, Diagnosis, Engineering, Hotline, Inspections, Maintenance, Online service platform, On-site services, Remote services, Repairs, Retrofits, Service engineers, Software tools, Spare parts, Trainings, Updates, Upgrades

J. D. Neuhaus GmbH & Co. KG: Annual Checks, Assembly, Assistance, Consumables, Diagnosis, Downloads, Information, Initial operation approval, Inspection, Installation, Maintenance, Manuals, Online operating time calculator, Online unit converter, Online FAQs, Overhaul, Repairs, Service staff, Technical support, Trainings, Workshops

KAESER KOMPRE-SSOREN SE: Air Service: Advisory, Analysis, Consultancy, Consumables, Development, Diagnosis, Documentation, Engineering, Full-service, Information, Inspections, Maintenance, Spare parts, Technicians, Workshops

Kern AG: Advisory, Consultancy, Development, Engineering, Help desk, Inspections, Installation, Maintenance, Project management, Repairs, Technicians, Trainings, Workshops

KUKA Roboter GmbH: Industrieroboter: 24-hour hotline, Certification, Commissioning, Consultancy, Integration, Maintenance, On-site services, Production support, Project management, Robot programming, Simulations, Software development, Spare parts, Trainings, Upgrades/retrofits, Workshops

Manitou BF ltd: Commissioning, Control, Extended warranty, Financing, Installation, Maintenance, Renting, Repairs, Replacement, Spare parts, Start-up, Used machines

Chr. Mayr GmbH + Co. KG: Advisory, Engineering, Development, Installation instructions, Online CAD data, Online documentation, Operational instructions, Online manuals, Online video portal

OPTIMA packaging group GmbH: Advisory, Analysis, Commissioning, Consultancy, Control, Development, Documentation, E-mail support, Engineering, Hotline, Inspections, Maintenance, Project management, Relocation, Remote inspections, Service technicians, Spare parts, Start-up, Technical support, Trainings, Updates, Upgrades, Workshops

OTIS Gmbh & Co. OHG: 24/7 hotline, Adjustments, Cleaning, Consultancy, Consumables, Delivery, E-Mail support, Information, Inspections, Maintenance, Online documentation, Online manuals, Online platform, On-site services, Recycling, Repairs, Replacement, Rescue service, Service technicians, Spare parts, Tests, Updates

Pfeiffer Vacuum GmbH: Analysis, Commissioning, Diagnosis, Maintenance, On-site services, Remanufacturing, Repairs, Replacement, Service technicians, Spare parts, Start-up, Tools, Trainings, Troubleshooting

POLAR Mohr Maschinenvertriebsgesellschaft GmbH & Co. KG: Advisory, CAD-planning, Consultancy, Consumables, Cutting demonstrations, E-learning, Maintenance, Presentations, Security tests, Spare parts, Technical service, Trainings, Upgrades, Workshops

RENA Technologies GmbH: 24-hour helpdesk, Extended warranty, On-site services, RENA emergency service 24/7, Service technicians, Spare parts, Technical service

RENK AG: Analysis, Assembling, Availability, Cleaning, Commissioning, Diagnosis, Disassembly, Documentation, Extended warranty, Inspections, Installation support, Listing of engineering specifications, Maintenance, On-site services, Overhaul, Planning, Preparing project studies, Proposing solutions, Repairs, Service technicians, Spare parts, Technical advice, Trainings, Upgrades, Workshops, Worldwide support

Samhammer AG: 24/7 Call center, Advisory, Consultancy, Helpdesk software, Online marketing, Outsourcing, Replacement, Shop development, Software development, Terminal service

Scheuch Gmbh: Technology for clean air: Advisory, Analysis, Assembly, Calculations, Cleaning, Commissioning, Consultancy, Consumables, Delivery, Engineering, Inspections, Installation, Maintenance, Planning, R&D, Remote control, Remote diagnosis, Service hotline, Service technicians, Spare parts, Start-up, Tests, Trainings

Siemens SEG Hausgeräte GmbH: Accessories, Additional guarantee, Advisory, Consumables, Manuals, Online booking of technicians, Online service assistant, Repairs, Service shops, Spare parts

Telelift GmbH: 24-hours emergency service, Advisory, Assistance, Consultancy, Maintenance, Overhaul, Repairs, Service hotline, Spare parts, Upgrades

Terex MHPS GmbH: Material Handling & Port Solutions: Analysis, Commissioning, Consultancy, Customer support, Demag-Services, Engineering, Inspections, Maintenance, Overhaul, Planning, Project management, Repairs, Service hotline, Simulations, Software engineering, Spare parts, Start-up, Technical assistance, Tests, Trainings, Upgrades,

UNION Werkzeugmaschinen GmbH: Acceptance tests, Consultancy, Diagnosis, Engineering, Maintenance, Overhaul, Remote services, Replacement, Service hotline, Simulations, Spare parts, Tele service, Tests, Tools, Trainings, Upgrades, Workshops

Uster Technologies AG: Accessories, Analysis, Assistance, Certifications, Consultancy, Customer platform, Download center, Maintenance, Service technicians, Software tools, Spare parts, Statistics, Testing services, Trainings, Worldwide support

Viscom AG: Acceptance tests, Advisory, Commissioning, Consultancy, Control, Installation, Maintenance, On-site services, Programming, Remanufacturing, Remote access diagnosis, Repairs, Service hotline, Spare parts, Start-up, Technical assistance, Traceability, Trainings, Trouble shooting, Updates, Upgrades, Workshops

Voith GmbH: Assembly, Car services, Cleaning, Consultancy, Control cabinet & electrical installation, Cost engineering, Dis- and reassembly, Energy management, Hardware/software engineering, Inspections, Inventory management, Maintenance, Modifications, Operation, Overhaul, Procurement & supply chain management, Production management, Project management, Quality control, Relocation, Retrofits, Robot programming, Spare parts management, Supplier management, Tool management, Transportation/delivery, Waste management, Winter services

WAFIOS AG: Precision Maschinery for Wire and Tube: Advisory, Certification, Commissioning, Consultancy, Delivery, Development, Engineering, Financing, Hotline, Leasing, Maintenance, Online documentation, Overhaul, Remanufacturing, Remote diagnosis, Spare parts, Start-up, Tools, Trainings, Used machines, Workshops

Wirtgen GmbH: Acceptance tests, Analysis, Consultancy, Consumables, Diagnosis, Inspections, Maintenance, Online documentation, Online practical advice, Online shop, Repairs, Service technicians, Software, Spare parts, Technical advice, Trainings, Upgrades, Updates, Workshops

Xerox Corporation, Dokumentenverwaltung und IT Outsourcing: Automatization, Business intelligence, Centralized printing services, Cloud services, Consultancy, Consumables, Customer contact services, Customer relationship management, Document and data management, Document transaction processing, Data processing service center, Employee benefit solutions, Employee life cycle services, Employee training and development programs, End user support, Evaluation, Free of charge take-back, Integration, IT-outsourcing, Managed Print Services, Marketing, Optimization, Paisy payroll services, Recycling, Remote management, SAP user support, Service desk, Technical support, Translation

ZF Friedrichshafen AG: Motion and mobility: Consultancy, Consumables, Delivery, Diagnosis, Documentation, Installation, Maintenance, Online ordering, Overhaul, Practical

advice, Remanufacturing, Remote control, Repairs, Spare parts, Trainings, Workshops, "ZF-ServiceLine"

ZIEMANN International GmbH: Advisory, Analysis, Assembly, Commissioning, Consultancy, Control, Delivery, Engineering & Design, Feasibility tests, Financing, Planning, Project management, R&D, Remanufacturing, Repairs, Spare parts, Start-up, Trainings, Upgrades, Workshops

12.3.3 Customer Functions

- Assembly product(-components)
- Disassembly product(-components)
- Clean product (-components)
- Maintain product(-components)
- Repair/replace product(-components)
- Update/upgrade product(-components)
- Transport product(-components)
- Dispose product(-components)
- Reuse/recycle product(-components)
- Install product
- Ensure product's availability
- Ensure quality of product's outcome
- Monitor product
- Be aware of product's condition
- Know product's characteristics
- Change product's characteristics
- Supply consumables
- Receive (product-)guarantee
- Solve a problem at product usage
- Improve product usage
- Create and acquire product configuration
- Promote product's outcome
- Market product's outcome
- Manage business units and processes
- Receive support in processes
- Calculate risk, Identify requirements
- Provide transparency of costs
- Conduct project management
- Plan
- Adapt business processes
- Manage suppliers
- Manage human resources
- Receive tax consulting
- Receive certifications
- Provide tools

- Develop product
- Develop software
- Coordinate production
- Conduct production
- Enable capital transactions
- Manage investments
- Enable investments
- Enable synchronous communication
- Enable asynchronous communication
- Access data and documents
- Manage data and documents
- Create and process data and documents
- Provide electronic data processing
- Receiving latest software
- Run facilities
- Ensure security
- Improve sustainability

12.3.4 Service catalogue

Table 12-1 Service catalogue, category Services supporting Consumer Customer

Categories	Superclusters	Clusters	Concrete services	Description
Services supporting Consumer Customers (SSC)	Assistance for using the product	Problem solving by telephone communication	24-hours emergency service	A telephone hotline is offered for customers to help customers to solve problems.
			Trouble shooting	
			Service Hotline	
			Hotline	
			Toll-free hotline	
			Phone support	
		Problem solving by personal support	On-site technicians as back-up	Service staff visits customer's place to help him solve problems.
			Supporting personal	
			Service shops	
		Problem solving by platform-based communication	Customer platform	A communication platform (e.g. online, software) is offered to help customers to solve problems
			E-Mail support	
			SAP user support	
			Help desk	
			24-hour helpdesk	
			Helpdesk software	
		Assistance by consulting	Process-oriented consulting	Consulting the customer in using the product, understanding the product, or improving his processes.
			Technical advice	
			Practical advice	
			Online practical advice	
			Technology consulting	
			Assistance	
			Advice in need	
		Assistance by documentation	Online service assistant	Providing documents, knowledge, and information to support the customer in using the product.
			Online checklists	
			Online FAQs	
			Operational instructions	
			Manuals	
			Online manuals	
			Online documentation	
			Documentation	
			Description	
			Online service platform	

Services supporting Consumer Customers (SSC)		Product-specific training	Coaching	Training the customer or customer's employees in using the product or in improving their efficiency.
			Trainings	
			User training	
			Process-oriented training	
	Product acquisition	Product presentation	Listing of engineering specifications	Presenting the customer the product and how it works. Providing catalogues further data/information about the product.
			Digital mock-ups	
			Catalogs	
			On site demonstrations	
			Cutting demonstrations	
			Presentations	
			Online product search	
		Product configuration and acquisition	Needed accessories	Supporting the customer in selecting the best-fitting product configuration or in purchasing additional components/accessories.
			Accessories	
			Easy access to new products	
			Online ordering	
			Online configuration assistants	
			Contracting	
	Guarantee	Product guarantee	Extended warranty	Guarantee about the product's availability that guarantees that the product is working properly for a certain period.
			Guarantee even on wear parts	
			Spare parts availability for at least 20 years	
			Additional guarantee	
		Price guarantee	Money-back guarantee	Guarantee that there is a limit for the price (also for consumables).
			Fixed prices	
	Financial services	Overdraft services	Overdraft protection	Protecting the customer to overdraw his accounts or credits.
			Home equity credit line	
			Adjustable rate mortgages	
		Discounts	Credits (bonuses)	Granting discounts or financial bonuses to customers, e.g. based on the order quantity or customer relationship.
			B2B special discount rates	
		Credit	Credits & financing	Granting a credit for buying a product or supporting in financing a product.
			Microcredit & microfinance	
		Tax consulting	Tax preparations	Assistance to prepare the tax declaration efficiently and effectively.

SSC		Clearing services	Billing	Overtaking the tasks of a clearing house for customers, e.g. transacting money, creating bills.
			Automatic clearing house	
			Paisy payroll services	
		Asset management	Asset-management	Managing and administrating the customers' assets, e.g. by managing their bank accounts or opening new ones.
			Cash management account	
			Automatic savings account	
			Additional account	
		Transaction management	Financial services	Providing different kinds of pay methods or managing customers' transactions.
			Automatic paying	
			Online banking	
			Mobile banking	
			Telephone banking	

Table 12-2 Service catalogue, category Services supporting business customer

Categories	Superclusters	Clusters	Concrete services	Description
Services supporting Business Customers (SSB)	Human resource management	Staff development	E-learning	Improving skills of customers' employees by providing courses, workshops, trainings, webinars etc.
			Employee training and development programs	
			Webinars	
			Teaching	
			Workshops	
			Courses, trainings and workshops	
			Business-oriented training	
			Learning campus	
		Staff administration	Employee life cycle services	Overtaking tasks of human resource management, e.g. recruiting, managing employees' data, analyzing human resources.
	Product and software development	Software development	Programming	Developing and programming software for customers and their use cases.
			Software development	
			Robot programming	
			Software engineering	
		Product development and design	Patent research	Supporting the customers in or overtaking of activities related to product development and design, e.g. mechincal engineering, hardware engineering, oncept design.
			Design studies	
			Cost engineering	
			Mechanical design	
			Hardware engineering	
			Development	
			R&D	
			Concept design	
			Engineering & Design	
			Engineering	
			Product development	
		Product advancement	Evolution	Improving customers' products, processes or parts of them.
			Optimization	

Services supporting Business Customers (SSB)	Planning	Structure planning	Preparing project studies	Supporting the customer in planning his product's structure and/or overtaking these tasks.
			Proposing solutions	
			CAD-planning	
			Planning	
		Investment planning	Business-oriented consulting	Planning the costs, investments and expected profits for the customer and his business models.
			Investment planning	
			Budget planner	
			Cost estimation	
			Calculations	
	Tools	Tools for planning	Online operating time calculator	Tools to support customers in planning their processes and products.
		Engineering tools	Engineering tools	Software and online programs that can be used for engineering, e.g. simulation-software or methods and proceedings.
		Specific tools	Tools	Individual tools for specific problems and use cases of customers.
			Online unit converter	
			Software tools	
			Online tools	
	Communication channels	Asynchronous communication channels	Digital mail-administrating center	Tools, platforms, services, and other measures that enables customers to asynchronously communicate with their customers/consumers. Asynchronous communication means a time-displaced sending and receiving of information.
			Innovation portal	
			Text messaging services	
			Commerce connector	
			Consumer forums & communities	
		Synchronous communication channels	Online platform	Tools, platforms, services, and other measures that enables customers to synchronously communicate with their customers/consumers. Synchronous communication means a simultaneous sending and receiving of information.
			Communication channels	
			Customer contact services	
			Information exchange	

Services supporting Business Customers (SSB)	Management	Certification	Auditing	Certifying products, processes or employees to enable more professional businesses.
			Certification	
		Quality management	Process improvement	Managing of all quality management related tasks and responsibilities for the customer.
			Quality management	
			Quality control	
			Quality assurance	
		Project management	Project management	Planning, attending, realizing project management activities for the customer.
		Administration	Administration	Administrating or controlling the customer's processes or divisions.
			Remote management	
	Data management	Transparency control	Traceability	Making product's characteristics and their causes (e.g. requirements) and processes transparent and easy to understand.
			Transparency	
			Transparent maintenance costs	
			Business intelligence	
		Document management	Document and data management	Managing customers' data and documents, including creating, storing, administrating, converting, compressing, editing, etc.
			Document creating and storing	
			Translation	
			Document converting, compression, editing	
			Automatic creation of forms and templates	
		Security systems for electronic data processing	Document transaction processing	Providing systems or supporting the customer for secure processing of electronic data.
			Dynamic password system	
		Provision of data	Data processing service center	Different kinds of measures to provide data for customers, e.g. by downloading.
			Cloud services	
			Download center	
			Downloads	
			Online library	
			CAD parts online	
			Driver	
			Duplication service	
			Centralized printing services	

Table 12-3 Service catalogue, category Services supporting product

Categories	Superclusters	Clusters	Concrete services	Description
Services supporting Product (SSP)	Product installation	Pre-/Dis-/Reassembly	Pre-assembly	Pre-/dis-/reassembling the product or parts and components of it.
			Assembly	
			Dis- and reassembly	
			Disassembly	
			Rebuilding	
		Product implementation and integration	Integration	Integrating, installing, or implementing a component or part system into the whole product.
			Integration of used products	
			Implementation	
			Commissioning	
		Installation support	Installation support	Supporting the customer in installing the product.
			Installation instructions	
	Product maintenance	Update and Upgrades	Modifications	Updating or upgrading the product by replacing older parts by newer ones.
			Upgrades	
			Software updates	
		Ensuring the product availability	Availability	Guarantees a proper working of the product and its functions.
			Terminal service	
			Back-up tools/equipment	
		Product monitoring	Alerts, notifications, reminders	Provider monitors the product that is running at the customer's site to check if the product is working properly and to identify measures to improve product's functions.
			Remote control	
			Control	
			Condition Monitoring	
			Remote monitoring	
			Remote-services	
			Diagnosis	
			Remote diagnosis	
		Product inspections	Annual Checks	Provider checks, analyzes and inspects customer's product.
			Inspections	
			Remote inspections	
		Product maintenance	Calibration	Different kinds of maintaining the product, e.g. on-site maintenance etc. Maintenance services focus on ensuring the operating of the product.
			Maintenance	
			On-site customer service	

		Product overhaul	Weekend services	Overhauling the whole product and its concept by exchanging components or replacing wear parts. Overhaul can include upgrades to adapt the product to changing requirements.
			Overhaul	
			Refurbishing	
			Exchange of defective components	
			Repairing out-of-guarantee	
			Repairs	
			Exchange	
			Replacement of wear parts	
			Spare parts	
	Product reuse	Product relocation	Reinstallation	Overtaking all the tasks that are necessary for relocating a product or a machine.
			Relocation	
			Machine relocation	
		Product recycling	Used machines	Recycling the product after the end of the life cycle and using some components for new products.
			Recycling	
			Reuse	
		Product (components) transportation	Transportation	Transporting the products or some components to another place.
			Removal	
	Spare parts	Supplier organization	Supplier evaluation	Managing the customer's suppliers, spare parts, and optimizing the supply chain.
			Part availability	
			Check of delivery times online	
			Spare-planning	
			Spare parts management	
			Supplier management	
			Procurement & supply chain management	
		Spare parts delivery	Spare part supply	Delivering spare parts, consumables, or upgrade parts.
			Adjusted supply	
			Delivery	
			Supplying	
			Consumables	
			Upgrade parts	

Table 12-4 Service catalogue, category Services supporting outcome

Categories	Superclusters	Clusters	Concrete services	Description
Services supporting Outcome (SSO)	Product tests	Specific product tests	Initial operation approval	Testing different issues of products, processes or components to check their fitness. Mainly focused on technical details
			Security tests	
			Functions tests	
			Testing	
			Axes measuring	
			Color identification	
		Risk analysis	Risk assessment	Analyzing and evaluating the risk concerning different factors.
			Business risk assessment	
		Product's performance evaluation	Acceptance tests	Testing and assessing the product's performance to find out if the product meets market requirements defined before. Mainly focused on the product's concept.
			Feasibility analysis	
			Bench test	
			Capability studies	
			Simulations	
	Sales and Marketing	Sales channels (for customer's products)	Online shop	Supporting the customer in creating sales channels or providing the customer sales channels. Customers will use the sales channels for selling their products to their customers (consumers).
			Shop development	
			Distribution	
		Marketing (for customer's products)	Promoting	Supporting the customer to market their products or overtaking the marketing activities of customers.
			Online marketing	
			Marketing	
			Communication campaigns	
			Customer relationship management	
	Production	Production management	Production management	Managing, organizing, and controlling the customer's production, e.g. managing tools or supporting the automatization.
			Tool management	
			Automatization	
			Production	
		Production assistance	Production support	Supporting the customer in producing his components/products.
			Construction support	

Services supporting Outcome (SSO)		Manufacturing	Construction	Overtaking manufacturing or manufacturing processes from the customer.
			Synchronized construction	
			Manufacturing	
			Control cabinet & electrical installation	
			Sizing	
			Hardening	
			Grinding	
			Heat treat	
			Painting	
	Operating facilities	Catering services	Coffee services	Providing food and drinks for the customer's facilities.
		Energy and environment management	Environmental protection	Managing all tasks related to energy, e.g. electricity of facilities or reducing energy consumption of customer's plants.
			Energy management	
		Waste management	Waste management	Taking customer's waste back or managing customer's waste.
			Take back	
			Free of charge take-back	
			Take back of leftovers	
		Facility services	Winter services	Maintaining and cleaning the customer's facilities.
			Cleaning	
		Inventory	Inventory management	Managing all tasks related to the customer's inventory.
			Furniture inventory analysis	
		Personal safety services	Rescue service	Protecting customer's facilities and providing safety for them.
			Security	
			Safe keeping	

12.3.5 Service Catalogue Categorization “Literature”

Table 12-5 Service catalogue categorization “Literature”

Category	Supercluster
Product-oriented services	Assistance for using the product Product installation Product acquisition Guarantee
Maintenance services	Product maintenance Product reuse Spare parts
Services for optimizing the product usage	Human resource management Product and software development Planning Product tests Sales and Marketing
Provider services	Tools Communication channels Production Management Data management Operating facilities Financial services

12.3.6 PSS cases for experiments

Case #1: Construction Machine (B2B market)

You are working as a product manager at the company World Digger that partly produces and sells construction machines. The digger model ATX-100 was a great success during last years, the customers like the long availability and durability of the digger. Your customers are building companies that need the digger for their construction sides. The new model ATX-200 will be launched soon that includes more functions than the previous model. Since offering additional services can increase the profit and increases the connectivity to customers, the CEO decides to add services to this product instead of only selling it. This digger model is considered as a high quality product and the price is higher than competing products. Testing the prototype has turned out that some users have problems in understanding and using the digger because of various functions.

Case #2: Generator for Wind Power Plants (B2B market)

You are working as a product manager at the company WindPower that produces, sells and maintains generators for wind power plants. Generators are one of the main components of wind power plants and they need maintenance on a regular basis. The company has two customer groups:

1. producer and provider of wind power plants (your company is their supplier)
2. operators of wind power plants (your company offers maintenance services to maintain the generators of their wind power plants).

During last years, more and more extern service providers have entered the market of generators' maintenance. The extern service providers offer their maintenance services to a lower price. Other competitors that also produce, sell and maintain generator have reduced their prices for maintenance services. For those reasons, your company has lost customers in both customer groups. To regain customers from both groups, your company wants to offer more services than just the maintenance service.

Case #3: Dishwasher for Private Customers (B2C market)

You are working as a product manager at the company CleanKitchen that develops, produces, and sells dishwashers for private usage. There are two main reasons why customers do not buy your products: the first reason is that the costs of purchase of your products are higher than the costs of purchase of your competitors' products. This is caused in the better quality your products have compared to your competitors' products. However, costs seem to be more relevant than the quality for customers. The second reason is that some customers are not aware of dishwashers' benefits: they are used to wash their dishes by hand and they do not know about the necessity and the benefit of having a dishwasher. Since your company wants to sell more products by increasing the market share and the market in total, you have to find service offers that are capable of regaining customers from competitors and of persuading people of buying a dishwasher.

Case #4: Mountain Bike (B2C market)

You are working as a product manager at the company Bikes4You that develops, produces, and sells mountain bikes. One important quality criterion of mountain bikes is the durability of the gear box. Cheaper mountain bikes have gear box with a lower durability. A few months ago, the supplier of the gear box has delivered some gear boxes with production faults and those gear boxes failed after a few weeks of usage. This became public and it was a big scandal for your company. Many customers lost trust to your company and they switched to your competitors and the number of sales decreased rapidly. To win the customers back and strengthen the connectivity to your customers, the strategy planners of your company decide to offer some additional services. You as a product manager have to plan some services to win customers back and increase the trust of your customers and how they perceive the bikes' safety and reliability.

Task Description

As the product manager, you have to suggest services that can be additionally offered to this product. Since time is limited, you only have 10 minutes to find suitable services. For finding services, please use the service catalogue. You have to present the services in a meeting with the management board. In this meeting, you have a 10 minutes time slot to present and discuss those services (this has an effect on the number of services and on the level of detail of the description). For presenting the services, you have to use the template.

Please note:

- The service catalogue should only serve as a support, the services do not have to be the same like the elements in the catalogue.
- You can also define new services that are not mentioned in the catalogue or that consist of more than one service.
- Offering too many services might be a problem, because the company also need to plan and developing services: only suggest services that would have a positive cost/benefit ratio (in your opinion).

12.3.7 PowerPoint Demonstrator

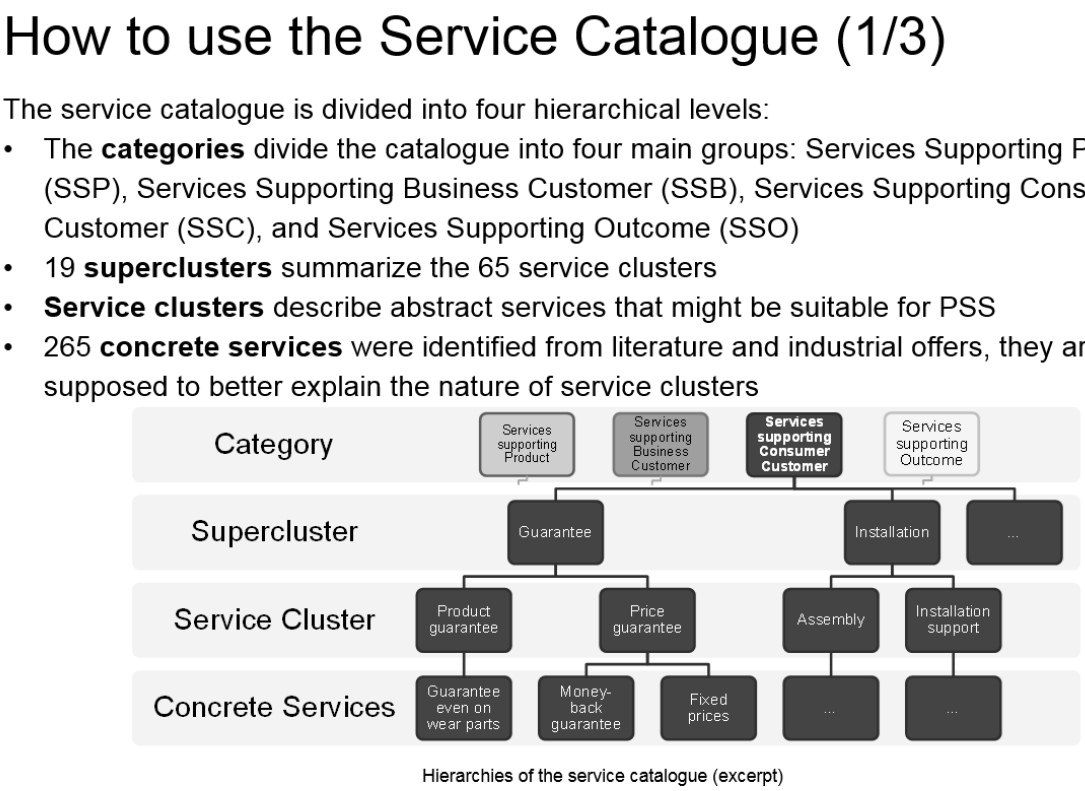

Figure 12-16 PowerPoint demonstrator: quick manual (part 1 of 3)

How to use the Service Catalogue (2/3)

- The service catalogue supports PSS planners (e.g. product managers) in identifying services that might be beneficial for offering in a PSS.
- The level of **service clusters** is the most suitable level to support PSS planners, because this level is detailed enough to understand services in detail but it is abstract enough to get a useful overview of services.
- The overview-slides of the categories give an overview of all service clusters. They can support in identify suitable services in a fast way.
- A common approach of using the service catalogue is to first identify relevant categories and analyzing service clusters of those categories. After finding suitable service clusters, they must be adapted to the company's, customer's, market's, and product's context.

Figure 12-17 PowerPoint demonstrator: quick manual (part 2 of 3)

How to use the Service Catalogue (3/3)

The service catalogue has two different kinds of slides. The four categories and their service clusters are bound together:

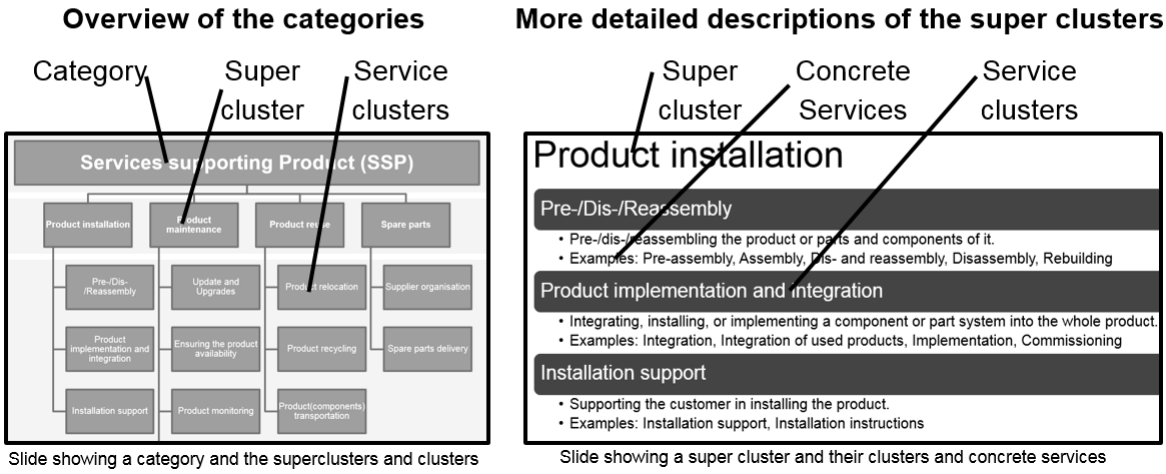

Figure 12-18 PowerPoint demonstrator: quick manual (part 3 of 3)

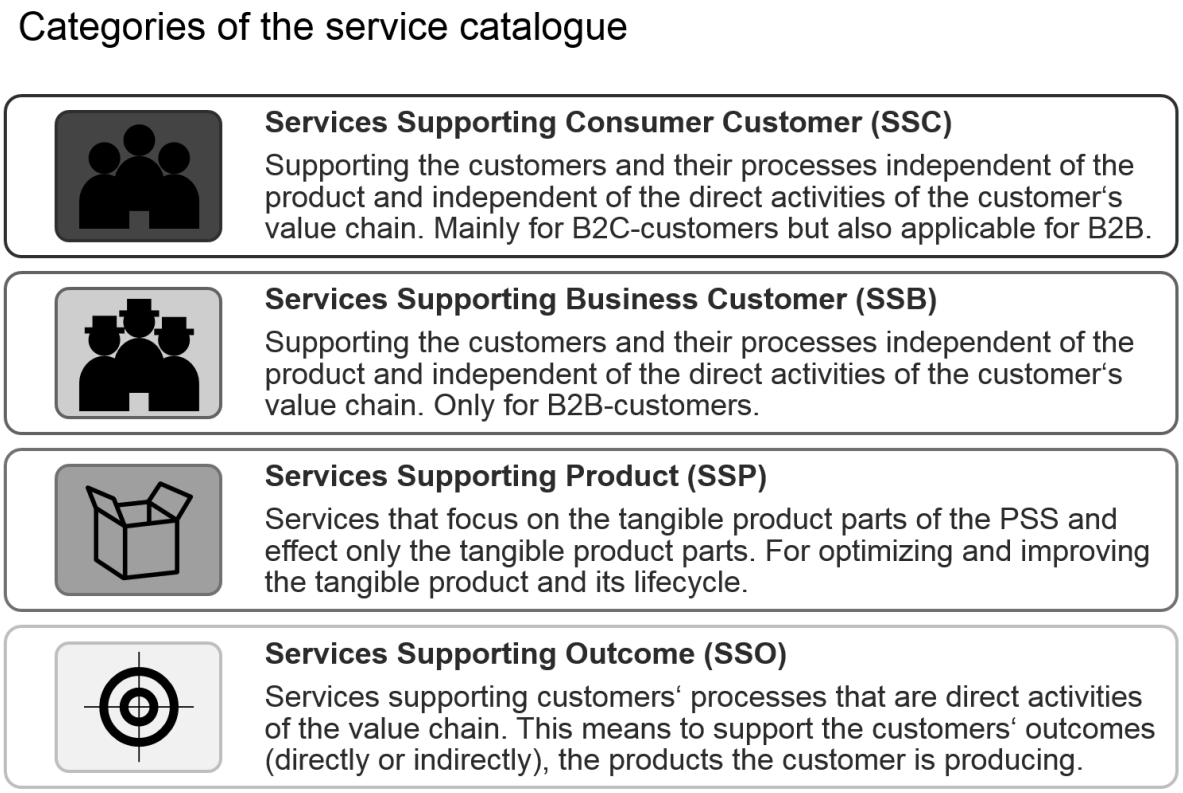

Figure 12-19 PowerPoint demonstrator: explanation categories

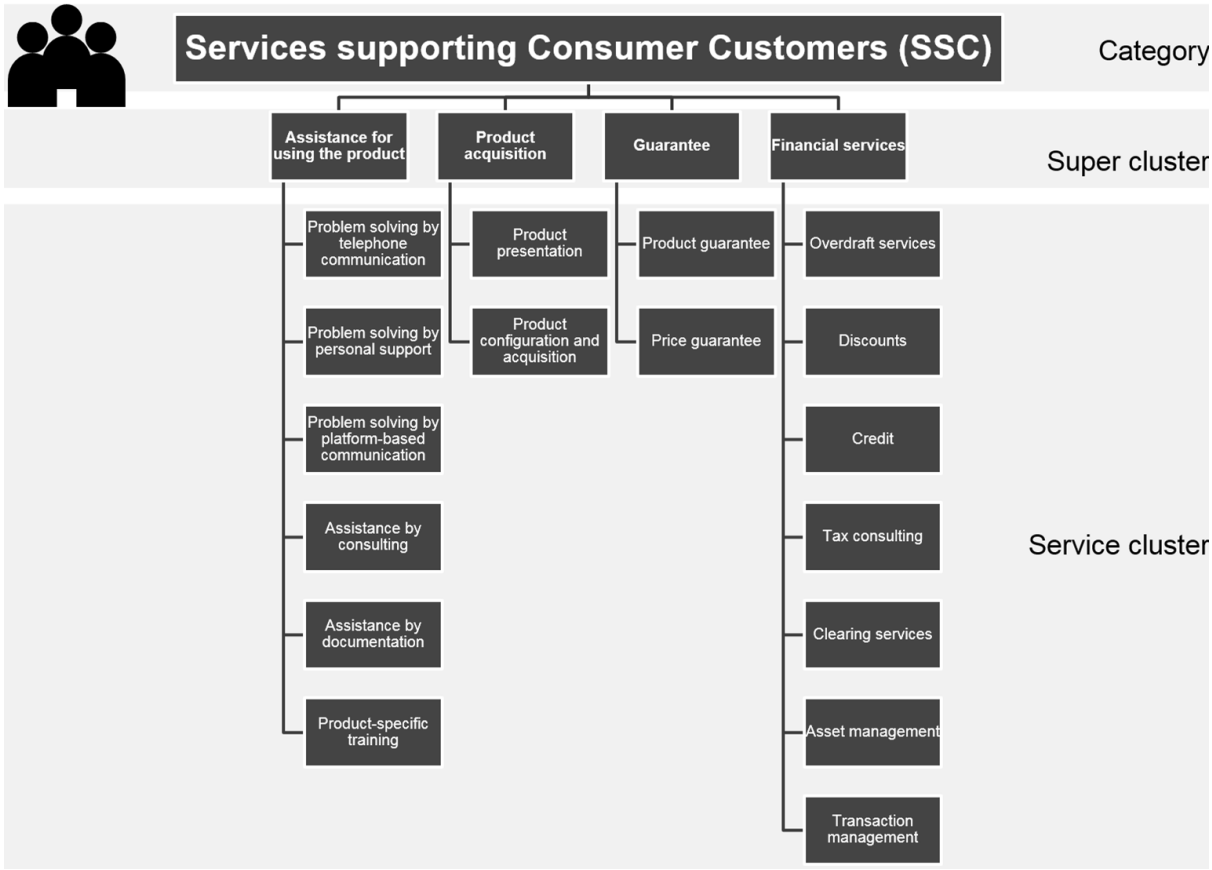

Figure 12-20 PowerPoint demonstrator: category SSC

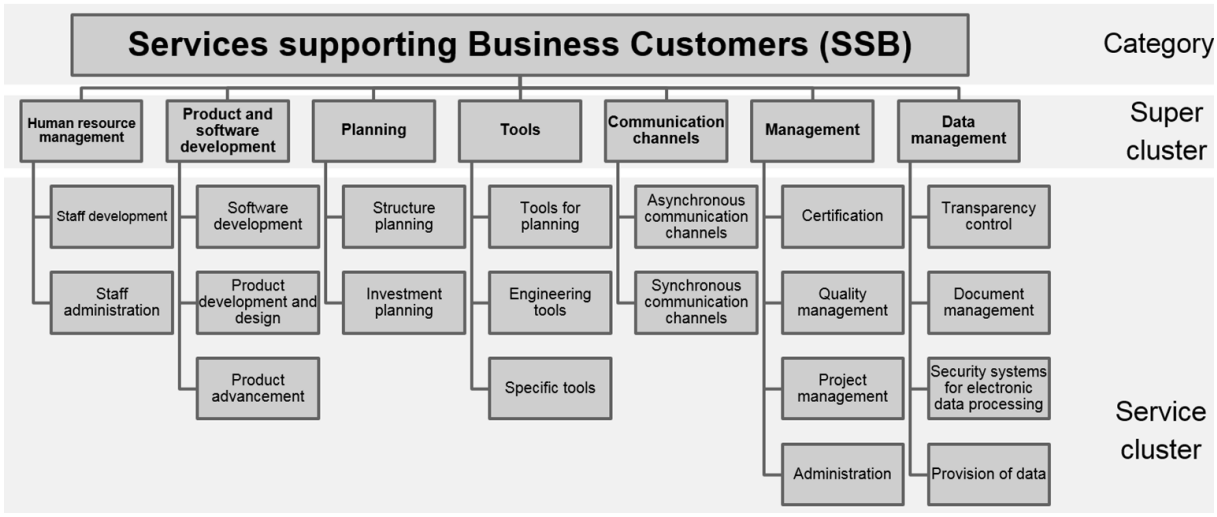

Figure 12-21 PowerPoint demonstrator: category SSB

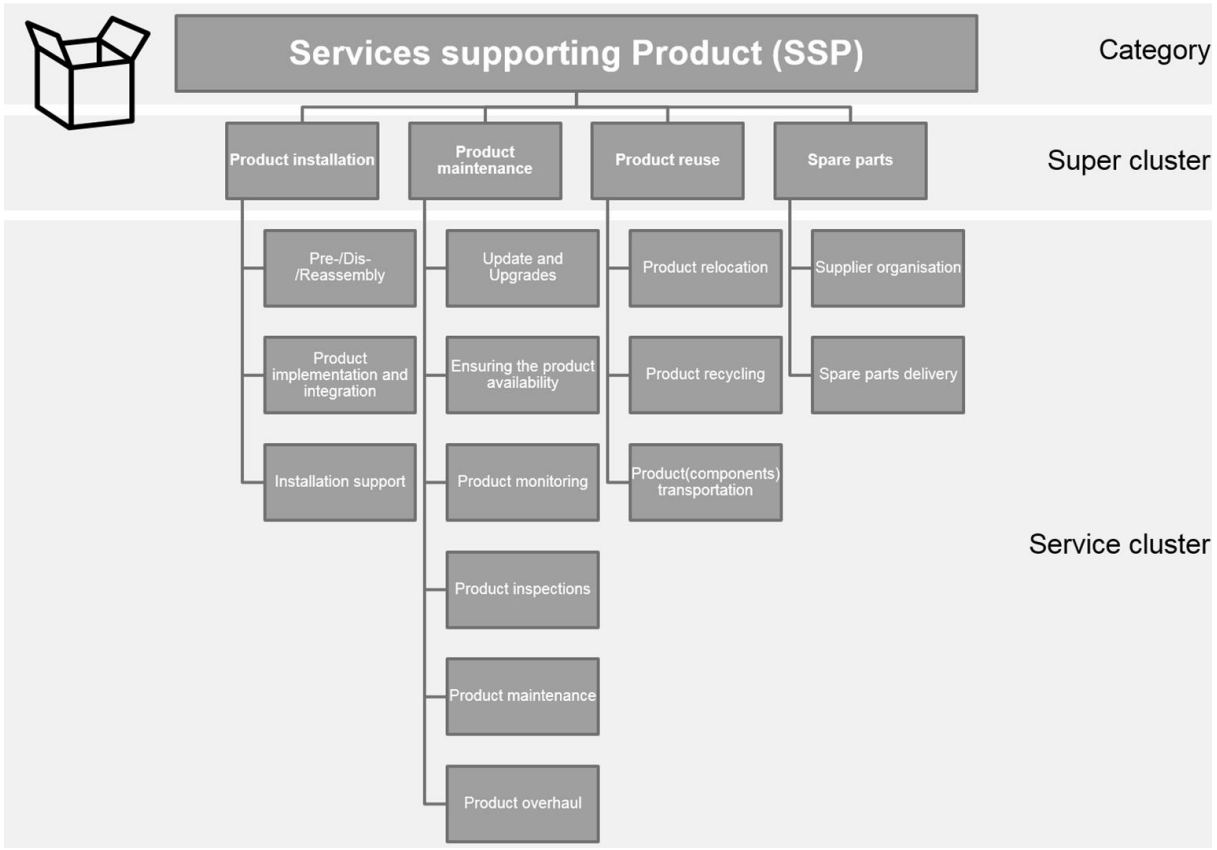

Figure 12-22 PowerPoint demonstrator: category SSP

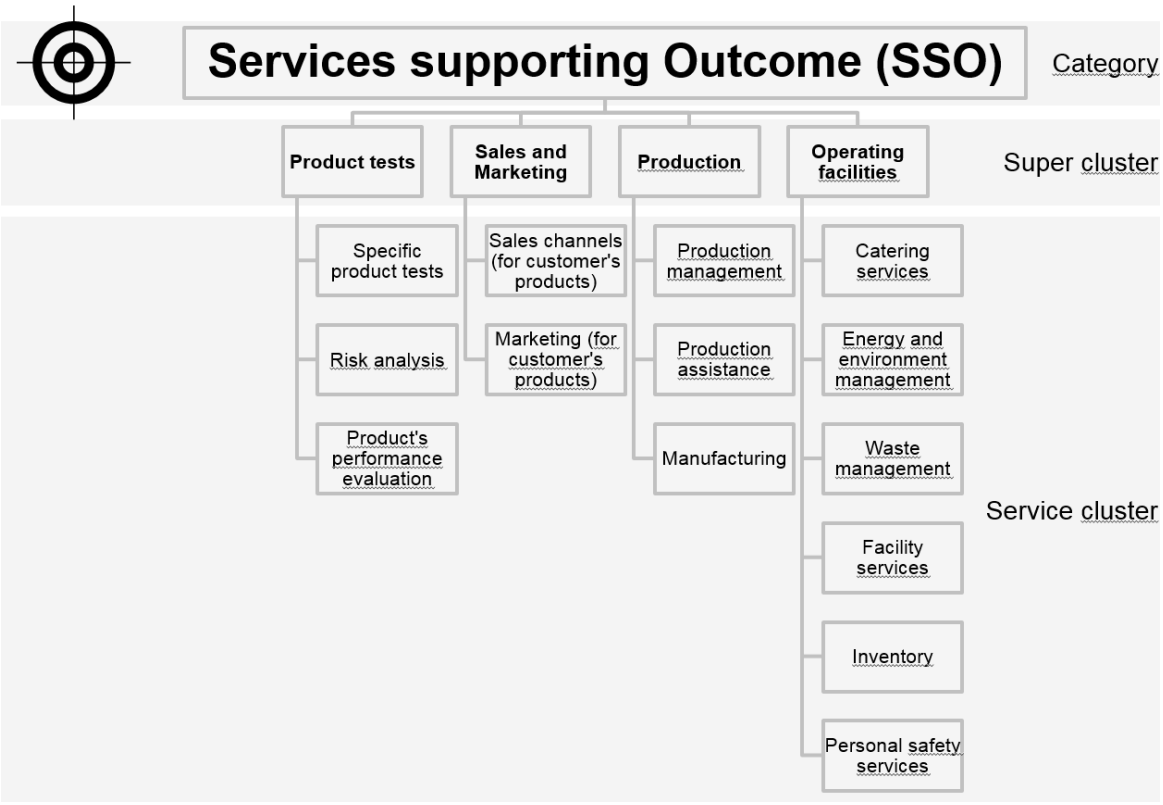

Figure 12-23 PowerPoint demonstrator: category SSO

Super cluster

Product maintenance

Update and Upgrades

- Updating or upgrading the product by replacing older parts by newer ones.
- Examples: Modifications, Upgrades, Software updates

Ensuring the product availability

- Guarantees a proper working of the product and its functions.
- Examples: Availability, Terminal service, Back-up tools/equipment

Product monitoring

- Provider monitors the product that is running at the customer's site to check if the product is working properly and to identify measures to improve product's functions.
- Examples: Alerts, notifications, reminders, Remote control, Control, Condition Monitoring, Remote monitoring, Remote-services, Diagnosis, Remote diagnosis

Product inspections

- Provider checks, analyzes and inspects customer's product.
- Examples: Annual Checks, Inspections, Remote inspections

Product maintenance

- Different kinds of maintaining the product, e.g. on-site maintenance etc. Maintenance services focus on ensuring the operating of the product.
- Examples: Calibration, Maintenance, On-site customer service

Product overhaul

- Overhauling the whole product and its concept by exchanging components or replacing wear parts. Overhaul can include upgrades to adapt the product to changing requirements.
- Examples: Weekend services, Overhaul, Refurbishing, Exchange of defective components, Repairing out-of-guarantee, Repairs, Exchange, Replacement of wear parts, Spare parts

Figure 12-24 PowerPoint demonstrator: supercluster product maintenance

12.3.8 Generic Question Catalogue

Sales Manager

1. Which market are you responsible for?
2. Which department are you responsible for?
3. Which brand do you work for?
4. For how long are you responsible for those markets?
5. For how long have you been working with this product?

Customer

6. What is important for customers and why?
7. What are the reasons why people do not buy this product?
8. What are the reasons why people do buy this product?
9. Select two or three main categories that are most relevant for the market/product/customer.

Values and Beliefs

10. Can you call the product a status symbol?
11. Do customer perceive the product as a status symbol?
12. How relevant is the exclusivity of the product?
13. Do customers have ethical/moral doubts concerning the product?
14. How is the product accepted on the market?
15. Which emotions does the product convey to customers?
16. Which emotions is the product supposed to convey to customers?
17. Which feelings/emotions does the customer have while using the product?
18. How does the brand influence the product/the purchase decision?
19. Which social group does the largest customer group belong to?
20. Who is the focused customer of the company/the product?
21. Which person of a household/company buys/uses the product?
22. Are there cultural barriers for purchasing/using the product?
23. Is it necessary to adapt the product to specific markets/countries/regions?
24. How do people from other cultures perceive/experience the product?
25. Do customers prefer traditional or innovative products?
26. How do customers of this market accept innovations or new technologies?
27. Are there religious barriers of using the product?
28. How should the product look like to be compatible to other religions?

29. Are there political restrictions that restrain the product's functionalities?
30. Which legal regulations are relevant for the product?
31. Do customers from other countries have reservations based on the origin country of the company/product?
32. What do customers from other countries associate with the origin country of the company/product?
33. How do people from other countries perceive the company/product?
34. How important is sustainability for the company?
35. How does the company meet the requirements of sustainability?
36. Are customers willing to pay more if the product/company is more sustainable?
37. Do the customers tend to be more and more sustainable?
38. Is sustainability is criterion to differentiate from competitors/competitive products?
39. Does the product focus on specific customer groups, e.g. LoHaS, LoVoS?
40. Which raw material is used for the product?
41. Are the raw materials recyclable?
42. Is it possible to separate the materials of the product after usage?
43. Does the product includes or needs critical materials?
44. Which social aspects does the company focus on?
45. How important is efficiency and effectivity in manufacturing for the company/product?
46. Which practical measures should improve the efficiency or effectivity in manufacturing?
47. How are working conditions of the company/suppliers compared to competitors?
48. What kinds of tests are conducted during product development?
49. Are there animal experiments?
50. Which is the main market of the product?
51. Which are the locations for manufacturing and how do they differ concerning the working conditions?
52. How relevant is the package of the product for the sustainability?
53. What is the average life time of the product?
54. Is it possible to repair the product?
55. Which resources are required for operating the product?

Unawareness of needs

56. Which circumstances make customers to buy the product?
57. Which circumstances require customers to use the product?
58. Are there different business models for the same product, e.g. purchase, leasing, pooling etc.?

59. Which advantages does the product mean for customers?
60. Are the customers aware of those advantages?
61. How is the benefit of the products communicated to the customer?
62. Which aspect of the product is underestimated?
63. What are the (main) reasons why customer do not know the product?
64. Which characteristics of the product do customers know?
65. Are the specific customer groups that mainly buy the product? Is this group the main part of customers?
66. Is the level of awareness of the product significantly higher for specific customer groups?
67. Which distributions channels and communication channels are used to contact customers?
68. Does the product mean a real benefit for customers and do customers know about this benefit?
69. Are the customers and users of the product the same?
70. How does the product distinguish itself from the previous generation/competitive products?
71. Is it possible to substitute the basic function of the product, e.g. by a different product/service?
72. Are there different technical solutions for the basic function of the product?
73. What are the weaknesses/potential for optimization of the product?
74. Which weaknesses do customer mention?
75. How are customers satisfied with the product?
76. Would customers buy the product again?

Trust

77. How easy is it for customers to change the product/provider?
78. Which costs/efforts do customers have to invest to change the product/provider?
79. How is the balance between customers' interests and company's interests?
80. How easy is the complaint management for the customers?
81. How are complaints managed and how are they evaluated?
82. Which channels can customers use to ask for feedback or to complain?
83. Do customers always know about the current order transaction?
84. Do customers understand the procedure of ordering?
85. Do customers receive information about the order transaction?
86. Do customers have access to all product characteristics/information?
87. What is the whole product/service portfolio of the company and what is the corporate strategy?

88. How can customers inform about the business model and the price structure?
89. Do customers know the provider's responsibilities?
90. Do customers get information of the provider's responsibilities?
91. Which requirements are necessary for sales personnel?
92. Do sales personnel participate training on a regular basis?
93. What do customers expect from the product?
94. How does the product meet the customers' expectations compared to competitors?
95. Are customers afraid of using the product?
96. Is it dangerous to use the product?
97. Which doubts against the product do customers mention?
98. Do customers benefit from new technologies/innovations that are integrated into the product?
99. Which advantages does the product have compared to the previous generation?
100. How are potential customers supporting in their purchase decision to find the best-fitting product?
101. How does the company convince customers to buy the product?
102. Is it possible to try/test the product before purchase?
103. Do customer buy the product/follow-up model again?
104. How important is the package of the product?
105. What is the function of the product's package?
106. Which properties/characteristics see customers in the product?
107. Which values does the company convey to customers?
108. Are emotions relevant for purchase decisions?
109. How is the turn-over-rate compared to customers of other providers?
110. What are points of sale?
111. How are the points of sale designed?
112. What is the most important characteristic of a point of sale?
113. Which feelings and emotions should the point of sale convey to customers?
114. Are there standards for points of sales?
115. How do the points of sale distinguish themselves from the competitors' points of sales?
116. Are the points of sales adapted to the product?

Psychological Phenomena

117. Do customers show irrational behavior concerning the product?
118. Which aspects of the product are relevant for customers' irrational behavior?

119. Are customers willing to pay more for additional features or functionalities?
120. How to customers evaluate/compare products of this market?
121. Which measures/methods do customers use to evaluate/compare products?
122. Which aspects of the price presentation are essential for the purchase decision?
123. Do the number of sales differ for varying variants of the product?
124. Which aspects are relevant for the product's aesthetics?
125. What is the objective of the product's aesthetics?
126. How important is the product presentation (product's aesthetics, design of point of sale) for the purchase decision?
127. Which aspect do customers perceive at a first impression at the point of sale?
128. How important is the first impression for the point of sale?
129. Do customers have a prejudice against the product/brand/company?
130. Are those prejudices justified? What are the reasons of those prejudices?
131. How is the recognition of the product/company supported?
132. How often to people/potential customers see/identify the product in their life/day?
133. How do customers evaluate additional features of those kinds of products?
134. Are the average lifecycle costs higher than the costs of purchase?
135. Are the average lifecycle costs or the costs for purchase more relevant for customers?
136. How important is the product presentation during purchase consulting?
137. Which business models are used for this product/service?
138. Is it possible to use the product without purchasing it?
139. How much are the costs of delivery?
140. How high is the rate of return and what are the reasons for returns?
141. How long do customers use the product?
142. In which time cycles should customers buy new products?
143. What the best time to replace the product?
144. Which services are offered during the usage phase? How often is it used?
145. How does the brand influence the product and the customer?
146. Does the product benefit from the brand?
147. Is it possible to sell the product without a strong brand?
148. Which emotions does the brand convey to customers?
149. What should customers associate with the brand/company?
150. Do customers really associate those aspects with the brand/company?
151. Why do customers appreciate the brand/company?
152. How popular is the brand/company compared to competitors?

153. What is the unique selling point of the product/brand/company?
154. How often do customers change the brand/company?
155. How many customers are new customers, how many are steady customers?

Perceived Complexity

156. Which elements does the price consists of?
157. Is the price structure transparent and easy to understand for customers?
158. What is the difference between the basic configuration and the most expensive configuration?
159. How many variants/configurations are possible? How do they differ?
160. Which are the distinctive characteristics between the product variants?
161. Is there a configuration manager for customers?
162. Which information/criteria does the configuration manager include?
163. Are potential customers able to test or try the product?
164. Which problems to customer have in using the product?
165. Is the product easy to understand/use?
166. Does the product identify and eliminate errors automatically?
167. Is it possible for customers to solve problems without specific knowledge/competences?
168. How long does it take for customers to use the product?
169. How does the current product's control differ from the control of the previous product generation?
170. Do customers have to learn the product usage after a while of not using?
171. Is the product usage complex for customers?
172. Do specific customer groups have problems in using the product?
173. Is it possible to buy the product online?
174. Is the online shop easy to use?
175. How often do customers cancel the online purchase process?
176. What are the channels of distribution/sales?
177. How are customers supported in finding the best-fitting product/variant?
178. Which services are offered before and after the purchase?
179. How often do customers use which service?
180. Which additional services might support customers before and after the purchase?
181. How is the customer supported in using the product?
182. Which activities of the customers are overtaken by the provider?

Costs and Prices

183. Which costs are relevant/most important for customers/users?
184. Which costs are notified by customers/users?
185. How important are those different costs for customers/users?
186. Do customers buy the product spontaneously?
187. How many efforts do customers have to spend before the purchase decision?
188. Do customers compare the product/product concept to others before the purchase decision?
189. Are specific competences/knowledge required for purchasing/using the product?
190. Does the product benefit from the brand/image?
191. Is the product stable in value?
192. What is the market strategy of the company (e.g. cost leadership, differentiation, innovation)?
193. Do customers change the provider? How high is the probability of changing the provider?
194. How high is the turn-over-rate in this branch?
195. What is the most often method of paying the product?
196. Are the products accessible for all potential customer groups?
197. Is there a financial service for the product?
198. How often and how do customers use financial services?
199. Is the costs of purchase the main evaluation criterion for customers?
200. What is more relevant for customers: costs of purchase or operating costs?
201. Is there a service for delivering/installing the product? Do customers have to pay additionally? How often do customers use this service?
202. Which resources does the product need for the complete functionality/best performance?
203. Are the similar products requiring different resources?
204. Are the guidelines for using the product?
205. How often do customers misuse the product?
206. Is the product maintenance-free?
207. How and how often does the product need maintenance?
208. Is there a disposal/deinstallation service for the product?
209. Do customers know about this service before purchase?

Interoperability

210. Is the product maintenance-free? Do the customers have to maintain the product?

211. Is it possible to check the state of the product? Is it possible for the customers?
212. Are customers able to identify and solve problems/errors?
213. Is it possible to individualize the product?
214. What kinds of individualization do exist?
215. Is the product upgradable?
216. Does the product need other products or equipment for operating?
217. Does the product require using other/complement products?
218. Are the modules of the product only compatible to this product?
219. Which tests/simulations were conducted to check the interoperability between the modules and the product?
220. Which steps/processes are necessary to startup the product?
221. Is it possible to use the product independent of the environment?
222. Will it be possible to use the product in the future?
223. Which environment/requirements/resources are needed for the product operating?
224. Which environment/requirements/resources are needed for the best performance of the product?
225. Are those environment/requirements/resources available?
226. Will the basic technology be used in the future?
227. What are the technology cycles of the basic technology?
228. How long are the innovation cycles of those kinds of products?
229. How could the next innovation/generation/evolution of the product look like?
230. How many households/companies/customers to own/use the product?
231. How many households/companies/customers to own/use similar/competitive products?
232. How will the market develop in the future?
233. Are there companies providing similar products?
234. What is the market position of the company compared to competitors?
235. Do other competitors have different market strategies, e.g. cost leadership, differentiation, innovation?
236. Which strategy does the company have?
237. Are there essential fluctuations in the demand?
238. Are there times/moments/days when the product is used more often?
239. Are there industrial standards for this kind of product?
240. Does the product have own standards or open/closed interfaces?
241. Is the product compatible to products from other providers?

Reliability and Availability

242. What are the main risks customers perceive?
243. How relevant are financial risks, performance risks, physical risks, and psychological risks for customers?
244. Do customers really have risks in buying/using the product? Do customers know/are they aware of those risks?
245. How to customers evaluate the level of innovativeness of the product?
246. Do customers know the benefit of innovative/new solutions compared to existing/conventional solutions/products?
247. Which benefits do innovative products of the company provide to customers compared to conventional products?
248. Is it possible to test/try the product before usage?
249. Do customers understand how the product works?
250. Which requirements need customers to fulfill for a proper usage of the product?
251. Are the guidelines for using the product?
252. Is the product easy to understand/use?
253. Is it possible to misuse the product?
254. Do customers know/recognize if they misuse the product?
255. Does the product prevent the customer from misusing the product?
256. Might the product get damaged because of customers misusing the product?
257. Does the product correct automatically errors during operating?
258. How do customers identify errors during operation?
259. How often are malfunctions of the product?
260. Which consequences/problems might emerge because of malfunctions?
261. Which safety/security precautions does the product include?
262. Is the customer able to bypass safety/security precautions?
263. Which safety/security concerns do customers have?
264. Does the product fulfill all (legal) regulations concerning safety/security?
265. Is the product more safe/secure than competing products?
266. Which security/safety tests were conducted to check the product?
267. Did the company make long-term studies to exclude health restrictions?
268. Does the product include toxic materials?
269. If safety/security systems fail, are the dangers for humans, environment, or the product?
270. Are there trainings for a safe/secure handling of the product?
271. Are singular costs of repair more expensive than the value of the product?

272. How long is the product life time?
273. In which cycles to technical innovations approach the market?
274. In which intervals does the product's environment change?
275. Is there a voluntary guarantee by the provider?
276. Which components/models tend to fail? Do they have a specific guarantee?
277. Does the company provide support for customers?
278. What are the channels for customers to get support? Do they have to pay for them?
279. Do customers have local servicing? Do they have to pay for this service?
280. Is the product tested for quality on a regular basis? Are those tests hidden and independent?
281. Are the suppliers and their quality certified?
282. Which personal data does the company receive from their customers?
283. Which data of customers does the company receive during the whole lifecycle?
284. Does the product force the customer to input personal data?
285. How does the company protect personal information of customers?
286. Do customers know that the company protects the personal information of customers?
287. What is the average delivery/waiting time of products in the branch?
288. How long does it take from incoming order until delivery to customers?
289. Do customers purchase spontaneously?
290. Are there essential fluctuations in the demand?
291. Are there times/moments/days/months the product is used/purchased more often?
292. Are there supply shortages of the product?
293. How many large-scale orders do occur?
294. Which efforts would customers have to generate/manufacture the product/service by himself?
295. Which tools/methods are used to ensure the product quality?
296. What are the important dimensions of quality for the product (performance, features, reliability, conformance, durability, serviceability, aesthetics, perceived quality)?
297. During which period are customers able to get spare parts?
298. How long does it take from incoming order to delivery of spare parts to customers?
299. Is it possible to individualize the product?
300. What kinds of individualization do exist?
301. Which costs do customers have to spend for individualization?
302. Which future regulations/restrictions might occur in the branch?
303. How often do legal regulations change?
304. Which lifecycle phase is your current product in?

305. Can customer use the product in 10/30 years without any restrictions? If not, why?
306. Are there technical innovations emerging in the near future?
307. How often does the company launch new versions of this product?
308. What are the major differences between product generations?
309. How long does the company offer support for the product (spare parts, services, updates)?
310. Can customer use the product in 10/30 years without any restrictions? Will there be enough material and immaterial resources?
311. How long does it take to get required supplies and resources?
312. Which efforts does it take to get required supplies and resources?
313. How often is the product down?
314. How long is a typical down time?
315. How often are similar products down?
316. How long is a typical down time of similar products?
317. What are the most often reasons why customers cannot use the product? How do customers accept those reasons?
318. Do customers accept the down time of the product?

12.3.9 Matching Services to Customer Aspects

Service clusters	Values and Beliefs													Unawareness of Needs	
	contentment	ethics	emotions	social incidents	culture	religion	politics	in producing and processing raw materials	in development	in manufacturing	in distribution and packaging	in product usage	in recycling and disposal	due to a lack of information	due to a n incentive problem
Personal safety services	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Inventory	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Facility services	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1
Waste management	0	0	0	0	0	0	0	0	0	0	0	0	3	1	1
Energy and environment management	0	0	0	0	0	0	0	3	3	3	3	3	3	1	1
Catering services	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Manufacturing	0	0	0	0	0	0	0	3	0	3	0	0	0	2	2
Production assistance	0	0	0	0	0	0	0	3	0	3	0	0	0	2	2
Production management	0	0	0	0	0	0	0	3	0	3	0	0	0	2	2
Marketing (for customer's products)	0	0	0	0	0	0	0	0	0	0	3	0	0	2	2
Sales channels (for customer's products)	0	0	0	0	0	0	0	0	0	0	3	0	0	2	2
Product's performance evaluation	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Risk analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Specific product tests	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Spare parts delivery	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Supplier organization	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Product(components) transportation	0	0	0	0	0	0	0	0	0	0	0	3	3	0	1
Product recycling	0	0	0	0	0	0	0	0	0	0	0	3	3	0	1
Product relocation	0	0	0	0	0	0	0	0	0	0	0	3	3	0	1
Product overhaul	0	0	0	0	0	0	0	2	2	2	2	2	2	1	1
Product maintenance	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Product inspections	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Product monitoring	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Ensuring the product availability	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Update and Upgrades	0	0	0	0	0	0	0	2	0	2	2	2	0	0	1
Installation support	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Product implementation and integration	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Pre-/Dis-/Reassembly	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Provision of data	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Security systems for electronic data processing	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Document management	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Transparency control	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Administration	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Project management	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Quality management	0	0	0	0	0	0	0	3	3	3	3	3	3	1	1
Certification	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Synchronous communication channels	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Asynchronous communication channels	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Specific tools	0	0	0	0	0	0	0	0	2	0	0	0	0	1	1
Engineering tools	0	0	0	0	0	0	0	0	2	0	0	0	0	1	1
Tools for planning	0	0	0	0	0	0	0	0	2	0	0	0	0	1	1
Investment planning	0	0	0	0	0	0	0	0	2	2	2	0	0	1	1
Structure planning	0	0	0	0	0	0	0	0	2	2	2	0	0	1	1
Product advancement	0	0	0	0	0	0	0	0	2	0	0	0	0	1	1
Product development and design	0	0	0	0	0	0	0	0	2	0	0	0	0	1	1
Software development	0	0	0	0	0	0	0	0	2	0	0	0	0	1	1
Staff administration	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Staff development	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Transaction management	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Asset management	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clearing services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tax consulting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Credit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Discounts	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Overdraft services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Price guarantee	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Product guarantee	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Product configuration and acquisition	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Product presentation	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Product-specific training	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2
Assistance by documentation	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Assistance by consulting	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2
Problem solving by platform-based communication	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Problem solving by personal support	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Problem solving by telephone communication	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

Service clusters	Trust										Psychological Phenomena												
	changing cost	opportunism and lacking commitment	complaint management	communication and information availability	lacking innovativeness, new products	customer's ability to evaluate products	comparison to previous products	quality and perception of packaging	brand loyalty	point of sale	framing effect	anchoring effect	status quo bias	representativeness bias	herding effect	discout effect	mere-exposure effect	endowment effect	sunk-cost effect	emotional bias	availability bias	value function	relativity bias
Personal safety services	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Inventory	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Facility services	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Waste management	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Energy and environment management	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Catering services	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Manufacturing	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Production assistance	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Production management	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Marketing (for customer's products)	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Sales channels (for customer's products)	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Product's performance evaluation	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Risk analysis	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Specific product tests	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Spare parts delivery	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Supplier organization	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Product(components) transportation	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Product recycling	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Product relocation	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Product overhaul	-1	1	2	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Product maintenance	-1	1	2	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Product inspections	-1	1	2	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Product monitoring	-1	1	2	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Ensuring the product availability	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Update and Upgrades	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Installation support	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Product implementation and integration	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Pre-/Dis-/Reassembly	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Provision of data	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Security systems for electronic data processing	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Document management	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Transparency control	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Administration	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Project management	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Quality management	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Certification	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Synchronous communication channels	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Asynchronous communication channels	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Specific tools	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Engineering tools	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Tools for planning	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Investment planning	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Structure planning	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Product advancement	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Product development and design	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Software development	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Staff administration	-1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Staff development	-1	1	0	2	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Transaction management	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Asset management	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Clearing services	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Tax consulting	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Credit	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Discounts	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Overdraft services	-1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-1
Price guarantee	-1	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Product guarantee	-1	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Product configuration and acquisition	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Product presentation	0	0	0	0	2	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2
Product-specific training	0	1	0	2	2	3	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0
Assistance by documentation	0	1	3	3	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Assistance by consulting	0	1	3	3	2	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0
Problem solving by platform-based communication	0	1	3	3	2	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0
Problem solving by personal support	0	1	3	3	2	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0
Problem solving by telephone communication	0	1	3	3	2	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0

Figure 12-25 DMM matching aspects of customer acceptance with service clusters (part 1 of 2)

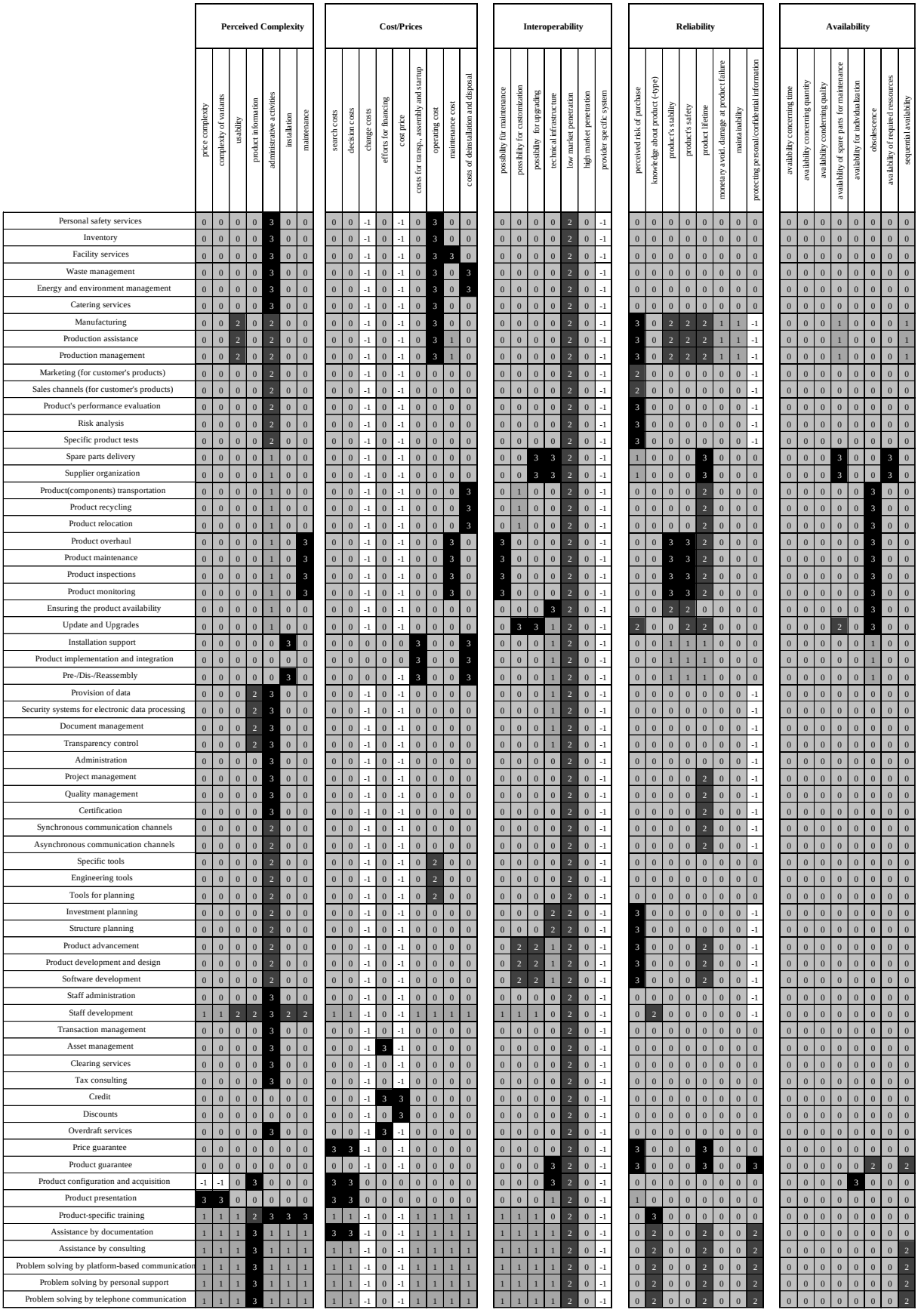

Figure 12-26 DMM matching aspects of customer acceptance with service clusters (part 2 of 2)

12.4 Guideline for Evaluation Interviews

Section 1: Information about the Person

1. What is your job description? What are your tasks?
2. Academic background (degree and profession)?
3. Professional work experience (in years, branches, topics)?
4. Experience with services, product-service systems? If yes, what kind of and how long?
5. Main branch/industry sector?
6. Which market/product are you responsible for? (Location, B2C, B2B…)
7. Which department are you responsible for/working in?
8. Which company/brand do you work for?

Section 2: After presenting the Methodology

Section 2.1: Model of Customer Acceptance

9. Do you understand the model of customer acceptance and its purpose?
10. Can you imagine any benefits of using the model of customer acceptance?
11. Do you know any other aspects of customer acceptance that are not included in the model of customer acceptance?
12. Do you have any ideas in which situations this model of customer acceptance will be used? Who might be the user?
13. How would you estimate the costs/efforts of applying and adapting the model of customer acceptance on a real situation?

Section 2.2: Decision-Making Process for Planning PSS

14. Do you understand the Decision-Making Process for Planning PSS and its purpose?
15. Can you imagine any benefits of using the Decision-Making Process for Planning PSS?
16. Are the relevant activities in PSS planning that are not mentioned by the planning process?
17. Do you have any ideas in which situation this planning process will be used? Who might be the user?
18. How would you estimate the costs/efforts of applying and adapting the planning process on a real situation?

Section 2.3: Service Catalogue

19. Do you understand the Service Catalogue and the matching between service catalogue and model of customer acceptance? Do you understand their purposes?
20. Can you imagine any benefits of using the service catalogue for planning PSS?
21. Do you know any essential services that are not included in the service catalogue?
22. Do you have any ideas in which situation the service catalogue will be used? Who might be the user?
23. How would you estimate the costs/efforts of applying and adapting the service catalogue on a real situation?

Section 3: After presenting the Case Studies

24. Do you understand the model of customer acceptance, the service catalogue, and the decision-making process better now?
25. Do you belief that those models and processes are applicable and usable for those cases? Why?
26. Do you think those models and processes were beneficial in those cases? Why? What would you have done in those situations?
27. Did the cases show the application and benefit of the models and processes?
28. Do you think the processes and models are compatible to each other?
29. Which markets/branches/products do you consider the processes and models as relevant for? Are they relevant for e.g. construction machines, cars, trucks, ships, trains, machine tools, manufacturing facilities, home appliances, mobile phones, laptops, or consumer electronics (B2B/B2C markets)?
30. What kinds of companies might need those processes/models? What kinds of companies, which situations, which strategical setting?
31. Do you see any weaknesses or potential for optimization of those models and processes?
32. Do you think the transforming from a product-seller to a PSS-provider can enable companies to increase customer acceptance?

12.5 Template for Analyzing Evaluation Inteviews

Interview ID: _____

	RQ #2: Model of Customer Acceptance	RQ #3: Service Catalogue	RQ #4: Decision-making process
Applicability			
Benefit			
Consistency			
Adaptability			

SWOT

Strengths	
Weaknesses	
Opportunities	
Threats	

General comments:

12.6 Relevant Student Theses in the Context of this Work

Bauer, P. (2014), Analyse und Identifikation von Aspekten der Kundenakzeptanz, (unpublished master thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (59).

Braun, F. (2014), Customer acceptance of Product-Service Systems on the example of electro vehicles in carpools, (unpublished master thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (65).

Böttcher, L. (2016), Verknüpfung eines Service-Kataloges mit Aspekten der Kundenakzeptanz, (unpublished bachelor thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (282).

Breyer, M. (2016), Konzipierung eines Produkt-Service Systems für ein elektrisches Skateboard, (unpublished semester thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (2933).

Brüderle, P. (2015), Steigerung der Kundenakzeptanz durch Produkt-Service Systeme, (unpublished semester thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (2866).

Brüderle, P. (2016), Verbesserung eines Produktangebotes durch Anwendung eines Ansatzes zur Steigerung des Service-Anteils, (unpublished master thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (165).

Curraj, V. (2016), Verknüpfung von Ansätzen der Produkt-Service-System Entwicklung mit Aspekten der Kundenakzeptanz, (unpublished semester thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (2965).

Felber, D. (2016), Produkt-Service Systeme zur Steigerung der Nutzerakzeptanz von Geschirrspülmaschinen, (unpublished semester thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (2921).

Festl, T. (2015), Steigerung der Kundenakzeptanz mit PSS bezüglich Zuverlässigkeit und Verfügbarkeit, (unpublished bachelor thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (182).

Hecht, T. (2015), Steigerung der Kundenakzeptanz durch Produkt Service Systeme in Bezug auf Nachhaltigkeit, (unpublished semester thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (2836).

Herzog, V. (2015), Product-Service Systems Influence on Reliability and Availability for Increasing Customer Acceptance, (unpublished semester thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (2852).

Hofbauer, S. (2016), Geschäftsmodelle für dezentrale Energiespeicher, (unpublished semester thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (2920).

Hübner, D. (2015), Interoperabilität durch Produkt-Service Systeme, (unpublished bachelor thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (188).

Hübner, D. (2016), Aufbereitung von Designunterstützungsmethoden für die praktische Anwendung, (unpublished semester thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (2955).

Huthmacher, M. (2016), Strategische Beeinflussung der Kundenakzeptanz durch Produkt-Service Systeme, (unpublished bachelor thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (259).

Jaugstetter, M. (2015), Klassifizierung von in Produkt-Service Systemen verwendeten Dienstleistungen, (unpublished master thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (188).

Jiménez Fernández, J. M. (2015), Increasing Customer Acceptance Using Product-Service-Systems, (unpublished master thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (91).

Klanner, M. (2015), Entscheidungsfindung in frühen Phasen der Produktentwicklung, (unpublished master thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (92).

Kleinmichel, F. (2015), Steigerung der Kundenakzeptanz durch Produkt Service Systeme in Bezug auf Komplexität, (unpublished semester thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (2840).

Klinkner, J.-N. (2015), Steigerung der Kundenakzeptanz in Bezug auf wahrgenommene Komplexität durch Produkt-Service Systeme, (unpublished bachelor thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (187).

Kügler, M. (2016), Barriers and Enabler of Circular Economy, (unpublished master thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (204).

Lolov, J. (2015), Steigerung der Kundenakzeptanz durch Produkt-Service Systeme im Hinblick auf Kosten und Preise, (unpublished bachelor thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (198).

Malaschewski, O. (2014), Entscheidungsprozess in der PSS-Planung, (unpublished semester thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (2799).

Malaschewski, O. (2015), Increasing Customer Acceptance Using Product-Service-Systems, (unpublished master thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (95).

Nguyen, D. T. (2016), Product-Service Systems for Increasing Consumer Acceptance of Dishwashers in the Growing Markets, (unpublished semester thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (2922).

Novak, G. (2015), Industrie 4.0 in Forschung und Entwicklung, (unpublished semester thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (2874).

Porta Comin, M. (2015), Zuordnung von Services zu Kaufbarrieren zur Steigerung der Kundenakzeptanz, (unpublished semester thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (2883)

Preuß, A. (2015), Entwicklung eines Produktmanagement-Werkzeugs für die frühen Phasen der Produktentwicklung zur Entscheidungshilfe bei multi-Parameter Entscheidungen, (unpublished master thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (82).

Schuck, S. (2015), Use of Product-Service Systems to Influence Product Complexity as a Barrier of Customer Acceptance, (unpublished bachelor thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (197).

Urquidi Guerrero, J. (2013), Kundenerlebnis und Kundenanforderungen an Ladesysteme von Elektrofahrzeugen, (unpublished bachelor thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (81).

Vollmann, T. (2014), Beziehungen zwischen Produkteigenschaften und irrationalen Kundenentscheidungen, (unpublished bachelor thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (130).

Wibowo, M. V. M. (2016), Strategic Influence of Product-Service Systems on Customer Acceptance, (unpublished bachelor thesis), Technical University of Munich, Munich, Germany, Chair of Product Development (258).