Customer-centric Service Management
Conceptualization and Evaluation of Consumer-induced Service Composition

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Summary

The customer takes over the center stage of tomorrow’s economy. In the wake of customer-centric service industries, traditional intermediaries are becoming increasingly obsolete and are substituted by self-services. Additionally, because of the ongoing digitalization, e-services provide various alternatives to the customer. Thus, self-directed customers must overlook and manage an increasingly complex network of services and providers themselves. Technology is a central factor in this context. On the one hand, it is the leading cause of the current challenges whereby, on the contrary, it is the key to solving them.

This work proposes the concept of Customer-centric Service Management (CSM). It is an interdisciplinary approach to adopt the service composition process from the field of business and IT to the particularities of consumers. Combining modular services to individualized and valuable service bundles is its objective. Making this type of interaction accessible for consumers requires a substantial reduction of complexity in the front end. The key to achieving this is by taking an outside-in perspective. This means understanding the decision process of the customer and speaking his language in a field that has been dominated by formal description standards and product parameters for a long time.

This work hypothesizes that a paradigm-shift enables consumer-driven service composition. Thus, the concept of customer-centricity is applied to service management. By letting the consumer describe himself, respectively his distinct needs and requirements, a better customer value is achieved than by traditional product-centric approaches. Unlike existing product-centric configuration tools, customer-centric configurators do not elicit product parameters. Instead, they rely on a structured description of customers’ intentions and values captured in a domain specific customer model. Consequently, the concept applies to a more abstract level of service categories instead of specific product instances. This refers to the pre-purchase phase of the consumer journey – a phase that is widely neglected by academia and practice yet.

This work analyzes the concept of CSM on a technical, process-related, and strategic level. Three elements are identified as the core of CSM: the customer model, the service model, and the composition logic. Each item is elaborated in detail at the example of financial services.

The concept of CSM facilitates current knowledge from different fields of research and finally implements them into a prototype. This demonstrator is the basis for a large field experiment to answer two questions: in the first place, does customer-centric service composition provide higher customer value regarding perceived complexity, solution utility and process utility? Moreover, secondly, does a reduced complexity, in respect of the amount of information that needs to be handled, without changing the configuration paradigm, have a greater impact on customer value?

Empirical validation shows that the customer-centric approach has significant advantages over the product-centric one. It offers higher customer value with respect to perceived complexity, perceived solution utility and perceived user experience. This proves the high potential of this concept. The findings of this thesis form the basis of a new form of customer interaction and enable new business models.
Content Overview

Declaration of Originality ................................................................. ii

Acknowledgements ................................................................................... iii

Summary .......................................................................................................... iv

Content Overview .......................................................................................... v

Table of Contents ............................................................................................ vii

List of Figures ................................................................................................... xi

List of Tables ...................................................................................................... xiv

List of Abbreviations ........................................................................................ xvii

1 Introduction .................................................................................................. 1
  1.1 Initial Situation and Problem ................................................................. 1
  1.2 Contribution and Research Question ..................................................... 8
  1.3 Research Approach ............................................................................... 13
  1.4 Thesis Structure .................................................................................... 17

2 Foundations .................................................................................................. 18
  2.1 Services .................................................................................................. 18
  2.2 Complexity ............................................................................................. 24
  2.3 Individualization .................................................................................... 30
  2.4 Service Management ............................................................................. 44

3 Conceptualization of Customer-centric Service Management ................. 55
  3.1 Customer-centric Service Management .................................................. 55
  3.2 Customer Model .................................................................................... 65
  3.3 Service Model ......................................................................................... 103
  3.4 Service Composition Logic ...................................................................... 122
4 Empirical Validation .......................................................... 144
  4.1 Objectives ........................................................................ 144
  4.2 Conceptualization ............................................................ 147
  4.3 Prototype .......................................................................... 159
  4.4 Experiment Design and Empirical Testing ......................... 169
  4.5 Data Analysis and Results ............................................... 174

5 Results, Evaluation and Outlook ............................................. 183
  5.1 Summary and Results ......................................................... 183
  5.2 Customer-centric Service Management as a Business-Model –
      Practical Startup Experiences ............................................. 186
  5.3 Outlook and Impact of CSM .............................................. 190
  5.4 Limitations and Need for Future Research ......................... 195

6 References .......................................................................... 196

Curriculum Vitae....................................................................... 228

Bibliographic Data.................................................................... 229
Table of Contents

Declaration of Originality ................................................................. ii

Acknowledgements ........................................................................... iii

Summary ................................................................................................. iv

Content Overview .................................................................................. v

Table of Contents ................................................................................... vii

List of Figures ......................................................................................... xi

List of Tables ............................................................................................ xiv

List of Abbreviations .............................................................................. xvi

1 Introduction .............................................................................................. 1

1.1 Initial Situation and Problem ............................................................... 1
  1.1.1 Digitalization of Services ................................................................. 1
  1.1.2 Consumerization ............................................................................. 1
  1.1.3 Paradigm Change towards Customer-Centricity ......................... 3
  1.1.4 Transformation of the Service Sector using the Example of the
      Financial Services Industry .............................................................. 5
  1.1.5 Disintermediation of the Customer Relationship ......................... 7

1.2 Contribution and Research Question .................................................. 8
  1.2.1 Vision of Customer-centricity in Service Systems ....................... 8
  1.2.2 Research Contribution ................................................................. 9
  1.2.3 Research Questions and Hypotheses ......................................... 11

1.3 Research Approach ............................................................................ 13
  1.3.1 Methodology ................................................................................. 13
  1.3.2 Research Setup ............................................................................ 14
    1.3.2.1 Competence Center ............................................................... 14
    1.3.2.2 Service Science Setting ......................................................... 15

1.4 Thesis Structure .................................................................................. 17

2 Foundations ............................................................................................. 18

2.1 Services ............................................................................................... 18
  2.1.1 Classification of Services ............................................................... 18
    2.1.1.1 Service Systems .................................................................... 22
    2.1.2 Service-Dominant Logic ............................................................ 23
2.2 Complexity ......................................................... 24
  2.2.1 Conceptualization of Complexity .............................. 24
  2.2.2 Complex Services ........................................... 26
  2.2.3 Complexity in Customer Interaction ........................... 27
  2.2.4 Complexity Management .................................... 28

2.3 Individualization .................................................. 30
  2.3.1 Individualization and Disintermediation ...................... 30
  2.3.2 Mass Customization ......................................... 31
  2.3.3 Mass Customization in the Service Industry ................ 33
  2.3.4 Mass Customization and Complexity ........................ 35
  2.3.5 Information Systems for Product Individualization ...... 37
    2.3.5.1 Mass Customization Configuration Toolkits ........... 37
    2.3.5.2 Recommender Systems .................................. 40
    2.3.5.3 Decision Support Systems ................................. 41
    2.3.5.4 Deficits of existing Information Systems for
      Customer-centric Service Individualization ............ 42

2.4 Service Management ............................................ 44
  2.4.1 Definition and Classification of Service (Lifecycle)
      Management .................................................... 44
  2.4.2 Business Perspective on Service Management .............. 46
    2.4.2.1 Service Lifecycle Management .......................... 46
    2.4.2.2 Sales and Advisory Process ............................. 47
  2.4.3 IT Perspective on Service Management ........................ 49
    2.4.3.1 Service Composition Process .......................... 49
    2.4.3.2 Product Configuration Process ......................... 50
  2.4.4 Consumer Perspective on Service Management ............ 53
    2.4.4.1 Consumer Decision Process (CDP) ..................... 53

3 Conceptualization of Customer-centric Service Management
.................................................................................. 55

  3.1 Customer-centric Service Management ........................... 55
    3.1.1 Definition of Customer-centric Service Management .... 55
    3.1.2 Generic Process for Customer-centric Service Management 58
    3.1.3 CSM-Framework .............................................. 63

  3.2 Customer Model .................................................. 65
    3.2.1 Deficits of Customer Models for Customer-centric Service
      Management – an Empirical Evaluation .......................... 65
    3.2.2 Overview of Customer Modeling Approaches .............. 70
    3.2.3 Generic Approaches to Customer Modeling ................ 72
      3.2.3.1 Classification of Customer Models ........................ 72
      3.2.3.2 Customer Modeling Approaches ........................ 74
    3.2.4 Customer Modeling in the Context of CSM ............... 76
      3.2.4.1 Generic Properties of CSM-oriented Customer Models
      ............................................................................. 76
      3.2.4.2 Consumer Decision Making in the Field of
      Complex Services .................................................. 78
## 3.2.4.3 Formalization of the Information for Consumer Decision Making in CSM .................................................. 79

3.2.4.4 Customer Model Elicitation ................................................. 89

3.2.5 VOC-OE – A Methodology for Bottom-Up Customer Modeling ........................................................................... 92

3.2.5.1 Ontology Engineering .......................................................... 92

3.2.5.2 Voice of the Customer Analysis ............................................. 95

3.2.5.3 Ontology to Model Mapping ............................................... 99

3.2.5.4 Application of VOC-OE in the Financial Services Industry ................................................................................. 100

### 3.3 Service Model .................................................................................. 103

3.3.1 Service Classification and Structuring ........................................ 103

3.3.1.1 Modularity as a Guiding Principle for Services ............... 103

3.3.1.2 Service Granularity and Service Typologies .................... 103

3.3.1.3 Service Domain Representation ....................................... 106

3.3.1.4 Customer-centric Service Ecosystems ............................... 109

3.3.2 Service Description Standards .................................................. 110

3.3.3 Customer-centric Service Evaluation ....................................... 111

3.3.3.1 Consumers Decision Making Strategies ......................... 111

3.3.3.2 Customer-centric Quantification Approach ...................... 114

3.3.4 Exemplary Service Model for Financial Services ................... 118

### 3.4 Service Composition Logic .............................................................. 122

3.4.1 Matching Markets ..................................................................... 122

3.4.2 Service Composition Approaches ........................................... 123

3.4.2.1 Definition and Classification of Service Composition ........ 123

3.4.2.2 Existing Service Composition Approaches ...................... 124

3.4.2.3 Phases of Service Composition ....................................... 128

3.4.3 Service Selection Phase ........................................................... 128

3.4.3.1 Laddering Task ................................................................ 128

3.4.3.2 Matching Task .................................................................. 129

3.4.4 Service Bundling Phase ............................................................ 135

3.4.4.1 Bundling Task ................................................................. 135

3.4.4.2 Linking Task ................................................................. 140

3.4.5 Service Composition for the Example of Financial Services .... 140

### 4 Empirical Validation ........................................................................ 144

4.1 Objectives ......................................................................................... 144

4.1.1 Customer Value of Customer-centric Service Management .... 144

4.1.2 Formalized Hypotheses ........................................................... 145

4.2 Conceptualization .......................................................................... 147

4.2.1 Research Model Evaluation ................................................... 147

4.2.2 Formalization of the Research Model .................................... 153

4.2.2.1 Structural Model ......................................................... 153

4.2.2.2 Measurement Model .................................................... 156

4.3 Prototype ......................................................................................... 159
4.3.1 Objectives and Requirements ........................................ 159
4.3.2 Generic Architecture of a Configurator System .................. 160
4.3.3 Specification and Implementation .................................... 161

4.4 Experiment Design and Empirical Testing ............................. 169
4.4.1 Research Procedure and Experiment Design ..................... 169
4.4.2 Focus Group Interviews ........................................... 170
4.4.3 Field Experiment .................................................. 171

4.5 Data Analysis and Results ............................................. 174
4.5.1 Qualitative Results ................................................ 174
4.5.2 Quantitative Analysis .............................................. 178
4.5.3 Quantitative Results .............................................. 179

5 Results, Evaluation and Outlook ......................................... 183
5.1 Summary and Results .................................................. 183
5.2 Customer-centric Service Management as a Business-Model – Practical Startup Experiences ............................................. 186
5.3 Outlook and Impact of CSM ........................................... 190
5.3.1 Technological Impact of CSM ................................... 190
5.3.2 Business Impact of CSM ......................................... 191
5.3.3 Social Impact of CSM ............................................ 193
5.4 Limitations and Need for Future Research .............................. 195

6 References .............................................................................. 196

Curriculum Vitae ........................................................................ 228

Bibliographic Data ..................................................................... 229
List of Figures

Figure 1-1: Service Intensity Matrix and types of customer interaction..................2
Figure 1-2: Paradigm-change towards customer-centricity ..................................3
Figure 1-3: Challenges towards disintermediation in the service sector ...............8
Figure 1-4: Aspects and implications of customer-centric service individualization. 10
Figure 1-5: Research questions and hypotheses ....................................................12
Figure 1-6: Generic overview of the consortium research tool set .......................14
Figure 1-7: Interdisciplinary research setting of this work in the context of service science..........................................................16
Figure 1-8: Thesis structure ..............................................................................17
Figure 2-1: Service classification ........................................................................22
Figure 2-2: Classes of customer interaction processes and their inherent complexity ........................................................................................28
Figure 2-3: Illustration of Teslers law ..................................................................29
Figure 2-4: Evolution of service management concepts and the relationship between complexity transformation and consumerization .....................30
Figure 2-5: Classification of mass customization approaches .............................38
Figure 2-6: User-knowledge in context of parameter-based and need-based configuration ....................................................................................39
Figure 2-7: Classification of mass customization examples regarding their degree of freedom.....................................................................40
Figure 2-8: Multiperspective service management landscape ............................45
Figure 3-1: CSM as meta-advisory .................................................................62
Figure 3-2: Self-advisory process .......................................................................63
Figure 3-3: Hybrid-advisory process .................................................................63
Figure 3-4: Framework for Customer-centric Service Management ..................64
Figure 3-5: Experiment design for the evaluation of consultation template from banks ......................................................................................67
Figure 3-6: Scope of customer modeling vs. scope of customer profiling ..........72
Figure 3-7: Classification of customer models ..................................................73
Figure 3-8: Decision Making Core ....................................................................81
Figure 3-9: Components of Customer Perceived Value ....................................85
Figure 3-10: Kano's model of customer satisfaction ..........................................87
List of Tables

Table 2-1: Differences between goods and services ........................................ 20
Table 2-2: Qualitative characteristics of complexity ....................................... 25
Table 2-3: Mass customization in customer interaction .................................... 32
Table 2-4: Deficits of existing individualization systems considering customer-centric service individualization .................................................... 43
Table 2-5: Service Lifecycle Management process ......................................... 46
Table 2-6: Universal advisory process ......................................................... 47
Table 2-7: Generic advisory process for banks .............................................. 48
Table 2-8: Service composition process ....................................................... 49
Table 2-9: Product configuration process ...................................................... 51
Table 2-10: Propose-Critique-Modify service configuration (e3 Service Framework) ......................................................... 52
Table 2-11: Consumer Decision Process (CDP) model .................................. 53
Table 3-1: Distinction between customer-centric and product-centric individualization ........................................... 57
Table 3-2: Extraction of relevant activities for Customer-centric Service Management .................................................... 60
Table 3-3: Reference process of CSM and its tasks ....................................... 61
Table 3-4: Elements of a standardized consultation protocol from a customer perspective ......................................................... 66
Table 3-5: Content of consultation minutes by the sample banks ...................... 68
Table 3-6: Calculated difficulty index for each question type ............................ 69
Table 3-7: Quality attributes of conceptual models ....................................... 76
Table 3-8: Specifics of customer models in the application area of CSM ........... 77
Table 3-9: Qualitative specifics of customer models in the application area of CSM ......................................................... 78
Table 3-10: Exemplary granularity levels of consumer intentions .................... 81
Table 3-11: Expression of customer intentions based on different reference points.. 82
Table 3-12: Models of human needs .............................................................. 84
Table 3-13: Overview of elicitation techniques for self-service scenarios .......... 91
Table 3-14: Overview of Ontology 101 methodology ..................................... 95
Table 3-15: Characteristics of the data fields in the customer model and mapping rules .............................................................................. 100
Table 3-16: Overview of service domain representation concepts .................. 108
Table 3-17: Comparison of service evaluation approaches .......................... 115
Table 3-18: Service composition approaches and their deficits in the context of CSM ........................................................................................................ 127
Table 3-19: Logical matching filters .................................................................. 132
Table 3-20: Core elements of the generic product model .................................. 136
Table 4-1: Comparison of customer-value-related conceptual models for the experiment .................................................................................................. 152
Table 4-2: Items of the structural equation mode .............................................. 158
Table 4-3: Description of the configuration variants that are implemented for the empirical validation .................................................................................. 168
Table 4-4: Stages of the experiment ...................................................................... 170
Table 4-5: Preference ranking of configuration variants ..................................... 177
Table 5-1: Characteristics of a solution engine .................................................. 191
Table 0-1: Design-science research guidelines .................................................... 231
Table 0-2: Structure and content of the consultation template of Bank 1 (anonymized) .............................................................................................. 234
Table 0-3: Structure and content of the consultation template of Bank 2 (anonymized) .............................................................................................. 236
Table 0-4: Structure and content of the consultation template of Bank 3 (anonymized) .............................................................................................. 238
Table 0-5: Structure and content of the consultation template of Bank 4 (anonymized) .............................................................................................. 239
Table 0-6: Sample size iteration procedure for ANOVA ................................. 252
List of Abbreviations

ANOVA - Analysis of Variance
ATM - Automated Teller Machine
CC - Customer-centric
CDL - Customer-Dominant Logic
CDP - Consumer Decision Process
CSM - Customer-centric Service Management
DFT - Decision Field Theory
DSS - Decision Support Systems
EU - Expected Utility
HC - High Complexity
IS - Information Systems
IT - Information Technology
LC - Low Complexity
MC - Mass Customization
OE - Ontology Engineering
PC - Product-centric
PU - Perceived Usefulness
QoS - Quality of Services
RS - Recommender Systems
SDL - Service-Dominant Logic
SEM - Structural Equation Model
SLM - Service Lifecycle Management
SM - Service Management
SST - Self-Service Technology
TAM - Technology Acceptance Model
USDL - Universal Service Description Standards
VOC - Voice of the Customer

Abbreviations for technologies and models, which are accepted proper names or are given solely as examples, are not listed.
“I invented nothing new.
I simply assembled the discoveries of other men behind whom were centuries of work.”
(Henry Ford)
1 Introduction

1.1 Initial Situation and Problem

1.1.1 Digitalization of Services

The service sector has become the largest economic sector with an approximate share of 68 percent of the global Gross Domestic Product (World Bank, 2017). This sector is not only relevant because of its size and its rate of growth - the ongoing differentiation of the product class “service” makes it a recent field of interest for academia and practice.

The relevance of services in the economy is expected to increase even further. For some time, corporations were trying to sell market packages of customer-oriented combinations of goods, knowledge, and services. The trend that services are becoming the dominating part of these offerings is called servitization (Vandermerwe & Rada, 1988). The corresponding process of augmenting an organization’s service business orientation is concurrently referred to as “service infusion.” In today’s economy, terms like “product service system” or “hybrid offerings” denote the presence of servitization in practice. The economic importance of services is expected to grow even further across many industries (Kowalkowski, Gebauer, Kamp, & Parry, 2017).

Electronic- and hybrid forms of service creation and delivery do increasingly supplement or substitute traditional services. Five out of the ten most valued companies in the world1 have service-based business models - most of them facilitate IT as the foundation of their value proposition (Financial Times, 2013). That fact depicts the digitalization of the service sector. To reflect this technological factor, the term digital service or e-service is used to describe services that are provisioned digitally. Unlike traditional services, that are mainly based on manual labor and personal interaction (e.g., a haircut), digital services are usually conducted online and only occasionally require manual labor (e.g., service chats) or can be automated completely (e.g., transaction processing).2

Because of servitization and digitalization, the number and heterogeneity of (digital) services and providers have significantly increased. There is a direct effect on the consumer that leaves him overwhelmed by the choices among the existing options - demanding for further assistance. This work is settled in the field of services and e-services. It takes the view of the consumer on the specifics of this area and the effects of digitalization of the evolving service sector.

1.1.2 Consumerization

Over the recent years, the corporate environment is more and more infiltrated by innovations that emerged from the consumer sector (Ingalsbe, Shoemaker, & Mead, 2011). This

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1 In 2013, these companies were Apple Inc., Berkshire Hathaway Inc., Wal-Mart Stores Inc., Microsoft Inc., and IBM Inc.
2 A more formalized definition of e-service is given in Section 2.1.1.
trend shows a substantial impact on today’s economy and is frequently referred to as “consumerization” (Weiß & Leimeister, 2012).

The advent of Web 2.0 technologies, such as blogs, wikis, and social networks led to the observation that technology and IS are no longer developed with experts and skilled users in mind. Instead, improving the accessibility of IT for consumers became a leading design principle. Since then, the trend has been confirmed by recent technologies, like mobile devices, apps, and also by concepts like gamification (Weiß & Leimeister, 2012).

The result of this development is that consumers have more powerful tools at their disposal than ever before. Information is abundant, and consumers can refer to multiple sources they trust. Information asymmetry is shifting away from providers and intermediaries to the advantage of the client. No longer is the user restricted to be solely a consumer of a service. Instead, he has been enabled to design and compose services on his own.

Several psychographic trends in society back this technology-driven empowerment of the customer. New capabilities meet new requirements: an increasing number of customers prefers electronic interaction over traditional physical contacts (Forbes, 2014; IBM ExperienceOne, 2014; Jacobs, Girouard, & Helders, 2012; Roland Berger, 2013). Traditional intermediaries face a massive loss in trust (Accenture, 2012). Again, financial services serve as an example: Even five years after the financial crisis, 71 percent of the people think, that banks have not learned from their mistakes (“Financial crisis, five years on: trust in banking hits new low,” 2012). A study by Edelman (2012) shows that consumers trust financial services less than any other industry. Inevitably, slogans like “Nobody cares more about your money than you do” established for increasingly financial aware consumers (J. D. Roth, 2009). The same applies for other industries, too. Comparison engines, review portals, and online communities are increasingly popular tools to compensate the lack of trust. At the same time, people demand more transparency and want to have control over their belongings.

Figure 1-1: Service Intensity Matrix and types of customer interaction

The effects of consumerization on the service sector can be illustrated by using Teboul’s Service Intensity Matrix (2006, p. 41ff.). This model describes the primary factors that

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3 Consumerization is often used in the context of privately owned IT that is used for business purposes. In this regard, it primarily focuses on the implication of consumer IT on the internal processes and structures of companies. However, its original definition has a much broader view. It describes the design of IT aligned to the purpose of consumers.
determine the concept of service intensity. It proposes a direct correlation between the amount of interaction and the extent of standardization. Service creation is subdivided into frontstage- and backstage services. Frontstage processes are visible to the customer whereas backstage processes are not. Each commercial service is a combination of both – with a gradual transition. The extremes of this model show two antithetic types of customer interaction. One, where an individual service is usually delivered through personal interaction, and another, where a standardized service is provided through a low level of interaction, like online interaction respectively self-service.

Naisbitt et al. (1999) refer to these extremes as “high touch” and “high tech.” High touch caters to the traditional understanding of “good service” with close person-to-person interaction, which stands in contrast to high tech interaction that symbolizes cheap and inferior self-service. However, what makes a “good” service is subject to change. One of the most obvious examples of this shift in consumer behavior may be the extermination of the gas station attendant. Once the embodiment of excellent service and a differentiator in competition, the attendant quickly vanished after the first self-service gas station appeared in the 1970s. Very high turnovers refuted initial skepticism quickly. Meanwhile, self-service refueling became standard, and many customers nowadays have hesitations about service personnel that has been reintroduced sporadically (Kilimann, 2013). This example shows a general tendency towards high tech interaction in society and is backed by other studies (e.g., Gavett, 2015). However, what still lacks in high tech interaction is personalization (Teboul, 2006). A gap between self-service and individualization emerged, that must be closed (see Figure 1-1). The user must not only be able to consume services via high tech interaction, but he also must be able to configure the service offering according to his individual needs (on his own).

1.1.3 Paradigm Change towards Customer-Centricity

Because of the trends presented before - namely, the digitalization of the service sector and the consumerization of IT - a fundamental shift is believed to take place in tomorrow’s economy. Due to these two forces, the balance of power is shifting away from businesses towards the customer. Thus, a paradigm change towards customer-centricity in tomorrow’s economy is a basic assumption of this work.

![Figure 1-2: Paradigm-change towards customer-centricity](link)

As Figure 1-2 shows, the conception of businesses being at the center of any economic activity is increasingly becoming obsolete. Once, businesses sold their products to customers respectively customer segments. Most business models were based on the assumption, to be the only provider to fulfill customer needs in a specific domain (no interrelations to other firms do exist). From their point of view, customers had to adapt to their
product offering. Nowadays, empowered customers are taking over the center stage (cf. Heinonen & Strandvik, 2015). No longer have customers to rely on a single vendor. Instead, they facilitate the “best” provider available for each purpose. Out of a variety of specific vendors, they choose the best to fulfill a given need. Furthermore, nowadays, individualized solutions replace yesterday’s standardized products (Österle & Senger, 2011).

In literature, one of the first to recognize the starting trend towards customer-centricity was Galbraith (2005). He considered customer-centricity as the opposite to product-centricity. Indeed, the concept of product-centricity is very similar to company-centricity and is therefore used synonymously throughout this work. Several advantages of customer-centric strategies have been identified, e.g., higher returns on investment, lower customer retention costs and more sustainable competitive situations (cf. Selden & Colvin, 2003). Table 1 summarizes the characteristics of the ongoing paradigm change.

<table>
<thead>
<tr>
<th>Goal</th>
<th>Product-centricity</th>
<th>Customer-centricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Offering</td>
<td>New products</td>
<td>Personalized packages of products and services</td>
</tr>
<tr>
<td>Value Creation Route</td>
<td>New products, new applications, useful features</td>
<td>Customizing for best overall solution</td>
</tr>
<tr>
<td>Most Important Process</td>
<td>Product development</td>
<td>Solution development and customer relationship management</td>
</tr>
<tr>
<td>Perspective</td>
<td>Inside-Out</td>
<td>Outside-In</td>
</tr>
</tbody>
</table>

Table 1: Product-centric versus the customer-centric paradigm (cf. Galbraith, 2005, p. 9ff.)

In fact, the concept of customer-centricity⁴ is not new at all. As early as 1954, Peter Drucker (2010, p. 37ff.) already stated “it is the customer who determines what a business is. For it is the customer, and he alone, who through being willing to pay for a good or service, converts economic resources into wealth, things into goods”. Kirchgeorg (2014) defined customer-centricity as the orientation of all market-related activities of a company to meet the needs and problems of customers. In this sense, customer-centricity is also a strategic instrument, especially for service businesses.

A recent contribution to the concept of customer-centricity is the work of Gulati (2010). He considers customer-centricity as a mental view. It describes the paradigm shift of businesses as a transformation from “inside-out” thinking (“We make, you take”) to customer-centered “outside-in” thinking (“Your problems are our problems”) (Gulati, 2010, p. 195ff.). Gulati defines inside-out companies as heavily focused on products, sales, and organization, while outside-in businesses aim to provide solutions to the customer. To prove the benefits of customer-centric organizations, Gulati calculated an average shareholder return of customer-centric companies, which is more than ten times higher as the average S&P 500 performance (Gulati, 2010, p. 11ff.). A more resolute plea for customer-centricity takes Fisk (2009), who states that “[t]he customer perspective is the only correct perspective for the modern service organization. All other perspectives are imperfect at

⁴ The main distinction is, product-centricity is usually used by companies to describe the market, whilst company-centricity is used from an external market view to describe the market-structure.

⁵ Moreover, customer-centricity should not be confused with customer-orientation or customer-focus. The latter ones still follow inside-out thinking and are steps on the transition towards customer-centric organizations.
best.” He argues, that although the customer’s view is known in the subfield of marketing, it is not known in other fields yet. In his opinion, this is a critical necessity for the service sector to embrace: “adopt as customers are liberated, or they liberate themselves” (Fisk, 2009). The idea that the customer belongs at the center of attention of any business, also lead to the **Customer-Dominant Logic** (CDL) – a holistic scientific theory that has received noteworthy attention by academia and practice recently (Heinonen & Strandvik, 2015). CDL is built on five key elements: business perspective, customer logic, offering, value formation and customer ecosystem. It emphasizes marketing and business logic based on customer dominance and provides managerial and theoretical implications.

Assuming the paradigm changes towards customer-centricity, this work contributes both, an approach that facilitates the shift towards customer-centricity in practice and that is designed from an outside-in perspective itself.6

### 1.1.4 Transformation of the Service Sector using the Example of the Financial Services Industry

A good example for the digitalization of an entire industry is the **financial services sector**.7 The financial services industry, especially banking, has been a leader in the facilitation of information technology (IT) since the beginning (Ambrus, 2007). For financial companies, information processing is a core capability, whereas data is their primary production factor (Puschmann & Alt, 2016). However, due to the complexity of the provided services, the face towards the customer has been the local branch respectively the personal advisor for decades. This is going to change: IT is no longer restricted to the back office – it plays an increasingly important role for the customer front, too (B. King, 2010, p. 14ff.).

In 1960, the first ATMs emerged and revolutionized retail banking. This event marks the beginning of an evolution towards **self-services** in the financial industry. ATMs source straightforward and repetitive tasks to the customer. Since then, this concept has proven to be highly successful, due to higher convenience and availability for the clients. Providers do also take advantage of self-service by saving costs and increased revenues (S. C. Berger, 2009). Since then, self-service technologies (SST) have steadily amplified the importance of IT (Ambrus, 2007).

Another milestone in the evolution towards e-services marks the advent of direct banks. In the 1990s, the Internet has reached a maturity level, that allowed an adoption of self-service as the foundation of new banking business models. Online banking made many banking services accessible directly to the customer. This event triggered a transformation from traditional brick-and-mortar into “click-and-mortar” banking that is still going on. Physical channels are losing relevance for the benefit of digital channels (Cortiñas, Chocarro, & Villanueva, 2010; Martins, Oliveira, & Popovič, 2013). Compared to traditional branches, online banking causes only 25 to 30 percent of the costs for its providers (Ho & Ko, 2008). The most recent milestones of this ongoing transformation process are

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6 The transformation from a company-centered business to a customer-centric organization is a distinct field of research and out of the scope of this work. The focus of this work is not on the intra-organizational challenges of business, but rather on the considerations of customers in respect how they manage service networks on their own.

7 For the reasons stated in Section 1.3.2, financial services industry is further on referred to as an example throughout the entire work. Nevertheless, this work is intended to be generic and applicable to other service sectors too.
today’s mobile- and social banking innovations as well as decentralized infrastructures, such as Blockchain.

**Information technology** (IT) is the first, among three drivers, that currently enables a profound transformation of the financial service industry (Sachse, Puschmann, & Alt, 2012b). IT has shown its transformative potential on business models and value chains in other industries before (see e.g., Gordijn, Osterwalder, & Pigneur, 2005; Grewal, Chakravarty, & Saini, 2010; Kagermann, Österle, & Jordan, 2010). For instance, the convergence of the Internet, electronic music players, music streaming and digital music stores made the physical distribution of music almost immediately obsolete. This leads to a fundamental change in market structures and redefined the balance of the power in the media industry (Alon & Gurvich, 2008). Although the banking sector has been among the pioneers in IT adoption of e-commerce solutions and has undertaken substantial investments in IT infrastructure (Khansa, Zobel, & Goicochea, 2012). The same effects can be observed in the financial services industry today. Innovations like mobile devices and social networks establish an infrastructure for future means of payment and financial advisory. Big data concepts, smart appliances, and personal assistants are just some other key technologies that are potential disruptors in this domain.

Second, is the changing behavior of customers. For instance, interaction preferences have changed. Nowadays most bank customers (97 percent) use multiple channels to interact with their bank (Cortiñas et al., 2010). The vast number of clients (88 percent) prefer the online channel instead of branches (51 percent). Customers demand the freedom to choose the most appropriate channel as they wish and even want to switch anytime among them. As a result, multichannel and cross-channel strategies have emerged and established. Another trend in finance are multi-vendor relationships. Two out of three customers intentionally keep affiliations to several financial service providers (Sachse et al., 2012b).

Third, competitors from foreign sectors have disrupted the financial service sector. Third-party providers like telecommunication providers, IT-companies, and start-ups (so-called "FinTechs") offer new services, such as e.g., online investment advisory, and substitute existing ones, for example, through peer-to-peer business models. The number of these new actors and their highly innovative services is proliferating. Nonbanks have strength in recognizing unsatisfied customer needs. Market niches, underserved populations, and unutilized technologies are often the cornerstones of their business model (Weichert, 2008). Other reasons may be that banks consciously decide to not get involved because of investment requirements and reputational risks (Tarantin & Cernauskas, 2010). Banks are also more restricted from a regulatory point of view in expanding their business (M. Spence, Leipziger, & Commission on Growth and Development, 2010, p. 47ff.). In conjunction with electronic ecosystems, even small niches become viable markets. As a result, besides the growing number of e-services offered by banks, heterogeneous providers, and different services add additional variety to this market.

These factors qualify the financial industry as an appropriate application example for this work. The trends of digitization, servitization, and consumerization perfectly apply for this industry. The paradigm shift towards customer-centricity is more evident than in most other sectors: The customer has choices among alternative services in almost every

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8 Those trends are leading to profound changes in the overall industry structure. While today the banking industry is still characterized by one-customer to one-bank-relationships (“main bank-model”), a shift towards technology-enabled infrastructures, intermediaries and connected markets as in other industries is expected to happen (Guba & Lincoln, 1994, p. 107).
aspect, and self-service interaction can take place over many channels. What customer-centricity means and how one enables it can be exemplified throughout this work based on this domain.

1.1.5 Disintermediation of the Customer Relationship

A customer-centric economy, as outlined in Section 1.1.3, exposes the customer to new challenges. The benefits of putting the customer at the center of business do not come without a price: In addition to the already given customer involvement and efforts during service consumption, he must from now on compose and manage a network of service providers himself. Cutting out the middlemen presents new problems to the customer. Parts of the value chain are relocated to him. This process is called “disintermediation.” Disintermediation describes a loss of importance of intermediaries (mediators between different actors) in an economic system (Chircu & Kauffman, 1999). Referring to the example of the financial services industry, disintermediation can already be observed by the trend that advisors become obsolete, and customers increasingly inform and sign financial services themselves over the Internet.

Paradoxically, the notion of a customer-centric economy means that customers have an increasing need for assistance in fulfilling the additional tasks they now have to handle themselves. Intermediaries exist for good reasons. Cutting them out inevitably raises the need for dedicated tools (i.e., IT-systems) that enable the customer to fulfill sophisticated tasks via self-service, which once have been done by mediators before.

Intermediaries are used in two cases: Either to integrate a number of services for the customer during use, or to make inaccessible services accessible to the customer during the initial search and purchase phase. The single purpose of intermediaries is to provide “coordination” (Sarkar, Butler, & Steinfield, 1995). This purpose encumbers functions like search and evaluation, needs assessment, product matching, purchase influence and information dissemination (Sarkar et al., 1995). By providing these functions, intermediaries deliver benefits for the customer. Namely, the benefits of an improved customer experience during service interaction, the higher utility of the consumed service and reduced complexity during the service evaluation and consumption process.

According to this, in a customer-centric self-service setting the functions of an intermediary must be taken over by the customer himself. This will probably be accomplished by some form of IT support. Otherwise, the above benefits convert in their opposites and become major obstacles towards self-service in customer-centric settings. Figure 1-3 shows the challenges towards customer-centricity which are the threads to a proper disintermediation.

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9 The process of “Service Management” is subject to Section 2.4 in detail. Every service lifecycle embodies two major phases: First, the phase of identifying, individualizing and purchasing services, that is referred to as “design time”. Second, the phase of using and consuming services, known as “run time”.

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Figure 1-3: Challenges towards disintermediation in the service sector

The first obstacle towards proper disintermediation is the utility. Utility describes the positive qualities of a product as experienced by the customer (Tversky & Kahneman, 1986). Utility results from the outcome of a service. Significant domain expertise of intermediaries ensures a high-quality result. If instead, a customer with low expertise personalizes a service bundle with little or no utility compared to intermediaries, the adoption of customer-centricity is at risk.

The second obstacle is the customer experience. While the utility focuses on the outcome of a service; experience covers the cognition of the service delivery process as perceived by the client. If customer-centric approaches cannot compete with intermediaries in aspects like convenience, speed or understandability, they are likely to be avoided by customers. This prevents acceptance and lowers practical relevance of customer-centric approaches.

The third and last obstacle is the complexity. Complexity relates to the amount of information that is necessary to describe a (service) system (Norman, 2011). Since every function an intermediary provides is related to information processing, complexity is a ubiquitous issue in customer-centricity. Complexity is an explanatory variable to the two above factors. This means, both rely on the factor complexity. Because of the importance of this factor, Section 2.2 covers complexity in detail.

From a consumer’s perspective, these three factors summarize the challenges that prevent disintermediation, respectively any form of self-service individualization in the service sector. This work considers them in an integrated approach to enable a transformation of the service economy towards a customer-centric economy.

1.2 Contribution and Research Question

1.2.1 Vision of Customer-centricity in Service Systems

This work envisions a customer-centric service economy, to which the initially stated trends and characteristics fully apply. At this background, the arising needs of the customers will be used as the guiding principles. A scientific contribution towards this future form of economy shall be given. To be more specific: This work aims to find an approach
on how customers can create an 1) individualized service solution on their own with 2) limited knowledge and 3) high expectations towards process experience and the resulting utility. At the same moment, the stated adverse effects of improper disintermediation must be avoided or minimized.

This vision represents the core principles of an integrative concept that will be named “Customer-centric Service Management (CSM)” and which is the core artifact of this work. Chapter 3 introduces CSM as a framework and a methodology. Also, a formalized definition and an exhaustive classification of CSM and its related aspects are given there.

Until then, the work is centered around the concepts of customer-centricity and service individualization. It is essential to understand the “what” before the “how” can be derived thoughtfully. Some central assumptions define the focus of this research:

- **Individualization**: A service consumer must pass two major phases: The design time-phase and the run time-phase. Run time describes the actual service creation and consumption. The design time covers the composition of service elements in a meaningful way before consumption. Only the design time-phase describes the process of service individualization and thus is the focus of this work.
- **Service domain**: This work entirely focuses on services as the elements of individualization. Their particularities will be elaborated and differentiate this work from prior research that almost entirely focuses on physical goods.
- **Consumer focus**: The term “consumer” is consistently used throughout the entire work with the meaning of a typical retail customer within a business-to-consumer (B2C) and consumer-to-consumer (C2C) setting. His or her distinct expectations towards solution utility and user experience characterize the consumer. Furthermore, the relatively low level of expertise and domain knowledge (on average across all individuals) distinguishes him from other service customers, such as experts and professionals.\(^{10}\)
- **Self-directed**: The elimination of intermediaries during the individualization process results in the increased inclusion of the customer throughout the process. A customer who is more self-directed will need support that may arise from IS via self-service technologies. Throughout the work, the customer is the active part that acts on its own. This notion is also referred to as “customer-induced.”

### 1.2.2 Research Contribution

The idea of customer-centric service individualization covers different aspects, and its implications can be assigned at various levels (see Figure 1-4).

\(^{10}\) The term “customer” is also used regularly throughout this work. It describes any person or party that receives value from a provider. According to this definition, it could theoretically refer to professionals in a B2B-setting too. But in context of this work, it refers to consumers only.
Figure 1-4: Aspects and implications of customer-centric service individualization

On a broad sense, customer-centric service individualization describes a new paradigm\(^{11}\) in service economies, which promotes the notion that consumers can and should create individualized service solutions on their own, without the means of intermediaries. This paradigm-view comprises different facets that are covered during this work:

- **Customer-centric, regarding being “run” by the customer:** This work fosters information systems that are designed for and used by end consumers. Putting the consumer at the center stage demands new skills and creates new rules for businesses. It also poses new requirements towards IT-systems which are offered to the customer within the field of application.

- **Customer-centric, regarding being focused on customer needs:** Business models, as well as information systems, have long been centered around products. Instead, customers demand solutions that are based on their particular needs and are part of an open ecosystem, which is defined by the customer.

- **Service-focus:** Servitization of the economy requires formerly product-centric companies to understand the particularities of services in order to succeed with their new competitors.

This work contributes a general view on customer-centric service individualization in the context of the current economic situation and future trends. Its findings serve as a strategic guidance to understand the changing conditions and how to take appropriate actions.

On a narrower sense, customer-centric service individualization, respectively CSM, serves a framework\(^{12}\) for applying customer-centric service configuration for mass customization in the domain of complex services. It provides a multi-perspective view: this work takes the belongings of three major stakeholders into account: customers, businesses and IT. For each group, their particularities will be considered on a strategic-, process-, and IT-level. This allows the adoption of the findings into practical use.

\(^{11}\) A paradigm is a worldview or a “basic belief system based on ontological, epistemological, and methodological assumptions” (Johnson, 1997). It serves as a standpoint that is usually in stark contrast to other paradigms.

\(^{12}\) From a technological viewpoint, a framework is a “reusable design of all or parts of a system that is represented by a set of abstract classes and the way their instances interact.” (Wong & Aspinwall, 2004, p. 94). In a business context, a framework is a theoretical basis that relates to “a structure that comprises relevant entities or a set of guiding principles and ideas that support a discipline” (Peffers et al., 2007). This work combines aspects of both definitions.
In its core, customer-centric service individualization and especially the concept of CSM is a methodology for formalizing and implementing customer-centric service composition into a configuration toolkit. This is also the emphasis of this work and the field where most of the scientific contribution will take place. It comprises three major artifacts:

- **Methodology for needs classification**: Customers must state their intentions and needs to find individual solutions. For this purpose, a method to define domain-specific preference profiles (customer model) is proposed and validated.

- **Methodology for service evaluation**: Services must be classified and described in a way, that they can be matched to the customer profiles and at the same time comply with business constraints (service map and service model). For this purpose, a methodology for service description and quantification is introduced that takes the particularities of decision making from a customer-perspective into account.

- **Methodology for selection and bundling**: Finally, the customer and provider side must be matched to create individual solutions. Therefore, methodologies for service selection and solution bundling are derived and implemented.

The methodological toolset is the core of this work. The paradigm- and framework level serve as an overall context for it. The methodology fills the major part of this work and obtains the highest depth of research. Its scientific contribution is of integrative and interdisciplinary nature. Its findings are backed by empirical validation, such as expert interviews and prototype-based focus group- and field research.

### 1.2.3 Research Questions and Hypotheses

This work aims to present an approach on how even lowly expertized customers can create individualized solution bundles on their own. It is believed that this can be achieved with the later introduced concept of CSM. Therefore, the work ultimately intends to validate the proposed concept of CSM and document its benefits. To operationalize this goal, a sequence of hypotheses and research questions is addressed to narrow down the field systematically:

13 A methodology is “a system of principles, practices, and procedures applied to a specific branch of knowledge” (Österle & Otto, 2010). Unlike a framework, that describes the (static) elements and their inherent interrelationships in a given domain, a methodology defines the process of how to gather the knowledge and information to instantiate a framework.

14 These four research questions accord to the four stages of design science research (cf. Vargo & Lusch, 2015). See Section 1.3.1.
Figure 1-5: Research questions and hypotheses

RQ 1 (Analysis): Which deficits do existing self-service individualization approaches have?

The concept of CSM is based on the assumption that service individualization does significantly differ from the customization of physical products. E.g., configuration toolkits from the field of mass customization do hardly take the characteristics of services, such as intangibility and co-creation, into account. On the same hand, a high willingness of consumers for self-service technologies does exist.

RQ 2 (Design): How can customer-centric individualization of complex services be enabled?

Based on the characteristics of customer-centricity and the derived requirements a suitable approach is deducted. It is hypothesized that the key lies in letting the users describe themselves, i.e., their needs and demands in their own language. The elements that make up customer-centric service composition must comprise interdisciplinary fields of research.

RQ 3 (Evaluation): Does customer-centric service composition provide a significant value to the customer?

After having proposed a concept for customer-centric service composition, the key question arises, is it any “better” than existing approaches? The customer-centric approach is believed to overcome the downsides of existing approaches and may provide additional benefits to the involved stakeholders, especially to the customer. It is hypothesized that CSM is “better,” as it delivers a higher customer value and lowers the level of perceived complexity.

RQ 4 (Diffusion): Which practical and theoretical implications do occur from customer-centric composition?
Knowing the potentials and limitations of customer-centric configuration, the consequences towards business models and markets must be examined. It is hypothesized that customer-centric information systems, as well as customer-centric business models, will quickly become relevant for practice. The key takeaways are derived from the findings of previous steps and practical implementation. The learnings will also be of relevance for future research and academic work.

1.3 Research Approach

1.3.1 Methodology

Research in information systems aims at explaining, describing, designing and predicting computer-based information systems and their use in business, administration and private environments (Laudon, Laudon, & Schoder, 2010, p. 61). Acquiring such knowledge involves two distinct research paradigms: firstly, behavioral science from the field of natural science research that explains or predicts phenomena surrounding information systems. Secondly, design science from engineering and sciences of art for solving problems (March & Smith, 1995). Behavioral science describes what can be observed, in contrast, design science builds and evaluates new artifacts to meet identified needs. The goal of the first one is the truth, of the second, is the utility (Hevner, March, Park, & Ram, 2004). This work is settled in the second one – design science. The primal of design science research is that knowledge is acquired by building artifacts (Hevner et al., 2004). It aims to deliver results which are both, of scientific rigor and practical relevance (R. Winter, 2008). In this context, artifacts can be models (abstractions and representations), constructs (vocabulary and symbols), instantiations (implemented and prototype systems), and methods (algorithms and practices) (Hevner et al., 2004).

In contrast to other fields of research, the design science approach faces unique problems like unstable requirements, ill-defined environments, complex relationships among subcomponents and critical reliance upon human abilities like creativity or teamwork (Hevner et al., 2004). As a result, guidelines for design science in information systems research have established, e.g., by Hevner et al. (2004) (see Appendix 1), or the Design Science Research Methodology (DSRM) by Peffers et al. (2007) (cf. Österle & Otto, 2010). However, in its broad scope, it leaves researchers alone on how to conduct research in cooperation with the practitioner community. To strengthen the practical relevance besides scientific rigor, the “consortium research” methodology has been developed (Österle & Otto, 2010). It provides guidance on how to foster knowledge transfer between practitioners and academics in design-oriented IS research. Consortium research aims to ensure relevance through the participation of professionals, access to resources of partner companies, rigorous artifact design through iterations with multiple partners and dissemination of research results in academia and practice. This is done by

- the common definition, assessment, and evaluation of research objectives,
- a community of several research partners,
- an artifact designed to solve practical problems,
- the commitment of partner companies to support, test and finance the research process,
Consortium research embraces existing approaches, such as design science guidelines, from Hevner et al. (2004), DSRM from Peffers et al. (2007), case study research and participatory action research. Figure 1-6 gives an overview of the applied consortium research method during this work. This illustration is not extensive and relevant techniques, methodologies and components for this work will be introduced later.

Figure 1-6: Generic overview of the consortium research tool set (Österle & Otto, 2010)

### 1.3.2 Research Setup

#### 1.3.2.1 Competence Center

An aspect of consortium research is the concept of Competence Centers (CC’s) (Back, Krogh, & Enkel, 2007). This work is based on consortium research as proposed by (Österle & Otto, 2010) that has been conducted between 2011 and 2014 within the “Competence Center Sourcing in the Financial Industry” (CC Sourcing). This project is a collaboration of several universities\(^\text{15}\) and 18 companies from the financial industry\(^\text{16}\) in

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\(^\text{15}\) Institute of Information Management by University of St. Gallen (CH), Information Systems Institute by University of Leipzig (D), Swiss Finance Institute by University of Zurich (CH) and Swiss Design Institute for Finance and Banking by Zurich University of the Arts (CH)

\(^\text{16}\) see http://ccsourcing.org
Germany and Switzerland. The research took place during the fourth and fifth iteration of the competence center which was focused on technology-driven innovations and customer-driven value creation in the financial industry. To guarantee stable research conditions and practice commitment, companies financed the project and contracted to a two-year involvement (that corresponds to one phase of the project). In return, the research scope was defined by a steering committee of the partner companies. During each phase, six consortium meetings took place. These meetings were workshops to present, discuss and evaluate the main results among scientists and practitioners. Each session lasted three days. Additionally, bilateral workshops and projects took place to deepen certain aspects and ensure practical applicability.

Besides the collaboration within the project community, which is the core of this research, some sub-projects have significantly affected this work:

**Banking Innovations:** During the beginning of this work, first examples of disruptive innovations in the financial industry emerged. Companies demonstrated services like finance communities and mobile payment solutions and concurrently raised scientific interest. A continuous collection of Fintech-Startups, and later on institutionalized market screening for technology-driven innovative financial services, was done to research the activities in this transforming market. This led to a repository that captures the variety of available services. Further on, this list has been developed towards a freely accessible online database called the “Banking Innovation Database”. The Banking Innovation Database is a unique service and was the first of its kind in the German-speaking area to collect innovative services with a worldwide scope. Each of the collected innovations was scientifically analyzed according to an expert-defined framework (see Appendix 2). This led to an in-depth understanding of Banking Innovations which resulted in the definition of “Banking Innovation” (a term that was coined in the CC Sourcing and is now commonly succeeded by the term “FinTech”) for renowned Gabler’s Lexicon of Banking (Gramlich, Gluchowski, Horsch, Schäfer, & Waschbusch, 2014). Furthermore, the “Banking IT-Innovation Award” was granted yearly since 2011 which built knowledge and span a network among the FinTech-community.

**Lectures and Lab Nights:** Academic duties have been a constant part of the research process. Besides lectures on financial information systems and business process management, so-called “Banking Innovation Lab Nights” ensured a steady knowledge exchange with students. This has been a valuable inspiration for the creative aspects of DSR and also ensured constant access to sources for qualitative and empirical evaluation of basic hypotheses.

Since there is significant expertise in the domain of financial services based on the stated research setup, financial services industry will be used as a leading example throughout the entire work (see also Section 1.1.4).

### 1.3.2.2 Service Science Setting

This work is placed in the interdisciplinary field of service science. **Service science** integrates a variety of research areas in engineering, computer science, business and other associated fields by concentrating on service as the essential phenomenon. It envisions the

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17 see http://banking-innovation.org
“discovery of the underlying logic of service systems and the establishment of a common language and shared research frameworks” (Fragidis & Tarabanis, 2011). Despite its interdisciplinary approach, service science belongs to IS research that has its “realm […] at the confluence of people, organizations, and technology” (Hevner et al., 2004). To describe the importance of the interdisciplinary approach, the major stakeholders, that will be referred to throughout the entire work, are briefly introduced:

**Business**: Customer-centricity has many implications for businesses, such as process redesign, altered value propositions or strategic orientation. The business view is necessary to gain domain expertise and to understand the process of meeting and satisfying customer needs.

**Customer**: Understanding the customer is key to this work. For a long time, the client's perspective was missing in IT and played only a minor role in business. The originality of this work results from the switch to outside-in-thinking. Recognizing how customers perceive services and how they decide which service to use is a fundamental aspect of this work.

**Technology**: IT provides the means to capture and implement the formalized customer-centric process beyond bold marketing claims and vague strategic decisions. IT describes the information processing in a universal, yet precise and repeatable way.

![Interdisciplinary research setting](image)

*Figure 1-7: Interdisciplinary research setting of this work in the context of service science*

A stated by Gregor & Hevner (2013), a fundamental issue of service science is that nothing is really “new.” Everything is built out of something else and upon existing ideas. In light of this, the contribution of this work can be seen as an integrative achievement that creates something new out of existing, but formerly distinct, elements.
1.4 Thesis Structure

The thesis is structured into five parts. In the previous Chapter 1, the research is motivated and the research setup is introduced. Chapter 2 defines the basic terms and concepts as the foundation for this work. It also presents the research framework. Chapter 3 presents a conceptual approach to Customer-centric Service Management. The major artifacts, namely the customer model, the service model and the composition logic, are derived and instantiated at the example of the financial services industry. Chapter 4 empirically validates the customer-centric paradigm and shows practical implications to business models of financial service companies. The final Chapter 5 summarizes this work and shows links for future research and practical usage.

Figure 1-8: Thesis structure
2 Foundations

Some key terms and concepts are essential to this work. Although many of these expressions, that have been used during the introduction, might be intuitively understood, they have highly ambiguous meanings and must be further clarified to operationalize them for subsequent research.

Services are the central entities of this work. They describe to which field this research refers. The characteristics of services define the particularities of this work and help to point out the challenges that arise. As elaborated in Section 1.1.5, complexity is an essential aspect of those challenges. It is a broad term that covers relevant topics such as service systems and customer interaction. Individualization and its various occurrences in practice, finally describe the intended goal of this work. In this regard, understanding the “why” helps to derive the correct “how.”

Scientific work usually relates to existing concepts and builds upon established models. This work is no exception. The process of arranging and administering services has a sound foundation in IS research. It is settled in the field of Service Management. The research takes a multi-perspective view on the process of service individualization from a business, technological and consumer viewpoint. In their conjunction, the foundations of a customer-centric individualization approach can be derived.

At this point, each of these aspects is covered separately. The elaboration of these core concepts serves as the foundation for the integrated model that is developed in Chapter 3.

2.1 Services

2.1.1 Classification of Services

Being broadly defined as intangible commodities, a traditional view on services often emphasizes personal interaction and manual labor as their constitutional characteristics. However, the facets of services have steadily broadened in recent years: for example, the advent of electronic commerce leveraged virtual interaction and process automation. Consequently, a new type of services, named digital services, emerged. Since then, digital services grew in relevance steadily. This trend is still going on and it even gains traction. Nowadays, new service-subclasses such as social- and mobile commerce are blending the fringes between traditional services based on manual labor and modern digital services.

An increasing number of services incorporate hybrid forms of customer interaction, where there is no longer a clear distinction between physical and electronic contact. These new ways of service contribute further heterogeneity to the spectrum of the service economy.

The term service is understood and defined in a broad range of meanings. Viewpoints depend on domain and research area. Therefore, it is necessary to rely on a precise working definition for the purpose of this work. To achieve this, an understanding of two broad conceptions of services is required: the business view and the technical view on services.
**Business-driven definitions** of service do emphasize the value provision towards a customer. In this sense, a service is a “revenue generating offering. Something that the company performs for a customer who sees value in it and is, therefore, willing to pay for it” (Wilson, 2006, p. 31). A service is a product offered to the customer that provides value. Service thinking gained attraction especially in the field of marketing. A popular definition of Kotler (2011) stresses four characteristics of services applied in a business context:

- **Intangibility**: Services are not physical and cannot be touched, tasted, seen or detected with other human senses. This has implications towards understandability and uncertainty for customers.

- **Inseparability**: Physical products can be produced and consumed at different times and places. Services are produced and consumed simultaneously. Furthermore, since the customer receives the outcome of the service at the same time it is delivered, he is also highly integrated into the creation process (“co-creation”). This fact also has implications towards scalability: since each customer has to be treated individually, service provision is hardly scalable to large volumes (if performed manually).

- **Variability**: The quality of a service depends on several aspects. Who provided it, when, where and to whom? These question words illustrate the reliability of the perception of a service on contextual factors. Since service buyers are aware of this potential variability, they have developed strategies to deal with this uncertainty, e.g., by relying on recommendations or gathering excessive information.

- **Perishability**: Services cannot be stored. Companies providing 24/7 customer service have to provide sufficient resources for service delivery permanently right at the moment of demand. Dealing with peaks and lows is a non-trivial task and in most cases subject to continuous optimization.

These characteristics by Kotler (2011) are primarily focused on the fundamental distinction between intangible services and physical goods. This disjunction is critical since services and goods are often inaccurately referred to as ***products***.

<table>
<thead>
<tr>
<th>Goods</th>
<th>Services</th>
<th>Resulting Implications</th>
</tr>
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<tbody>
<tr>
<td>Tangible</td>
<td>Intangible</td>
<td>Services cannot be inventoried.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Services cannot be patented.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Services cannot be readily displayed or communicated.</td>
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<tr>
<td></td>
<td></td>
<td>Pricing is difficult.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Services cannot be owned.</td>
</tr>
<tr>
<td>Standardized</td>
<td>Heterogeneous</td>
<td>Service delivery and customer satisfaction depend on employee actions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Service quality depends on many uncontrollable factors.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>There is no sure knowledge that the service delivered matches what was planned or promoted.</td>
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<tr>
<td></td>
<td></td>
<td>Services are harder to evaluate than goods.</td>
</tr>
<tr>
<td>Production separate</td>
<td>Simultaneous production and consumption</td>
<td>Customers participate in and affect the transaction.</td>
</tr>
<tr>
<td>from consumption</td>
<td></td>
<td>Customers affect each other.</td>
</tr>
</tbody>
</table>
Table 2-1: Differences between goods and services (T. F. Schröder, 2007, p. 72)

<table>
<thead>
<tr>
<th>Nonperishable</th>
<th>Perishable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees affect the service outcome.</td>
<td>Services cannot be returned or resold.</td>
</tr>
<tr>
<td>Decentralization may be essential.</td>
<td>Synchronizing supply and demand with services is difficult.</td>
</tr>
<tr>
<td>Mass production is difficult.</td>
<td>Services cannot be returned or resold.</td>
</tr>
<tr>
<td>Services can more easily be delivered via electronic channels.</td>
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</tbody>
</table>

Although in everyday use, "product" is often used synonymously to a physical good, it is not the same. For example, in the field of financial services bankers often speak of products regarding the financial services they sell (e.g., mortgage, funds). This is the view on "products" used by marketers: “In marketing, a product is anything that can be offered to a market that might satisfy a want or need” (Kotler & Keller, 2011). A more general definition characterizes products as “the core output of any type of industry” and “goods can be described as physical objects or devices, whereas services are actions or performances” (Lovelock & Wirtz, 2010). In this sense, services and goods are both subtypes of a product. This means, that both services and goods are a product, but not necessarily vice versa. If the term “product” is used further on in this work, it means both - goods and services as their supertype.

In contrast to the business perspective, technology-driven definitions of services see them as functional components with a certain degree of automation. Services are means to higher abstraction to make system architectures and application landscapes more flexible (Fischbach, 2014). In information technology and IS research, services are reusable software components. According to conventional definitions (cf. Arsanjani, 2004; Lawler & Howell-Barber, 2007; MacKenzie, Laskey, McCabe, Brown, & Metz, 2006), services have the following characteristics from a technological-driven point of view:

1. **Identity**: Technical services are instances of abstract service classes. Therefore, they must have a unique identifier to be accessible for other services.
2. **Modularity**: Services are structured in a way that minimizes dependencies between different services. Services are designed to encapsulate coherent logic and data into a single service (cohesion). Thus, each service acts as an autonomous unit that allows loosely coupled communication with other services. To achieve modularity, the interfaces of each service have to be defined to ensure interoperability with other services. Another benefit that results from interface orientation is a high level of platform independence in service use.
3. **Functionality**: Each service offers some functionality, usually by processing data. This function must be specified in addition to the interface specification.
4. **Facilitation of technology**: Services interact over an (information) network. Thus, information technology has to be facilitated to some degree.

An example for the technology-based view on services are **Web services**. Each Web service has a Uniform Resource Identifier (URI), through which it can be identified (1) and an interface described in a machine-readable format (usually WSDL) that defines how to interact with the Web service (2, 3). The communication may (but must not necessarily)
run on Internet protocols, such as HTTP and XML-based derivatives (4). Web services are purely intended for machine-to-machine interaction.

Web services are examples for the purely technical notion of services and commercial services are their corresponding counterparts from the business perspective. Commercial services are services found in physical-world marketplaces. They can be seen synonymously to “products” as perceived by consumers. Unlike Web services, commercial services are hardly describable regarding interface specifications. Instead, they inherit their attributes from fields of marketing and social studies (Razo-Zapata & Leenheer, 2012, p. 46).

At the intersection between business driven and technology-driven notion of services, a service category has emerged that unifies characteristics of both sides. These hybrid forms are referred to as e-services: with the rise of the Internet, services are increasingly offered via electronic means. In this area, the field of e-service-research has emerged to research especially the differences between the "old world of services" and the "new one" (Baida, 2006).

Fischbach summarizes the situation as follows: „from a business viewpoint, a service is the result of a process. From a technical standpoint, a service provides a defined outcome, is comprehensively specified and exhibits an interface that hides the internal realization of the service from the environment (encapsulation)” (Fischbach, 2014).

This work adopts the hybrid view on services and refers to them either as digital services or e-services. While researchers in the past argued the different perspectives on services represent distinct "extremes" (cf. Baida, 2006, p. 18), this work emphasizes the importance of the combination of both fields as a major contribution to academia and practice.

Besides the differentiation between physical and intangible products, and technical vs. business views on services, another important dimension defining services that must be mentioned is the level of automatization (Cook, Goh, & Chung, 1999). The degree of manual labor, IT intensity and other factors may vary widely. Some services, like haircuts, do consist almost entirely of manual actions, while other services like getting stock quotes are performed completely automated nowadays. In practice, many services are hybrid, containing manual and automated elements, respectively bundle hybrid elements. Another classification of service that is closely related to the level of automatization is between personal and impersonal services. Personal services are performed by service personnel, typically in the presence of the customer. Impersonal services are provided without physical service employees (T. F. Schröder, 2007). The later ones are nowadays referred to as self-services (Kelley, Donnelly, & Skinner, 1990).
To summarize the ambiguity of services, Figure 2-1 visualizes the stated classification: Service is a subtype of the product, which is characterized by its intangibility. Each service can be classified according to its level of automation and digitalization. This work and its further remarks refer to all variants of (intangible) services.

### 2.1.1.1 Service Systems

The ongoing notion of service-oriented thinking in business and technology led to the concept of service-oriented architectures (SOA) which connects both worlds. Service-oriented architectures are a design paradigm from software design, which is increasingly found in business environments. Kohlmann (2011, p. 26) defines SOA as a conceptual understanding to encapsulate similar (IT-based) business functionalities and to provide several organizational units across the company. SOA has its roots in distributed computing and modular programming and is evolving into novel technologies and concepts such as mashups, SaaS, and cloud computing. Core elements of every SOA are services. However, service repository and service bus make up two other mandatory elements of every SOA (Krafzig, Banke, & Slama, 2007, p. 78f.).

If applied in practice, the concept of SOA translates to service systems. A service system consists of at least a pair of entities (e.g., service providers and customers) that form a relationship to create shared value by sharing resources (Spohrer & Maglio, 2010). It “includes all the entities involved in the execution of interrelated services […] as well as the artifacts and resources that are used and possibly transformed by such services” (Barros & Oberle, 2012). Service systems are “dynamic configurations of resources, including people, organizations, information, and technologies” (Campbell, Maglio, & Davis, 2010). Service systems that build relationships and provide value to enterprises and consumers are also referred to as Service Value Networks (see Section 3.4.2.2). The notion of interrelated services that go beyond the boundaries of sole providers or distinct industries is a relevant aspect of customer-induced service bundles.
2.1.1.2 Service-Dominant Logic

On the intersection of business and technology, as well as between physical and intangible products, a comprehensive theory named Service-Dominant Logic (SDL) emerged recently. Introduced by Vargo and Lusch (2004), this concept is based on the idea that services are the foundation of every value creation and the basis for every economic exchange: without exceptions, all businesses are service businesses and all economies are service economies. Services are exchanged for other services in a global service system. Goods, if involved, are only vehicles for service provision. SDL has gained much attention in the field of marketing recently and has undergone many iterations (cf. Vargo & Lusch, 2015).

This paradigm represents a counterpoint to traditional good-centric marketing paradigms. SDL blurs the line between physical and non-physical products since goods are distribution mechanisms for service provision. Thus, every product is a hybrid product – even traditional goods, since their state is the result of some processing. This caters to the changed reality in today’s economy. An example is Apple Inc.: its iPhone and iPad, would have been considered as goods in a traditional sense since it is hardware only. However, according to SDL, these goods are the result of research, design, manufacturing, and distribution processes that make them indispensable of services. iTunes, App Store, and cloud services make the essential importance of services for these products even clearer, since they provide a substantial part of customer value and the business model for the provider.

SDL as a mental framework enables the derivation of some concepts that are essential assumptions of this work.18

1. Every product is a service: SDL removes the separation between goods and services. Every product is a service - this simple assumption broadens the scope of this work vastly. Since goods are vehicles for services and vice versa, this work becomes relevant for good-centric industries too (see Section 1.1.1 – Servitization). Guiding the consumer to the right service is the same as guiding him to a suitable good. In other words, consumers no longer choose a product. Instead, they pick a service to access the good. This concept also makes the distinction between different types of services obsolete (see Section 2.1.1). Consequently, this work applies to all kind of services, regardless of their point of view or degree of automation. However, for reasons of focus, this work further on sticks only to the intangible aspects of products.

2. Whole economies can be seen as a SOA: SOA usually has an intra-organizational focus. For good reasons, since the practicability of SOA relies on a shared understanding of services and service description. If the whole economy consists of services as proposed by SDL, the concepts of SOA must apply to it too. Just like companies orchestrate services to generate an outcome, orchestrated services are on the market to fulfill complex needs. This assumption lets the principles of SOA being adapted to markets and economies. This makes the distinction between physical and digital economy disappear.

3. A service recursively consists of other services: In business and technology as well, there is the consensual notion, which services can be combined to create more complex services which themselves can be further combined. The other way around, every service

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18 These assumptions are derived from the eleven fundamental premises and axioms of SDL (Rogoll & Piller, 2004) with regards to the research scope of this work.
can be divided into more specific sub-services: processes can be subdivided into single tasks, tasks into actions, actions into applications, applications into functions and so on. The level of service granularity is a continuum without clear boundaries. Defining the appropriate level of granularity for a given purpose is essential to deal with services as entities for value provision among providers and customers (see Section 3.3.1.2).

SDL in general and those three assumptions in specific deliver a substantiated theoretical model on how a service system can be modeled, i.e., how the offering of service providers and the solution space of the consumer can be represented in a structured and simplified manner.

Customer-Dominant Logic that has been introduced in Section 1.1.3 is built on the premises of SDL. Both theories complement each other. However, SDL explains how providers in service ecosystems should provide services to the customer (inside-out view), whilst CDL explains how customers receive and utilize services in their regards (outside-in view). CDL suggests “firms be concerned with how they can become involved in customers’ lives instead of figuring out how to involve customers in the firms’ business” (Heinonen & Strandvik, 2015).

2.2 Complexity

2.2.1 Conceptualization of Complexity

In concordance with the evolution of the service sector, the maturity of service offerings has increased. The service sector became more “complex,” due to aspects that will be explained in this section. In conjunction with this trend, the term “complex service” recently evolved (cf. A. Winter et al., 2012) – a term that is essential for this work but requires a profound definition based on core concepts.

In the scientific discourse, complexity is understood in a variety of meanings (cf. Schlindwein & Ison, 2004). A whole scientific branch named “complexity theory” has emerged in this field recently. Complexity theory is about systems of interacting agents, their interrelationships, behavior, and their evolution (Benbya & McKelvey, 2006; Koliba, Gerrits, Rhodes, & Meek, 2016). Such systems can be cities, immune systems, but also companies and markets (John H. Holland, 2006). The parallels between these examples and service systems are evident. That makes complexity theory an appropriate concept for this work.

Complexity theory distinguishes two points of view which are derived from systems theory (Maier & Rechtin, 2000): first, complexity, as a structural property of a system (Deshmukh, Talavage, & Barash, 1998; Frizelle, 1998). This view describes how individual system components relate to each other and how their relationships determine the overall system behavior. Second, the dynamic view, which is the behavior pattern emerging from interaction processes among the elements (Benbya & McKelvey, 2006; Kernick, 2006). In contrast to mechanistic theories that assume a centrally controlled governance structure, complexity theory supposes that order in systems mainly emerges through interactions of agents. Accordingly, Cilliers (1998) defines complexity as large-scale,
nonlinear interactions. A notion that indicates a close relationship between “complexity” and “interaction” - an important aspect that will be referred to again later.

To measure complexity, it is required to measure the state of a system at a given moment. Attempts of researchers to measure complexity have only recently evolved. For a quantitative description, entropy measures are prevailing (Arteta & Giachetti, 2004). They measure the amount of information necessary to specify the current state of a system. Unfortunately, entropy measures are difficult to calculate and strict measures do not seem very practical in service systems (Sutherland & van den Heuvel, 2002). Another approach that seems more suitable is a qualitative analysis of complexity. Prior works have evaluated drivers for the complexity of systems which are summarized in Table 2-2.

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<tbody>
<tr>
<td>Structural view</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Large number of elements</td>
<td>Complex systems have a significant number of market actors (agents).</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Diversity</td>
<td>The more different market actors are from each other, the more complex the system is.</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relationships</td>
<td>Number and type of interconnections (physical or non-physical) between the elements.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>Dynamic view</td>
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<tr>
<td>Variation</td>
<td>The higher the number and heterogeneity of interactions and elements, the greater are the possibilities to personalize and bundle.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
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<tr>
<td>Self-organization</td>
<td>New behavior patterns appear as consequences of market actors’ interaction.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamism and liveliness</td>
<td>The market actors in a complex system interact dynamically and individually.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Adaptation to their environment</td>
<td>Complex systems are open systems, in which market actors can learn from each other and adapt to their environment.</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Nonlinearity</td>
<td>The more nonlinear interactions, the more uncertain future states, and potentially surprising dynamics are possible.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Table 2-2: Qualitative characteristics of complexity (cf. Benbya & McKelvey, 2006; Koliba et al., 2016)
The conceptualization of complexity based on qualitative metrics allows a better understanding of the focus of this work. Consumers perceive complexity - they do not measure it. This premise supports the preference for qualitative factors throughout this work.

In the context of customer-centric service economies, the structural view is prevailing. The primary challenge for consumers is to find and combine the right functionalities (static view). Bringing them in the right sequence (dynamic view) is a secondary challenge and not in focus of this work.

### 2.2.2 Complex Services

The financial service industry and many other service industries meet the criteria mentioned earlier of (static) complexity (cf. Section 1.1.4). To generalize the application area of this work, shared characteristics of affected domains will be identified where this work applies to. The term “complex services” is introduced to name them.

Based on Table 2-2 complex service systems are characterized by the following properties:

- **A variety** of elements: the complexity increases with the number of system elements (e.g., options in the power configuration, the number of available providers for each service).
- **Heterogeneity** of the elements: the complexity increases with the diversity of the individual system elements (e.g., concerning the functionality, interfaces).
- A wide range of **relationships** between the elements: the complexity increases with the number of dependencies and interdependencies between system elements.

From a consumer’s perspective, the offerings within these systems are accordingly referred to as **complex services**. Complex services meet at least one of the criteria above. They appear in domains where consumers (or consumer segments)

1. …do not have transparency over the offerings on the market (variety).
2. …do not know services and their function (heterogeneity).
3. …cannot evaluate their fit to their needs and cannot combine services to create an individualized solution (relationships).

This definition is based on a subjective perception: what is complex depends on the level of expertise of an individual consumer. One consumer may have interest and knowledge in a particular domain whereas others may have never heard of fundamental principles in that same domain. On the other hand, the number of self-directed customers is rising (see Section 1.1.4). This might potentially result in higher average literacy among the customers as a result of “learning by doing.”

Complexity and expertise are inversely correlated. For an individual, both factors may also change over time. Based on changed customer literacy or changed market structures, domains considered as complex today may become less complex in future. However, assuming a constant overall expertise of the consumer, the trends of digitization, servitization, and consumerization gradually lead to a higher number of complex service domains in practice. This global trend drives relevance to this research. The term “complex services” further on describes domains and services that this research applies to.
2.2.3 Complexity in Customer Interaction

Complexity does not only arise in complex service domains due to their systemic characteristics - but complexity also has a dynamic aspect that has been neglected so far: The complexity of interaction processes.

Ford, Gadde, and Håkansson (2008) propose a two-sided view on interaction: interaction as a process (dynamic view) and interaction as the interrelationship of elements (structural view). This dualism is strikingly congruent with the classification of complexity. From a structural perspective, interaction is defined as the relationship between entities as well as the activities occurring between them (Dubberly, Pangaro, & Haque, 2009). A major focus here is on market actors and their interrelationships in a structural view (i.e., B2C, C2C). The relationships between them are formed by channels and products through which they interact with each other. From a dynamic perspective “interaction is the substantive process that occurs between business actors” (Ford et al., 2008).

Complexity differs among various types of interaction processes. For example, after the advent of electronic banking, for a long time advisory has been considered as too complex to be substituted by online means: “even the most digital-savvy consumers still prefer to visit a bank branch and speak to an advisor when it comes to more complex services, such as applying for a mortgage. Even in today’s digital world, consumers want the option to walk into their bank branch and receive expert, personalized advice” (Ian Rutherford, 2015). Meanwhile, new self-service technologies, such as robo-advisors and chatbots, indicate a different situation.

Three types of customer-facing processes do exist in the field of e-services and self-service: transactions, support processes and advisory (Curran & Meuter, 2005; Sachse, Puschmann, & Alt, 2012a):

**Transactions** are processes that perform a transfer of ownership, possession or rights concerning a specified asset. Transactions allow customers to buy directly, order, and exchange products and resources (Curran & Meuter, 2005). In the field of financial services, examples of transactions are payments or stock orders.

**Advisory** is a two-way exchange of often unstructured information between a client and an intermediary (consultant) (Auh, Bell, McLeod, & Shih, 2007). Its primary purpose is to support decision making. An advisory session usually begins with a specific need and ends when a solution has been worked out. Advisory processes are generally not reoccurring (cf. Section 2.4.2.2).

**Support processes** (also general service processes) belong in-between transactions and advisory. They do occur more frequently than advisory processes (per individual on average) and are broader and often less structured than transaction processes. Examples of support processes are questions regarding an account or changes to personal data.

Based on their characteristics, these types can be ranked according to their complexity level (see Figure 2-2).
Figure 2-2: Classes of customer interaction processes and their inherent complexity

This illustration also takes a reference to the already mentioned inverse correlation between complexity and expertise. Undergoing processes more frequently enhances consumer’s knowledge about it. As transactions represent the lower end of the complexity scale and advisory the upper end, complexity generally differs between design-time and run-time. In fact, the advisory is a design-time process that rarely occurs (per customer in average) in contrast to support and transactions which are run-time processes. This implies another relationship: a link between complexity and frequency which seems to be inverse too. This assumption may be attributed to two factors:

First, there are subjective reasons that describe customer’s perception. Especially learning effects are believed to describe the inverse correlation between complexity and frequency. The more often a customer undergoes a process, the more skilled and self-confident he will become with it. Most self-service processes are designed to be self-explanatory and provide the customer with the required knowledge.

Second, there are objective reasons for this relationship. Transaction and support processes are simpler, by objective means. The input and output of the process are usually clearly defined, and the required information can be easily elicited from the customer, as well as the delivered result can be described. Also, the creation phase of the process classes demands a lower inclusion of the customer. The more straightforward processes are, the more likely customers are going to give them a try and use them subsequently.

To conclude the interaction perspective on complexity: besides being settled in the field of complex services, this work is also focused on the advisory process, as the most complex class of interaction processes. This further emphasizes the importance of the factor “complexity” for this research.

2.2.4 Complexity Management

Complexity has been identified as a major challenge that prevents consumers from self-directed service individualization. In other words, the process of building individualized service solutions on their own must be made easier for customers.

In fact, a fundamental characteristic of complexity is its property to be transformable. During the 1980s, software engineer and researcher Larry Tesler found out that the quality of the user interface is as important for an application as its functionality. Improving accessibility makes software more useful, just as adding further features does. However, there is a contradiction between simplicity and functionality. He realized that complexity is an integral part of any software – and it is there for good reasons. This notion became
the foundation of a principle that is known today as Tesler’s Law or the “Law of conservation of complexity” (Saffer, 2010, p. 136f.). “Every application has an inherent amount of irreducible complexity. The only question is who will have to deal with it, the user or the developer” (Saffer, 2007). This principle says that the total complexity of a system is always constant. However, interaction with the system can be simplified for the user if complexity is taken away from him (“hidden complexity”). In return, the “complexity behind the scenes increases,” if the front end is made easier (Norman, 2011). The sum of both forms of complexity always stays the same. This law is a fundamental axiom in today’s human-computer-interaction research.

Besides human-computer-interaction, this aspect has been applied to service design too. The service blueprinting methodology relies on this law by introducing the “line of visibility” as a central element of its notation. It describes how much complexity is exposed to the customer and which essential complexity is provided out of his sight (G. Lynn Shostack, 1984). Concordantly, in service engineering the “line of interaction” separates actions that involve the customer from actions that solely refer to the provider (Fließ & Kleinaltenkamp, 2004).

Figure 2-3: Illustration of Tesler’s law

This insight regarding front end- and back end-complexity allows a retrospective on information systems for service management that helps to illustrate the intention of this work: the first concepts and toolkits for service management have been developed for technical experts with the purpose to manage and integrate Web services (e.g., WSDL). Recently, service management has been introduced to business experts who have no or little technical knowledge. This required technological details to be hidden from the user and the system must be smart enough to take care of these aspects itself. An example of this form of service management is Fischbach’s research (Fischbach, 2014). Subsequently, this work tries to capture as much business and technological know-how in the system that consumers can perform the task of service management and must not deal with business or technical details anymore. Figure 2-4 shows this evolution of application systems from expert systems to consumer applications.
Also, something complex does not necessarily have to be complicated. Being complicated is the result of a bad design which unnecessarily confuses the user. Simplification in terms of being less complicated does not have the axiomatic trade-offs that transformation of complexity has (Norman, 2011). This is an important point: this work follows no approach that gradually optimizes interfaces to make them less complicated. Instead, based on the named paradigm-shift, it wants to enable the transformation of complexity beyond the barrier that prevented customers from self-directed service individualization so far (see Figure 2-4).

For this work, two implications arise from the insights above: first, complexity is subjective. Depending on who determines the complexity in software- or service systems, complexity most likely will differ. Thus, the goal of this work is to minimize perceived complexity by the user. For validation, the customer perspective alone is important, because “simplicity must always be measured from a point of view” (Norman, 2011). Second, simplifying the front end is basically a backend task. It is of little use to examine interface deficits when the actual task is to enable the backend to perform the tasks that formerly skilled professionals like advisors have conducted.

2.3 Individualization

2.3.1 Individualization and Disintermediation

Although individualization offers benefits within the goods sector, its significance is notably higher for the services sector. Providing more individualization options improves (physical) goods – in contrast, individualization of services is essential to provide any value to the customer at all. For example, a second-hand car might be of lower value than a personally equipped new one, since it has, for example, a non-favorable color. However, it will likely serve the user very well in its core functionalities. On the other hand, a service, such as a haircut, would be unthinkable without any customer-specific individualization.
In the field of IS research, the term **individualization** is rarely used. Instead, the concepts of personalization and customization are widely adopted. Customization is a method of “changing something in order to fit the needs or requirements of a person, business, etc.” (P. Davis, 2015). Personalization is “a means of meeting the customer's needs more effectively and efficiently” that is “achieved when a system tailors an experience based on a consumer’s previous behaviors” (P. Davis, 2015). Furthermore, there are two types of personalization: role-based personalization is based on grouped stereotypes founded on shared characteristics. Individualized personalization considers individual information about every single customer (Schade, 2016). The main distinction between customization and personalization lies in the way the individualization is carried out. Customization is driven by the user, whereas personalization is done by the system. Furthermore, the distinct term “individualization” is intentionally used throughout this work, since it covers both meanings: the individual consumer explicitly mentions his needs and requirements as the starting point for the process when in fact the individualized solution is generated by a system.

For consumers, customer-centric individualization means the elimination or reduction of intermediaries (see Section 1.1.5). This process, called **disintermediation**, offers several benefits to the customer, e.g., lower prices, higher transparency, no conflict of interests, and more power to the client. A major advantage lies in the unrestricted and unfiltered market access (Delmond, Coelho, Keravel, & Mahl, 2016). No longer is the service portfolio of a single provider the frame of reference for how a need can be fulfilled. The customer can choose from the offerings of the whole market. Ultimately, this results in better individualization possibilities for the client. However, these advantages come at a price: the complexity the customer must deal with is rising (see Section 2.2).

The process of **service individualization** has been carried out for decades on a small scale. Usually referred to as advisory, it took place on a bilateral relationship via personal interaction. At that time, business models required a specialization of the company, either towards standardization via mass production, or towards individualization via a high-touch-approach (cf. Section 1.1.1). In today’s environment, this dichotomy falls apart: the concept of mass customization has influenced the goods sector for many years – now it can be adapted to the service industry as well.

### 2.3.2 Mass Customization

Mass customization (MC) is the most recent stage in the **evolution of production paradigms**. The beginnings of fabrication were manual productions on a small scale for self-supply, until more specialized manufactories emerged later. A milestone in the evolution of production marks industrial mass production in the 19th century. Mass production heralded the era of large-scale production of standardized goods. Since then, a constant challenge is to bridge the gap between individualization and scaling. Early attempts, such as flexible variant production, could not stand the high expectations. The latest stage of this evolution is MC which is enabled mainly by technical improvements and advances in information systems (Frank Thomas Piller, 2012, p. 4).

Nowadays, MC has become a capable strategy to meet changing customer requirements flexibly. While initially introduced in the business-to-business (B2B) context, the concept
of MC also gained a foothold in many business-to-customer domains, such as cars, computers, clothing and the like (Frank Thomas Piller, 2010). With the emergence of the social web, the third phase of MC is currently discussed in the context of customer-to-customer (C2C) commerce (Walcher & Piller, 2012b). The goal of MC is to individualize products via the variation of a specified number of product elements which are essential from a customer point of view.

The term "Mass Customization" has been coined by Davis in 1987 and has constantly been subject to research ever since (S. M. Davis, 1987). Thus, a plethora of definitions emerged that represents the relevance of MC for many fields and disciplines. For example, business-oriented definitions see MC as “the ability to provide your customers with anything they want profitably” (Hart, 1995). Process-oriented definitions characterize MC as a “customer co-design process of products and services which meet the needs of each individual customer regarding certain product features. All operations are performed within a fixed solution space, characterized by stable but still flexible and responsive processes. As a result, the costs associated with customization allow for a price level that does not imply a switch in an upper market segment” (Frank Thomas Piller, 2004). Strategic views define MC as the “process for aligning an organization with its customers’ needs” (Salvador, Holan, & Piller, 2009). Finally, Tseng and Jiao (2001) emphasize technological aspects: “[T]he technologies and systems to deliver goods and services that meet individual customers’ needs with near mass production efficiency” (Tseng & Jiao, 2001).

Although various definitions do exist that emphasize different aspects of MC, three common characteristics of MC can be identified (cf. Apte & Vepsäläinen, 1993; Hart, 1995; Pine, 1993; Silveira, Borenstein, & Fogliatto, 2001; Tseng & Jiao, 2001, p. 691):

- **Technology**: MC is enabled by IT and flexible production processes. This factor differentiates production processes of MC from industrial mass production.
- **Scale**: The “mass” in MC indicates its ability to be suitable for large-scale production processes. Thus, MC allows high volumes and high efficiency at the same time.
- **Variety**: Besides the benefits of large-scale production, the goal of MC is to provide individuality according to customer needs. To serve every customer individually, it may occur that every single good ever produced is unique.

According to these three factors, MC promises to combine the benefits of high-tech- and high-touch interaction (Table 2-3) and seems to be an effective concept to tackle the current challenges in the service sector (see Section 1.1.2).

<table>
<thead>
<tr>
<th></th>
<th>High touch interaction</th>
<th>High touch interaction</th>
<th>Mass customization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology</strong></td>
<td>High facilitation</td>
<td>Low facilitation (manual)</td>
<td>High facilitation</td>
</tr>
<tr>
<td><strong>Scale</strong></td>
<td>High volume</td>
<td>Low volume</td>
<td>High volume</td>
</tr>
<tr>
<td><strong>Variety</strong></td>
<td>Standardized</td>
<td>Individual</td>
<td>Individual</td>
</tr>
</tbody>
</table>

*Table 2-3: Mass customization in customer interaction (with reference to Silveira et al., 2001; Tseng & Jiao, 2001)*

MC promises **benefits** to the companies who incorporate this concept: there are qualitative benefits, such as higher customer satisfaction, higher customer loyalty, better alignment
of an organization with its clients’ needs, and improved innovativeness (cf. Coelho & Henseler, 2012; Harmsel, 2012; Juutinen, 2013). There are also quantitative benefits, such as higher efficiency in production, less or none stock keeping, and additional price premiums (Harmsel, 2012; Juutinen, 2013; Rogoll & Piller, 2004). Advantages also exist on the customer side: MC increases perceived product quality, it ensures better product fit to individual needs, and it favors clients who seek to emphasize their individuality (cf. Harmsel, 2012).

With all its advantages, the disadvantages of MC should not be overlooked: MC is no distinct way of doing business. It needs to be aligned with company structures, values, processes, and resources (Pine, Victor, & Boynton, 1993). There is also the risk that in highly competitive markets companies cannot gain advantages from MC. Competition might already offer sufficient variety to the customer so that everyone already finds well-suited products “right from the shelf” and the higher efforts of MC might not pay off (Frank Thomas Piller & Müller, 2004).

The definitions above conceive MC as a key concept for customer-centric individualization that includes both, the strategy and the technology to deliver mass customized products and services. In the context of this work, MC describes a comprehensive business strategy that is focused on the individualization in digital business environments. It is the fundamental concept, that is successively adapted to the specifics of customer-centricity in complex service domains. It builds a frame of reference for the scope of this work from a business perspective.

### 2.3.3 Mass Customization in the Service Industry

The success of MC is often attributed to the rise of e-commerce (Turban, 2012). Digitalization of production processes and customer co-creation created the foundation for MC. As described in Section 1.1 these factors increasingly apply for the service economy too. Thus, MC is believed to have significant relevance in this field in the years to come (cf. Nambiar, 2009).

Since the early days of MC, the concept has been subject to a steady evolution. Piller subdivides three cycles of MC so far (Ponoko, 2008): the first stage is related to production technologies such as computer-integrated manufacturing (CIM) and built-to-order in the industry. This stage was the prevailing notion during the 1990s. At this time, MC was subject to B2B settings. The second stage started with the Internet revolution in the 2000s. Digital information infrastructure allowed companies to connect customers efficiently to their flexible manufacturing technologies. This laid the foundation for the success of MC in the B2C setting. Currently, the third wave of MC is taking place. Ubiquitous and accessible information networks allow a form of MC that can be described as C2C-MC. This development is backed by trends such as Sharing Economy and 3D-printing. The fringes between consumers and producers are vanishing. Even niche markets can be served efficiently.

However, the whole evolution of MC misses an important point so far: it is almost entirely focused on the production of physical goods. MC in the service industry is a critical research gap and of high relevance for practice (cf. Sachse, Alt, & Puschmann, 2014a; Walcher & Piller, 2012c). Piller and Tseng (2010) explicitly stress the research gap in the existing base of literature on mass customization for the service industry.
The lacking adoption of MC in the service sector has several causes that originate directly or indirectly from the characteristics of services (see Section 2.1.1):

- De Mast (2006) names three differences between a manufacturing business and a service organization that have implications to MC: first, products in manufacturing are highly tangible while services are not. Second, production processes are more transparent for goods - problems and irregularities become obvious more easily. Third, the production process in manufacturing does hardly involve the customer. For services, however, the extent of customer integration directly determines the resulting service quality.

- Ferrario et al. (2012, p. 79) point out the fact that services have a temporal dimension. Unlike products, they are always developed in time: "services are complex events, while goods are objects".

- Zipkin (2001) names description complexity as a major factor that prevents the adoption of MC in any setting: the variety of service options makes selection difficult. For users, it is difficult to articulate their requirements towards intangibles in “foreign” domains. Choices and consequences are barely comprehensible without feedback concepts such as visualization. Hass and Kunz (2004, p. 610), share the same opinion. They say, “[t]he key challenge of mass customization for service organizations are translating customer needs into customization concepts and guidelines.”

The future evolution of MC hints in two directions: On the first hand, it focuses on integrated solution bundles, instead of distinct products. Secondly, product-centricity is replaced by customer-centricity. Instead of specifying product attributes, customers can describe themselves respectively their needs and desires (Sachse et al., 2014a). Although there are ongoing research activities in this regard, some white spots still do exist concerning MC in the service industry: first, MC approaches for service settings are generally insufficiently researched yet (Frank Thomas Piller, 2012). On the second hand, newer approaches, such as need-based configuration interfaces (see Section 2.3.5.1), are not necessarily customer-centric, although some aspects of it may be contained. For example, a slider element (GUI), labeled as “gaming performance”, describes the product instead of the user (cf. Randall, Terwiesch, & Ulrich, 2007). However, in the context of MC, the notion of need-based configuration can sometimes be interpreted to be synonymous to customer-centric configuration. Even though, the characteristics of customer-centricity are almost never regarded.

The existing stock of literature that exists in the field of MC and customer-centric service individualization hardly contributes to the scope of this work. It mostly covers the interface (GUI) of configuration tools (i.e., need-based configurators). Aspects such as identifying the relevant customer needs to generate individuated service solutions are missing. They are a central topic of this work. For a recap, this work takes an integrative approach. Single aspects, such as need-based interfaces, may already be known in academia and practice. However, a holistic concept that allows correctly implementing these artifacts (i.e., customer-centric) within the service domain is missing and is the scope of this work.
2.3.4 Mass Customization and Complexity

“The success of mass customization as an e-commerce strategy depends on the configuration system’s ability to reduce information overload, product unclarity, and process unclarity” (Matzler, Stieger, & Füller, 2011). Accordingly, complexity is a major obstacle towards the adoption of MC and needs special attention. Besides Matzler et al., other researchers agree with this point too (Blecker & Abdelkafi, 2006; Blecker, Friedrich, Kaluza, Abdelkafi, & Kreutler, 2005b; Fürstner & Aniši, 2012). Blecker & Abdelkafi (2006) name complexity “the main problem that may jeopardize the implementation of [mass customization].” With their statement, they refer to two forms of complexity: complexity as perceived by the customer (external complexity) and a company’s perception of complexity (internal complexity). External complexity can be referred to as all the difficulties a customer might encounter during the configuration process. Internal complexity describes difficulties experienced during production and service provision (Blecker & Abdelkafi, 2006). Schlindwein & Ison (2004) make a similar distinction by differentiating between perceived complexity and descriptive complexity.

These notions already make it clear that complexity may be the most important issue that must be solved to deploy the concept of MC into the field of services and towards consumers. This is no surprise, since on a more abstract level complexity already has been identified as the major challenge towards customer-induced service individualization (see Section 1.1.5). However, in the context of individualization, complexity has some nuances which are essential for an in-depth understanding and problem solving:

1. Product Variety Paradox

Companies strive to increase their product variety to meet customers’ demands better and subsequently raise sales. Paradoxically, offering more products and giving additional customization options to the customer actually results in a decline in sales. This effect is called the “product variety paradox” (Trentin, Perin, & Forza, 2013). More choices lead to higher complexity and greater cognitive load for the customer. This prevents decision making. In this scenario, complexity, as perceived by the customer, plays an important role. In MC settings, perceived complexity results from the following factors (Dellaert & Dabholkar, 2009; Trentin et al., 2013):

- The number of cognitive steps that are necessary to configure a product increase with a rising number of alternatives. This effect, also referred to as choice complexity, may overwhelm many consumers.
- The difficulty in translating needs and requirement into product specification. Besides the semantic gap, also the dilemma to choose among conflicting product differentiation properties hinders the customer in finding a solution.
- Dealing with product uncertainty: users must understand the causal relationship between design parameters and their needs. Without substantial technical or domain knowledge, this bears the risk of so-called “design defects” – a configuration that does not meet the expectations (Randall et al., 2007). It may also lead to negative emotion which overcomes customers after purchases if they compare the effects of other purchase alternatives post-priori (Post-decisional regret).
- Correct decision pressure: the plethora of information and possibilities to compare alternatives obliges the customer to consider every decision as important
and make a well-founded decision. This effect amplifies the mechanisms above and is a driver of the product variety paradox.

2. Design Defects

Complexity can cause deficits or errors in the outcome of the configuration process. Suboptimal customer utility is the consequence. Such errors are called design defects (Randall et al., 2007). Different factors cause design defects:

- **Subjective user needs**: The utility of a configuration is determined by the user’s satisfaction with the created solution. The stated requirements are subjective and the utility might be hardly communicable due to abstraction. This is particularly the case in self-service scenarios (Randall et al., 2007).

- **Holistic user needs**: The complex interdependencies among several design parameters can cause configurations that do not meet the expectations. These defects directly refer to the configuration systems and its underlying models (Randall et al., 2007).

- **Overwhelming confusion**: Once more, limited understanding and vast complexity are identified as a challenge for MC – this time as a source of design defects. Designs with overwhelming complexity cause confusion, especially for novice users (Randall et al., 2007).

3. Complexity Reduction in MC Systems

Considering the aspects above, a goal of every MC system should be to reduce complexity. This is a remarkable insight since it highlights the psychological aspects in this field. Meanwhile, several strategies to cope with complexity and to avoid user confusion have been applied in MC toolkits yet (Dellaert & Dabholkar, 2009; Trentin et al., 2013):

- **Focused navigation**: The ability to narrow down the solution space to a proper subspace quickly, improves user attention and lowers complexity.

- **Flexible navigation**: Design to minimize the effort for the user to modify prior configured solutions.

- **Easy comparison**: Simple and comprehensive comparison of properties that different configurations have.

- **Benefit-cost comparison**: Communication of the consequences that variations of a configuration have, regarding its benefits and costs/sacrifices.

- **User-friendly product-space description**: Adopt the description of the solution space to the abilities and the context of the customer.

- **Complimentary online services**: Corresponding services can provide the user with additional information and knowledge that make it easier for him to configure attractive products and simplify the process of using MC toolkits.

This overview shows the role of complexity in MC settings. It briefly motivates three critical areas that will be referred to again throughout this work: a) Consumer perception and psychological factors, b) qualitative properties of MC setups, and c) interdisciplinary attempts for complexity reduction (respectively complexity transformation, as pointed out in Section 2.2.4).
2.3.5 Information Systems for Product Individualization

MC is a business strategy that heavily relies on the facilitation of IT. Information systems are essential for this concept and have an impact on internal and customer-facing processes. This section provides an overview of information systems that relate to the customer interface. These systems belong to the overall category of self-service technologies (SST’s). SSTs are defined as “computer or electronic systems that provide the customer with the ability to perform and consume services without direct or primary interaction with the provider’s workforce” (Meuter, Ostrom, Bitner, & Roundtree, 2003). These systems “enable customers to produce a service independent of direct service employee involvement” (Meuter, Ostrom, Roundtree, & Bitner, 2000, p. 50).

One of the earliest and probably the most often referenced example of SSTs is the ATM (cf. Campbell et al., 2010; Meuter et al., 2000). Designed at a time when services played a less significant role in the economy, it marks a noteworthy cornerstone in the development of SST’s. It was one of the first innovations based on the value proposition to substitute personal service and avoids its inherent deficits. After its introduction, the anticipated benefits of the ATM have been exceeded by far (see Regan, 1963).

Today’s SST’s are no longer tied to stationary or proprietary hardware like ATMs. Instead, the technology increasingly focuses on the software side (Meuter et al., 2000, p. 50). Especially interfaces have gained much attention. Since the customer plays an active role in service creation and delivery, interaction plays an important role (Drennan & McColl-Kennedy, 2003; Edvardsson, 2005). Without SST’s, electronic forms of customer-provider interaction would be much more limited and the current upswing of digital services would probably have never taken place (Peterson & Balasubramanian, 2002).

Although digital services, that are a direct consequence of SST’s, are mainly driven by the market demand today (see Section 1.1.1), service providers were the ones that originally introduced them. Companies increasingly attempt customers to perform more actions on their own to drive efficiency, profitability and eliminate information barriers (T. F. Schröder, 2007, p. 94). In return, customers benefit from lower prices, better availability and consistent service quality (Globerson & Maggard, 1991).

In the following sections, a brief overview of SSTs, that are specifically used for the task of (product) individualization, is given.

2.3.5.1 Mass Customization Configuration Toolkits

Substantial IS research has been conducted in the field of MC for physical goods (in contrast to MC systems for services – see Section 2.3.3). These systems are usually referred to as configurators, configuration toolkits or mass customization platforms. Configuration toolkits are “an integral link between product development, manufacturing, and customer specification” (Reichwald & Piller, 2006, p. 245). They can be classified along three dimensions: first, according to their strategic approach towards MC. Second, according to the elicitation paradigm. Third, according to the supported degree of freedom of the solution space (see Figure 2-5).

Furthermore, in literature these systems are also referred to as choice boards, co-design-toolkits, design systems, platforms, or co-design-platforms (cf. Chandra & Kamrani, 2004, p. 29ff.).
**Figure 2-5: Classification of mass customization approaches**

**MC strategy**: Vendors can implement MC in two ways. Either they follow a make-to-order approach (pull-production), or they facilitate a make-to-stock system (push production). Some definitions of MC emphasize the moment of production as the major distinction between traditional mass production and modern MC (e.g., Gardner, 2009). MC is usually used on the pull system. It starts with the customer’s order and it triggers every subsequent production. It generates individualized products by unique production and processes. In contrast, the push system starts with the manufacturer that initiates production of a standardized product for a market (and not for a specific customer). This is often referred to as the traditional mass production strategy, but if the variety of the product repository is large enough, there is good chance that one of the stock-products comes close to the individual’s needs. Thus, the customization approach relies on the identification of the most appropriate product from stock (“match-to-stock”) (Turban, 2012).

**Elicitation paradigm**: The second distinction of configuration toolkits refers to the elicitation interface (cf. K. H. Christensen, 2012; Dellaert & Stremersch, 2005). Through the user interface of the configuration toolkit, the user can express his requirements and specify the product. At the same time, he is confronted with the corresponding description complexity that determines production.

Classical configuration interfaces are based on the elicitation of product parameters. Newer ones follow a needs-based approach (Randall et al., 2007). The parameter-based configuration allows customers to manipulate product parameters directly. It requires a significant number of decisions and profound knowledge about the product and production process. On the other hand, the parameters are transparent and relatively easy to implement (Randall et al., 2007). Parameter-based interfaces are the dominating form of MC toolkits today (Walcher & Piller, 2012a).

The need-based approach relies on preferences, requirements and the expected outcome that the user shares with the system. An algorithm translates the input into the product specification. Thus, it mimics the behavior of a salesperson and is more about recommendation than about specification. This approach translates the design parameters into a less-technical language for the user. Hence, making them more accessible for non-skilled clients. It usually contains a systematized optimization procedure. From a user’s perspective,

---

20 Some sources describe more detailed increments between these two extremes, e.g., match-to-stock and configure-to-stock (C. M. Christensen et al., 2007).
it resembles a black-box, since the causal relationship between input and production parameters remains unclear. In 2012, less than three percent of MC systems used a need-based approach (Randall et al., 2007; Walcher & Piller, 2012a).

Parameter-based and need-based interfaces aim at users with different skill levels. The parameter-based configuration provides better outcomes for highly expertized users, the need-based configuration for the low to the medium skilled user (see Figure 2-6).

![Figure 2-6: User-knowledge in context of parameter-based and need-based configuration (Randall et al., 2007)](image)

The degree of freedom: Another classification differentiates configuration systems according to their “degree of freedom.” According to Haak (2013), the customization process can either be structured, semi-structured or unstructured. In a structured configuration, the solution space is limited and the potential choices are predefined and obligatory. An example would be a car configurator where the configuration is limited to a specific car. All design choices are captured along a defined parameter-list. The focus is on one single product. In a semi-structured configuration, the solution space is more heterogeneous but also clearly limited. Travel platforms are an example of this type of MC. A vacation consists of heterogeneous elements (i.e., flight, accommodation, insurance). However, the provider and not the user predetermines the elements of the solution. This approach is essentially a collection of several structured configuration steps. For an unstructured configuration, the solution space is much more open and consists of various heterogeneous elements. The number of elements is larger and cannot be defined in advance. An example would be an individual financial solution for a customer who selects his services from different providers and can combine them to a new solution. In this case, the solution consists of heterogeneous services and is too extensive for structured or semi-structured configuration (Sachse, Alt, & Puschmann, 2014b).
2.3.5.2 Recommender Systems

As shown above, MC either can be performed via Make-to-order or Make-to-stock approaches. The second one tries to find the most appropriate product for the stated request (“matching”). It recommends the (existing) product instead of specifying its production process. This scenario is the field of recommender systems (RS).

“Recommender Systems are software tools and techniques providing suggestions for items to be of use to a user. The suggestions provided are aimed at supporting their users in various decision-making processes, such as what items to buy, what music to listen, or what news to read” (Ricci, Rokach, Shapira, & Kantor, 2011, p. vii). Their main functions are to guide users through a large space of alternatives to identify the most relevant options (Lops, Gemmis, & Semeraro, 2011). This support proved to be beneficial for businesses and customers alike (cf. Lops et al., 2011; Ricci et al., 2011):

- **Increased quantity of sold items**: RS play a fundamental role in many e-commerce business models. They suggest items to the user which will likely fit his needs. Thus, by increasing the conversion rate, the probability of selling more items increases significantly.

- **More different items sold**: Besides selling more items, also the heterogeneity of the items sold increases (“cross-selling”). RS increase the probability of selling items that would otherwise be not explicitly demanded or are otherwise hard to find. In the case of the media industry, this effect also leads to longer customer retention because other content of interest will be consumed.

- **Increased user satisfaction**: RS streamline the customer processes in e-commerce. The user finds more meaningful offers, and his cognitive efforts and information overload are reduced.

- **Increased user fidelity**: The quality of recommendations improves, the more frequent and longer a user interacts with an RS. Feedback mechanisms engage the user to be more involved in a service and at the same time helps to improve the recommendation quality in the future.

- **Better knowledge of customer needs**: RS create user profiles as a core element of their operation. This knowledge about the client can be leveraged by companies in many other fields.

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**Figure 2-7: Classification of mass customization examples regarding their degree of freedom**

<table>
<thead>
<tr>
<th>Interface Type</th>
<th>Structured</th>
<th>Semi-structured</th>
<th>Unstructured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need-based</td>
<td>Dell (need-based laptop configuration)</td>
<td>Nutmeg.com (Portfolio management)</td>
<td>Lookcraft.com (Fashion)</td>
</tr>
<tr>
<td>Parameter-based</td>
<td>Car configurators</td>
<td>Travel portals</td>
<td>n/a</td>
</tr>
</tbody>
</table>

### Degree of freedom

- **Structured**: High level of specification, detailed product configuration.
- **Semi-structured**:ある程度の自由度を持つ、詳細な製品構成が可能。
- **Unstructured**: No specific details, more about the overall product concept.

Example:
- Dell (need-based laptop configuration)
- Nutmeg.com (Portfolio management)
- Lookcraft.com (Fashion)
- Car configurators
- Travel portals
- n/a
RS are based on a common concept: they simulate a probabilistic system made of entities, items, users and transactions (Ricci et al., 2011, p. 7ff.). However, the underlying techniques that determine the functionality of RS differ considerably. The most common types of RS are (Ricci et al., 2011, p. 10ff.):

- **Collaborative Filtering**: The system learns what other users with similar preferences liked in the past and suggests these items to the user.
- **Content-based Filtering**: Recommendations are based on similarity of items to the ones that a given user has liked in the past (Lops et al., 2011).
- **Constraint-based methods**: Domain models externalize knowledge that recommends items based on given user needs.
- **Community-based methods**: Recommendations are based on the preferences of a user’s peer group (e.g., friends).
- **Hybrid-approaches**: Combine aspects of two or more of the approaches above.

In the retail sector, the facilitation of RS is increasingly referred to as guided selling or curated shopping. “Guided Selling leads customers and sales associates through the purchasing process for a complex product, tailoring product and cross-sell recommendations to a store’s inventory availability, pricing, and assortment” (Andrews & Schwartz, 2005). Guided selling as a sub-form of RS has not received much attention in IS research yet.

### 2.3.5.3 Decision Support Systems

Decision support systems (DSS) are “a class of computerized information system that support decision-making activities. Decision support systems are designed artifacts that have specific functionality” (Power et al., 2015). Power et al. (2015) distinguish five categories of DSS:

- **Communication-driven DSS** rely on communication technologies, such as emails, to suggest actions.
- **Data-driven DSS** utilize analytics to ground decision information on large datasets.
- **Document-driven DSS** retrieves their information from (digitalized) documents.
- **Knowledge-driven DSS** are based on expert knowledge and models such as decision trees and checklists. They are, sometimes, generically referred to as recommender systems or expert systems.
- **Model-driven DSS** rely on quantitative models for decision making.

In the classical sense, DSS are auxiliary systems that are not intended to replace skilled decision makers (Power, 2002). However, more recently the concept has been adopted to be used by end-users (consumer decision support systems). Their focus is not to improve decision quality based on sound reasoning and relying on extensive data. It provides support on product complexity and information overload. They have come to use in e-commerce scenarios (Al-Qaed & Sutcliffe, 2006).

Al-Qaed and Sutcliffe (2006) have classified existing types of “decision tools” that help customers in their decision process. These **decision support concepts** are based on the functional logic respectively the visualization that these tools facilitate:
- Filtering: Filtering tools provide an efficient way of presenting information to both lowly- and highly expertized users. Examples of this type of instruments are visual representations like scatterplot-diagrams and table-based representations like comparison matrixes.

- Recommendation agents: A recommendation agent is based on predefined dataset queries. It does not allow individualized queries to the user and returns only a pre-defined subset of the solution space. They are often used to select the alternatives in a given (sub-)domain.

- Concept-map: Concept-map tools are based on a visual representation of a hierarchical tree structure. They allow the users an interactive navigation in the solution space and can provide understanding about the hierarchies’ structures and characteristics.

- Decision-tree: A decision-tree is a guided approach for the user to narrow down the list of suitable alternatives. It can be designed to cover different levels of user expertise and ultimately determines an alternative. It is a static instrument that must be (re-)designed for each change in the solution space.

- Ranked-list: Ranked lists are a popular approach to making the solution space accessible to the user by showing alternatives in an ascending or descending order of a product attribute (e.g., price). Ranked lists are easy to implement and do usually consider only one attribute at a time.

- Example-based search: Suggestions are presented to the user after providing little to none (default) inputs. The initial solution then is successively modified (“critiqued”) by the user and a better alternative is shown.

- Anchoring examples: A decision-based approach that presents two or more alternatives of the solution space to the user. Based on the user selection subsequently, a new sample set is generated each time. This elicitation process is done until the final alternative is determined.

- Templates: Unlike recommendation agents, templates define the structure of the solution and may be manually instantiated. They do not dynamically incorporate new elements that are added to the solution space.

- Comparison matrix: Alternatives are shown side-by-side regarding differentiation solution attributes. They allow an in-depth comparison of selected options.

A central aspect of these tools is their degree of adaptivity. Depending on the context, some decision support concepts are more favorable than other ones. Moreover, all of the concepts above follow the product-centric paradigm. More specifically, these tools have shortcomings in the field of conflicting criteria, the weighting of importance, fuzzy representation of selection criteria, individual results and multi-element outputs.

2.3.5.4 Deficits of existing Information Systems for Customer-centric Service Individualization

An abundance of technologies and concepts is related to the field of product individualization. In most cases, these approaches can be classified to be subtypes of the three main
classes above – namely, configuration toolkits, recommender systems and decision support systems. Newer concepts, such as guided selling, often turn out to be derivatives of them.

This work takes an integrative approach. It combines aspects of the existing information systems to overcome their current shortcomings considering customer-centric service individualization. Deficits of the existing systems are:

- **Designed for experts**: Only a few applications support composition tasks for untrained or inexperienced end users. Existing approaches are usually expert tools. Overwhelming complexity and lacking user knowledge are insufficiently addressed. Configurators are still planned and implemented from the product side, instead of the client side (Drews, 2008). RS are often carried out passively: they suggest items to the user but have no interactive user interface to elicit the user input explicitly. The concept of DSS is rarely used in a consumer setting with the purpose of product individualization.

- **Focused on goods**: Especially configuration toolkits are highly focused on physical goods. Thus, parameterization is the common individualization principle for configurator toolkits. The more appropriate matching approach is common for RS instead. However, RS are mostly considered to have no elicitation interface at all. So, users cannot explicitly state their needs, as they are used from configurator toolkits for instance. Another particularity of services is their indefinite form of description: all three types insufficiently handle fuzzy criteria, conflicting requirements and subjective importance.

- **Isolated products instead of solution bundles**: Recommender systems have their focus on single items instead of solution bundles. Thus, there is no configuration functionality included for this type of information system. Configuration toolkits allow configuration but are focused on single entities too. DSS, such as decision trees and templates, are usually static and less individual. They hardly can be generically applied to broad solution spaces.

<table>
<thead>
<tr>
<th></th>
<th>Configuration toolkits</th>
<th>Recommender systems</th>
<th>Decision support</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Designed for experts</strong></td>
<td>Not designed for consumers with little or none domain knowledge</td>
<td>Usually implemented in an implicit (passive) way. No elicitation interface that lets the user directly state his requirements.</td>
<td>Expert systems in most cases (for knowledge-driven DSS), but can also be designed for lowly-skilled users</td>
</tr>
<tr>
<td><strong>Service focus</strong></td>
<td>Parameterization of products (configuration) via objective attributes</td>
<td>Matching of entities; RS provide no configuration functionalities</td>
<td>Various types of decision logics are possible; DS provide no configuration functionalities</td>
</tr>
<tr>
<td><strong>Solution bundles</strong></td>
<td>Configuration of isolated products</td>
<td>Suggestion of isolated products</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Table 2-4: Deficits of existing individualization systems considering customer-centric service individualization

In light of customer-centric service individualization, a perfect system would incorporate 1) the elicitation interface of configuration toolkits for explicit user interaction, 2) the matching capabilities of RS to appropriately link the user input with the solution space.
and 3) the expert-based models of DSS that ensure usefulness of the proposed solution beyond the limited abilities of the user.

2.4 Service Management

2.4.1 Definition and Classification of Service (Lifecycle) Management

This work is settled in the broad field of service science that is the study of complex services and service systems. It involves methods and theories from a range of disciplines. An important aspect of this field of research is the interaction processes of different stakeholders with services throughout their lifecycle. Hence, Service (Lifecycle) Management is a sub-field of service science that explains the process to optimize service utilization from different viewpoints and purposes.

From the very first idea to the moment of retirement, every service must pass through a lifecycle. The process of managing a service throughout its entire lifecycle is called Service Lifecycle Management (SLM). “SLM is the act of being responsible for and exercising control over service-related resources in order to design and run services that are demanded by service users”, it “includes strategic, process-related and technological aspects” and covers the entire lifecycle of a service as perceived by the service provider (Fischbach, 2014).

Closely related to SLM is the concept of Service Management (SM). The primary difference is that by definition SLM “covers the whole service lifecycle, ranging from the first service idea to deactivation and archiving” (Fischbach, 2014), while SM may focus only on certain phases of the lifecycle (as it is the case in this work). Hence, further on the concept of SM is thoroughly described as a foundation to adopt the consumer perspective to it later on.

It is the purpose of SM to ensure that a service meets the expected outcome for the service user (Hurwitz, Bloor, Kaufman, & Halper, 2009). According to Grönroos (1994), SM involves four aspects: 1) delivering customer utility, 2) organizing service creation, 3) organizing quality management and 4) ensuring and optimizing excellence in service provision.

The existing definitions of SM are mainly business-driven with an organizational focus in mind. This means SM is defined from a providers’ perspective. A structured SM process across the entire lifecycle does not exist from a customer perspective yet, especially not in a B2C-context from a consumer’s perspective. Corresponding customer processes are partially covered in the field of marketing and psychology such as customer’s purchase or decision models. Technical aspects of SM can be found in IS literature regarding service configuration and service composition. However, a generalizable and holistic model that unifies the different perspectives for customer-centric service individualization does not exist yet. This is especially surprising given the earlier insights that the service user is an essential part of the creation process.

Every service is a co-creation process (see Section 2.1.1). That is why different stakeholders and roles are involved throughout the process. Each of these participants has a different
view on SM. Therefore, specific SM-models do exist in the literature that cater to the process as perceived by the corresponding stakeholders. According to the service science approach introduced in Section 1.3.2, a multi-perspective view of the service lifecycle is intended. The following section gives an overview of the covered SM-models and their classification, that results in the Service Lifecycle Landscape (Figure 2-8).

![Figure 2-8: Multiperspective service management landscape](image)

Up to this point, customer-centric service individualization is seen holistically to be consistent with existing definitions of SM. This means the understanding embraces both runtime- and design-time-phases. However, considering the stated situation and problem focus of Chapter 1 and due to the overwhelming complexity of this topic, the focus of this work must be further narrowed:

Definitions of SM do agree in two major phases: that every service lifecycle model should incorporate (Fischbach, 2014; Raverdy, 2008). First, the stage in which a service is initially designed (**Design Time**). And second, the stage in which a service is used (**Run-Time**). These two phases are generic – regardless of domain or stakeholder. Customers’ challenges, to identify and evaluate services according to their specific needs, belong to the design time phase (from a customer’s perspective). Further on, runtime-aspects are mentioned but will not be deepened. Customer-centric service individualization is a customer-based view on the SM process. Due to the focus on self-service, it is placed at the intersection of business, technological and psychological domain. It does not recognize business-internal belongings of the service lifecycle, i.e., service innovation processes or distribution activities.

Each area of the Service Lifecycle Landscape (Figure 2-8) will be analyzed further on to outline the environment service individualization takes place in: first, for each section, a generic and holistic SM model is evaluated. It either has to be broadly accepted and often referenced, or it has to be built upon established models. For practicality reasons, only one model is evaluated for each section. Differences between competing models can be neglected since they usually become visible on a very detailed level only. Particular attention is given to SM models on customer-facing intersections between the perspectives. Second, each model will be briefly introduced and the process will be described in a structured way. Associated application systems will be mentioned too.
2.4.2 Business Perspective on Service Management

2.4.2.1 Service Lifecycle Management

Service Lifecycle Management has been introduced above as a comprehensive concept which covers every lifecycle stage from a service-centric perspective. It includes process-related, strategic- and technological aspects (Fischbach, 2014).

A comprehensive service management reference process is given by Fischbach (Fischbach, 2014) who comprises established approaches like ITIL, COBIT, and various SOA-governance models to derive a generic SLM-model.

<table>
<thead>
<tr>
<th>Service Lifecycle Management (SLM)</th>
<th>Phase</th>
<th>Activities</th>
<th>Description</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Identification</td>
<td>-</td>
<td>1. Identification and description of functionalities for new services.</td>
<td>(Fischbach, 2014)</td>
<td></td>
</tr>
<tr>
<td>2. Requirements Analysis</td>
<td>2a. Elicitation</td>
<td>Analysis, filtering, and documentation of business and technical requirements.</td>
<td>(Fischbach, 2014)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2b. Pruning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2c. Documentation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Conception</td>
<td>-</td>
<td>Construction of specific service models upon the derived requirements.</td>
<td>(Fischbach, 2014)</td>
<td></td>
</tr>
<tr>
<td>4. Development</td>
<td>4a. Programming of code artifacts</td>
<td>Development, testing, and documentation to realize the concept.</td>
<td>(Fischbach, 2014)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4b. Process implementation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4c. Organizational integration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4d. Testing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Implementation</td>
<td>5a. User training</td>
<td>The service is integrated into run-time systems and goes live.</td>
<td>(Fischbach, 2014)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5b. Data migration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5c. Infrastructure setup</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5d. Service rollout</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Operation</td>
<td>6a. Incident management</td>
<td>Ensuring continuous service operation within the specified service quality.</td>
<td>(Fischbach, 2014)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6b. Security management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6c. Continuity management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6d. Capacity management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6e. Configuration management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6f. Availability management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6g. Controlling and administration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Enhancement</td>
<td>-</td>
<td>Further developments of existing services, in particular through continual process improvements.</td>
<td>(Fischbach, 2014)</td>
<td></td>
</tr>
</tbody>
</table>

Table 2-5: Service Lifecycle Management process
SLM has received broad support from IT. Fischbach (Fischbach, 2014) identifies six consonant application clusters that are used during SLM: technical SOA, application management, IT-service management, business logic, business information and service configuration.

Especially the application cluster of service configuration is relevant for this work. It contains applications “that supports the user in service reuse by providing service configuration functionality” (Fischbach, 2014). This cluster includes configuration tools and pricing engines. Fischbach distinct into end-user configurators and expert-user configurators. His findings are consistent with the statements in Section 2.3.5.1 about MC configuration toolkits. He constitutes that from a technical point of view integrated software solutions do not exist yet in the field of SLM. Almost every application requires high expertise and targets the audience of skilled professionals.

2.4.2.2 Sales and Advisory Process

In retail markets, the process of selling (complex) services to a customer is usually referred to as “advisory,” since salespeople and other intermediaries are involved. Advisory is “a two-way interaction – a process of seeking, giving, and receiving help” (Lippitt & Lippitt, 1994, p. 1). Thus, it is a co-production process between the customer (client) and an intermediary (consultant) (Auh et al., 2007). Its purpose is to support customers’ decision making by transforming the needs of the customer into a specific solution concept. An advisor helps his client in decision making and points out actions to solve a given problem (Salacuse, 2000).

Amiri (2013, p. 9ff.) conducted extensive research about advisory- and consultancy processes to identify common tasks and reoccurring phases in consultancy situations. He defined a professional advisory process as “a predefined and systematic process between an advisor and a client with the purpose of helping the client solve a problem” (Amiri, 2013, p. 9f.). He concludes that all reference advisory processes share the same essential phases, regardless of the sector or company. Accordingly, Kubr (2002) states that in sophisticated consultation processes, adviser and client always pass the same predefined core-activities that can be grouped into phases.

<table>
<thead>
<tr>
<th>Universal Advisory Process</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase</td>
<td>Activities</td>
<td>Description</td>
<td>References</td>
</tr>
<tr>
<td>1. Initiation</td>
<td>1a. Preparing for contact 1b. Initial contact 1c. Problem exploration</td>
<td>The introduction of the participants towards each other.</td>
<td>(Amiri, 2013, p. 10)</td>
</tr>
<tr>
<td>3. Implementation</td>
<td>-</td>
<td>Taking actions based on the proposed concept.</td>
<td>(Amiri, 2013, p. 10)</td>
</tr>
</tbody>
</table>

Table 2-6: Universal advisory process
A specific example of an advisory process in the domain of complex services is the financial counseling process. In comparison to the universal advisory process, it has a higher level of detail and a better fit for the prototype-based evaluation that will follow in chapter 4. Due to the higher granularity level, the consultation phase and its outcomes, which are of particular interest, become clearer too.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Activities</th>
<th>Description</th>
<th>References</th>
</tr>
</thead>
</table>
| 1. Initiation  | 1a. Contact with client  
1b. Capture first information  
1c. Open/update client profile  
1d. Collect information  
1e. Prepare for advisory meeting | Activities of the adviser ahead of the first client meeting.                 | (Amiri, 2013, p. 25) |
| 2. Analysis    | 2a. Identify current situation  
2b. Assess risk capacity and risk tolerance  
2c. Determine target situation  
2d. Determine cross-/upselling potential | Elicitation of client information in a counseling session.                    | (Amiri, 2013, p. 25) |
| 3. Concept     | 3a. Generate/work out solution concept  
3b. Present solution concept  
3c. Adjust solution concept | Definition of a solution concept.                                            | (Amiri, 2013, p. 26) |
| 4. Offer       | 4a. Generate/elaborate contract  
4b. Present contract  
4c. Sign contract  
| 5. Implementation | 5a. Initiate measures  
5b. Execute measures  
5c. Send execution report  
5d. Review execution report | Provision of sold services.                                                 | (Amiri, 2013, p. 27) |
| 6. Maintenance | 6a. Monitoring  
6b. Reporting  
6c. Recognize need for action | Running and adjusting services throughout the ongoing client relationship.   | (Amiri, 2013, p. 27) |

Table 2-7: Generic advisory process for banks

An advisory session is often equated with “personal advisory.” This indicates the dominating notion that a counseling session is conducted in personal contact – via a physical interaction between client and adviser. In practice, this still may be true, although the level of IT-support for this process has steadily increased recently (Byrnes, 2017).

Not least, because of the increasingly significant differentiation against competition (especially in the financial services sector), providers are trying to differentiate themselves through the customer-facing consulting process. This sets the focus on process design and its qualitative attributes. At this background, software applications emerged that support the advisor in certain tasks. Individualized advisory requires complex information pro-
cessing and is therefore supported by IT systems. However, these systems tend to be product-driven and have their focus on pre- and post-consultation tasks and not the consultation itself (Nussbaumer, Slembek, Lueg, Mogicato, & Schwabe, 2009). Recent developments focus on this gap. An example is the advent of tablet advisory (Nueesch, Zerndt, & Alt, 2016). However, tablet advisory is still intermediator-driven and thus, in its current form, not suited for self-service.

2.4.3 IT Perspective on Service Management

2.4.3.1 Service Composition Process

The increasing relevance of service orientation (see Section 1.1.1) in the IS domain raised the need for more sophisticated and more formalized approaches to utilize the emerging service systems. The task of selecting and combining services has received attention especially in the realm of Web services. On the web, services are deployed and modified at a pace that is beyond the human ability to comprehend them and it is unrealistic to create a composition plan manually - especially if qualitative properties have to be met (Rao & Su, 2005). A Gartner report even predicted that “the act of composition will be a stronger opportunity to deliver value from software than the act of development” (Hill et al., 2009).

Service composition covers the sequence in which services are executed. It has a process-oriented focus. Thus, it covers the workflow among services. Service composition is complemented by service configuration which has a function-oriented scope (see Section 2.4.3.2) (Xiong, Fan, & Zhou, 2009). A comprehensive definition and classification of service composition and related concepts are provided in Section 3.4.2.

The service composition process proposed by Rao and Su (2005) describes automatic service composition in five generic phases (see Table 2-8).

<table>
<thead>
<tr>
<th>Service Composition Process</th>
<th>Phase</th>
<th>Activities</th>
<th>Description</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Presentation of an atomic service</td>
<td>-</td>
<td>Description and offering of atomic services on global marketplaces or directories.</td>
<td>(Rao &amp; Su, 2005)</td>
<td></td>
</tr>
<tr>
<td>2. Conversion of the specification languages</td>
<td>-</td>
<td>Translation between the language of the service user (external language) and the internal specification language.</td>
<td>(Rao &amp; Su, 2005)</td>
<td></td>
</tr>
<tr>
<td>3. Generation of composition process model</td>
<td>-</td>
<td>Definition of requirements and constraints by the service user. Process generator solves them by aggregating services.</td>
<td>(Rao &amp; Su, 2005)</td>
<td></td>
</tr>
<tr>
<td>4. Evaluation of composite service</td>
<td>-</td>
<td>If more than one generated service meets the requirements the alternative with the highest utility is determined.</td>
<td>(Rao &amp; Su, 2005)</td>
<td></td>
</tr>
<tr>
<td>5. Execution of composite service</td>
<td>-</td>
<td>Executing the evaluated services in order of the process model.</td>
<td>(Rao &amp; Su, 2005)</td>
<td></td>
</tr>
</tbody>
</table>

Table 2-8: Service composition process
Service composition is anchored in the technological realm. The scope of service composition has broadened up since its beginnings and is now far beyond Web services. The composition of Cloud services and mobile apps are more recent areas of application (Facemire, Hammond, Mines, & Wheeler, 2014).

The technology behind service composition consists of four core elements: the composition language, automation techniques, the execution platform and supporting tools (cf. Lemos, Daniel, & Benatallah, 2015):

The composition language “decides how composition occurs, which composition activities are supported, and how” (Lemos et al., 2015). It is the central conceptual element of any service composition approach. Its technical components are description languages (e.g., WSDL, OWL-S), data formats (e.g., JSON, XML) and interaction protocols (e.g., SOAP, REST). These components can be classified in manifold ways, for instance, according to the application type (data, application logic, user interface) or to the moment of service selection (design time, run time, deployment time) (Lemos et al., 2015).

The composition is a complex task that motivated automatization approaches for reoccurring activities early. Three automation techniques do exist: 1) Synthesis tries to mimic a given target behavior by identifying an orchestrator (respectively an orchestration logic) that can integrate all necessary services correctly. 2) Planning-based automation is based on semantic service description and AI-agents that understand and compose services into an aggregated service on their own. 3) Model-driven automation provides an abstraction layer that frees the developer from low-level coding and lets him instead specify the target application on a more abstract level. This is usually done via graphical notations and automation takes place via reuse of modular code fragments. The composition model must cover the composition logic and the data transformation procedures (Lemos et al., 2015).

The execution platform is where composite services are deployed and run. During the deployment phase, the composite service is made operational and ready for execution. This may take place in two ways, either through a cloud approach or on-premise. During the run phase, a platform hosts the aggregated service. This could either be a business process engine, a service bus or code generation (Lemos et al., 2015). The execution phase covers the runtime phase and is therefore no longer of scope for this work.

The activities above can be supported by dedicated development tool and integrated development environments (IDE) which assist the developer. Refactoring and versioning are the predominating functionalities in this regard (Lemos et al., 2015).

Despite the plethora of tools and techniques associated with service composition, a current limitation is that they do not make composition languages accessible to end users. “Service composition is still a prerogative of professional programmers” (Lemos et al., 2015), due to the required software engineering knowledge and development expertise. To enable the end user to use service composition systems, they should be able to declaratively specify composite services, for example via visual languages (Weber, Paik, & Benatallah, 2013).

2.4.3.2 Product Configuration Process

Product configuration, respectively service configuration, is about combining the right functionalities into a composite solution. It is the counterpart to workflow-oriented service
Composition. *Configuration* aims at maximizing the customer utility of a product that is made out of atomic elements and customized design parameters (Randall et al., 2007; Ulrich & Eppinger, 2011).

The product configuration process according to Scheer (2006) embodies three major stages: selection, combination, and parameterization (see Table 2-9). This view accords to other definitions, such as Puppe (1990), who sees configuration as selection, parameterization and aggregation of basic objects to a solution object. Alternatively, to Günter (1994) who defines configuration as the gradual process of instantiating, parameterizing and sometimes positioning elements into a configuration object. Also Felfernig et al. (2001) say that “configuration mainly comprises the selection (and instantiation), parameterization, and composition of components out of a pre-defined set of types in such a way, that a given goal specification, as well as a set of constraints characterizing the domain in general, will be fulfilled”.

<table>
<thead>
<tr>
<th><strong>Product Configuration Process</strong></th>
<th><strong>Phase</strong></th>
<th><strong>Activities</strong></th>
<th><strong>Description</strong></th>
<th><strong>References</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Selection</td>
<td>-</td>
<td>Selection of pre-defined product components that meet the specified requirements.</td>
<td>(Scheer, 2006)</td>
<td></td>
</tr>
<tr>
<td>2. Combination</td>
<td>-</td>
<td>Assembling of selected product components to meet the specified requirements.</td>
<td>(Scheer, 2006)</td>
<td></td>
</tr>
<tr>
<td>3. Parameterization</td>
<td>-</td>
<td>Modification of component properties while observing the configuration rules.</td>
<td>(Scheer, 2006)</td>
<td></td>
</tr>
</tbody>
</table>

*Table 2-9: Product configuration process*

A more granular view of the configuration process is provided by Razo-Zapata et al. (2012). As a part of their e3service Framework, they adopted the Propose-Critique-Modify (PCM) methodology (cf. Chandrasekaran, 1990) for the purpose of service configuration. This methodology takes the iterative nature of customer-provider interaction for the configuration process into account (cf. Razo-Zapata et al., 2012) (see Table 2-10).
### Propose-Critique-Modify Service Configuration

<table>
<thead>
<tr>
<th>Phase</th>
<th>Activities</th>
<th>Description</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Propose</td>
<td>Given a design goal, propose a solution.</td>
<td>(Chandrasekaran, 1990)</td>
<td></td>
</tr>
<tr>
<td>1a. Laddering</td>
<td>Linking high-level values that customer states to (functional) product attributes and specific requirements.</td>
<td>(Razo-Zapata et al., 2012)</td>
<td></td>
</tr>
<tr>
<td>1b. Offering</td>
<td>Description of the functional offering that a supplier makes to the customer.</td>
<td>(Razo-Zapata et al., 2012)</td>
<td></td>
</tr>
<tr>
<td>1c. Matching</td>
<td>Bringing the stated customer requirements (laddering) and supplier offerings together.</td>
<td>(Razo-Zapata et al., 2012)</td>
<td></td>
</tr>
<tr>
<td>1d. Bundling</td>
<td>Matching results in a pool of service elements that now must be combined in a meaningful way to provide a jointly offering to the customer.</td>
<td>(Razo-Zapata et al., 2012)</td>
<td></td>
</tr>
<tr>
<td>1f. Linking</td>
<td>Consider supply-side constraints that must be fulfilled to be sustainable for the supplier.</td>
<td>(Razo-Zapata et al., 2012)</td>
<td></td>
</tr>
<tr>
<td>2. Verify</td>
<td>Checking that the proposed solution satisfies functional and other specifications.</td>
<td>(Chandrasekaran, 1990)</td>
<td></td>
</tr>
<tr>
<td>2a. Fuzzification</td>
<td>Make uncertainty operational, e.g., by making statements partially true and false and adding weights.</td>
<td>(Razo-Zapata et al., 2012)</td>
<td></td>
</tr>
<tr>
<td>2b. Analysis:</td>
<td>Determines the amount of provided, missing and non-required functions by the solution.</td>
<td>(Razo-Zapata et al., 2012)</td>
<td></td>
</tr>
<tr>
<td>2c. Defuzzification</td>
<td>Computation of score that expresses the quality of the solution.</td>
<td>(Razo-Zapata et al., 2012)</td>
<td></td>
</tr>
<tr>
<td>3. Critique</td>
<td>Causes of any design failures are analyzed.</td>
<td>(Chandrasekaran, 1990)</td>
<td></td>
</tr>
<tr>
<td>3a. Select</td>
<td>Based on the computed ranking, the customer can select a given solution proposal (among its alternatives).</td>
<td>(Razo-Zapata et al., 2012)</td>
<td></td>
</tr>
<tr>
<td>3b. Trade-Off</td>
<td>Based on the solution proposal, a change of preferences to generate new and better-suited solutions.</td>
<td>(Razo-Zapata et al., 2012)</td>
<td></td>
</tr>
<tr>
<td>4. Modify</td>
<td>Using input about deficits of the proposed solution to recalculate a new solution that is closer to the specifications.</td>
<td>(Chandrasekaran, 1990)</td>
<td></td>
</tr>
<tr>
<td>4a. Adapt</td>
<td>Based on scores given by the consumer, new solution proposals can be calculated.</td>
<td>(Razo-Zapata et al., 2012)</td>
<td></td>
</tr>
<tr>
<td>4b. Update</td>
<td>Replace old solution elements by the newly found ones.</td>
<td>(Razo-Zapata et al., 2012)</td>
<td></td>
</tr>
</tbody>
</table>

Table 2-10: Propose-Critique-Modify service configuration (e3 Service Framework)

Due to their high relevance for this work, application systems for product configuration (configurator toolkits) have been examined separately in Section 2.3.5.1.
2.4.4 Consumer Perspective on Service Management

2.4.4.1 Consumer Decision Process (CDP)

Every product sale is the result of a purchase decision made by the customer. The more complex the product, the more sophisticated the decision process is. The Consumer Decision Process Model (CDP) by Blackwell, Miniard, and Engel (2005) provides a behavioral model that “captures the activities that occur when decisions are made” (2005, p. 71). The decision-making process is divided into three phases (Blackwell et al., 2005, p. 67ff.): pre-purchase, purchase, and post-purchase.

<table>
<thead>
<tr>
<th>Consumer Decision Process (CDP) Model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phase</strong></td>
</tr>
</tbody>
</table>
| 1. Pre-Purchase | 1a. Need recognition  
1b. Search for information  
1c. Pre-purchase evaluation of alternatives | Covers the aspects of need recognition, information search and alternative assessment in consumers’ decision process. | (Blackwell et al., 2005, p. 71ff.) |
| 2. Purchase | 2a. Vendor selection & contact  
2b. Product selection  
2c. Offer & closing | Reflects how and where consumers buy products and what factors influence their decision. | (Blackwell et al., 2005, p. 79f.) |
| 3. Post-Purchase | 3a. Consumption  
3b. Post-consumption evaluation  
3c. Divestment | Focuses on consumption and post-consumption. Unlike the prior two stages, post-purchase covers the runtime phase. | (Blackwell et al., 2005, p. 80ff.) |

Table 2-11: Consumer Decision Process (CDP) model

During these three phases, consumers go through seven major steps when making decisions.

1. **Need recognition**: Need recognition is the starting point of every consumer decision process. It occurs when “an individual senses a difference between what he or she perceives to be ideal versus the actual state of affairs” (Blackwell et al., 2005, p. 72). Consumers do not buy products solely due to their existence. They buy products when they believe a product’s ability fulfills a need (solves a problem) and the benefit of the product outweighs its price. In this sense, need recognition is understood synonymous to problem recognition. The decision process is not only driven by needs but also by desires (Blackwell et al., 2005, p. 72f).

2. **Information search**: Once need recognition occurs, consumers start searching for information. They want to satisfy their unmet needs and start looking for solutions. Information search can either be internal or external. Internal information retrieval relies on knowledge from memory but can also be affected by genetic tendencies. The external information comprises every knowledge from third-parties including IS. Information search can also be done passively when the consumer is exposed to information (for example through advertising) or in an active way. The whole consumer decision process is highly dependent on the situational context and external factors. This is particularly the
case for information search. Sudden incidents can limit the amount of available information or the time available for information search. Beyond that, the CDP model provides more substantiation on the information processing process of consumers - a multi-step process that starts with exposure, goes on with attention, comprehension, acceptance and finally results in retention (Blackwell et al., 2005, p. 73ff.).

3. Pre-purchase evaluation of alternatives: The search and information process will most likely result in several alternative options. Consumers must evaluate these choices to find the “best” option. What is “best,” is highly subjective but can generally be described as an optimal rational choice. The number of possible choices presents the solution space to the consumer and must be narrowed down to one before a purchase decision is made. Therefore, consumers rely on evaluation criteria and contextual decision strategies (Blackwell et al., 2005, p. 76ff.).

4. Purchase: After having decided to make a purchase, consumers go through two steps: first, they choose one vendor over another. Second, they make in-store choices. This narrows the solution space further down. First on a vendor level, second on a product level (Blackwell et al., 2005, p. 79). The sequence of these two decisions may vary in practice. For example, price comparison platforms may find the cheapest vendor if the consumer already prefers a specific product. In contrast, conducting a counseling session requires a decision for a specific vendor first, and the choice for a specific product is made afterward (during the advisory session). At this stage, businesses usually get in contact with their potential customers. This is also where traditional advisory processes do start and are focused on. For the prior stages (1-3), the customer is mostly left self-directed (Blackwell et al., 2005, p. 79f.).

5. Consumption: After purchase, the customer takes possession of the product. Regarding goods, this means to consume the product. For services, this is the moment when value creation takes place.

6. Post-consumption evaluation: With the end of consumption, the post-consumption evaluation begins. This is the moment where consumers decide if they are satisfied or dissatisfied with the purchase. This evaluation relies on perceived performance and is highly subjective. This is particularly the case for services where the quality of the product cannot be quantified objectively. Dissatisfaction occurs when the perceived utility falls short of expectations. Post-consumption evaluation increasingly results in the externalization of knowledge. Online review platforms put this activity on a new scale. The derived information subsequently influences other consumers in their information search and pre-purchase evaluation (Blackwell et al., 2005, p. 80f.).

7. Divestment: Divestment does only apply to physical goods, where activities, like recycling or trade-in, can be performed (Blackwell et al., 2005, p. 82).

Even though the CDP process is originated in the field of marketing, it represents the customer view to the best knowledge. It also emphasizes the postulated paradigm shift: organizations must adapt to the customer's processes to provide superior value. Associated application systems for purchase and decision making of customers have already been analyzed in Section 2.3.5.

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21 An in-depth analysis of the used criteria is given later in Section 3.2.
3 Conceptualization of Customer-centric Service Management

This chapter links to the previous section by merging the functions of different SM processes into a customer-centric derivative that incorporates the business, technology and customer perspective. Before this, the implications of the paradigm change towards customer-centricity on the task of service individualization will be elaborated.

Based on these fundamentals, the key concept of Customer-centric Service Management is finally introduced. It consists of three main elements, namely the customer model, the service model and the service composition logic. They are individually deduced, operationalized and evaluated. These artifacts build the core of this work: an integrated, holistic model for customer-induced service individualization.

Each element on its own passes the whole design science cycle (see Section 1.3.1) and is elaborated individually. In this regard, for each element an analysis of the current state of the art is conducted, specific design considerations are given and an exemplary implementation is shown for evaluation purposes.

3.1 Customer-centric Service Management

3.1.1 Definition of Customer-centric Service Management

To understand the implications customer-centricity has on service management, it is necessary to elaborate a fundamental paradigm that had a profound impact on IS (research and practice) during the last decades: the guiding principles of IS have been the needs and requirements of businesses for a long time. Although consumers have been considered as “users” too, IS have been primarily designed to support the processes of companies and to back their business models (T. Liang & Tanniru, 2007). This may be attributed to the substantial amount of resources required to implement IS – something that for a long time only businesses have been capable of.

The characteristics and deficits of business-driven IS can be illustrated by the example of individualization technologies (see Section 2.3) and SM processes (see Section 2.4). Although they are designed with the user in mind, their primary purpose is to operate the production processes of companies (product-centricity). Putting the paradigm of customer-centricity into the existing field of service individualization and service management requires, besides an interdisciplinary approach, a comparison with the existing paradigm to illustrate its characteristics and to derive a sound definition. To do this, the characteristics of the dominating individualization approaches are put in contrast to the expected characteristics of the customer-centric approach. In an earlier work of the author, the differentiating factors have been already motivated (cf. Sachse et al., 2014b). Table 3-1 summarizes the distinction.

*Individualization process*: A customer-centric individualization process begins prior to the product individualization: it starts by transforming needs into a solution via selection...
and bundling of elements. In contrast, product-centric individualization focuses on parameterization and instantiation of a specific product (Razo-Zapata, De Leenheer, & Gordijn, 2011).

**Scope:** Whilst product-centricity refers to specific goods and services, customer-centricity refers to overall product-types instead of specific instances. The scope of customer-centric individualization hence lies on generic service classes instead of specific services (H. J. Long, Wang, Shen, Wu, & Jiang, 2013).

**Information exactness:** Product-centric MC is an extension of the production process by involving the customer (Lampel & Mintzberg, 1996). It defines the role of the customer as an integral part of service design and development which composes the product in a predetermined solution space. The product specifications are then captured and forwarded to the supply chain. In contrast to a product-centric individualization where the specification relies on specific and formalized design parameters, customer data for customer-centric individualization are abstract and vague customer needs, which are harder to classify and highly ambiguous concerning IT processing (Randall et al., 2007).

**Heterogeneity:** A shortcoming of existing approaches without customer-centricity is the degree of heterogeneity, regarding the elements of the solution space (Dellaert & Streemersch, 2005). In most cases, a holistic solution consists of several heterogeneous elements. Product-centric configurators determine in a linear way, focused on one element at a time. If bundling is done in a configuration setting, it is typically limited to homogeneous modules (e.g., creating a portfolio of funds). A workaround is a semi-structured configuration that subdivides the configuration process into distinct steps for each of the homogeneous products. However, this solution is limited to a small number of elements that are predefined for every configuration process. In some fields (like finance) an unstructured configuration process has to take place. Here the solution space consists of heterogeneous services which may build the final solution (Haak, 2013).

**Outcomes:** Because of the heterogeneity, customer-centric individualization delivers complex solutions consisting of heterogeneous service modules, instead of isolated homogeneous products. This allows a much broader solution space and flexible solutions. The solution space comprises all modules that are subject to customization and can be considered broad if it has numerous elements or is highly heterogeneous. The second aspect also determines the high degree of freedom necessary for customer-centric individualization (Epp & Price, 2011).

<table>
<thead>
<tr>
<th>Individualization Process</th>
<th>Customer-centric Individualization</th>
<th>Product-centric Individualization</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformation of customer needs into a product bundle via selection and bundling</td>
<td>Parameterization of product instances</td>
<td>(Razo-Zapata et al., 2011)</td>
<td></td>
</tr>
<tr>
<td>Scope</td>
<td>Generic product classes (Meta-level)</td>
<td>Specific product instances (Service level)</td>
<td>(Weinmann, Hibbeln, &amp; Robra-Bissantz, 2011)</td>
</tr>
<tr>
<td>Information</td>
<td>Description of the customer (needs)</td>
<td>Description of the product (parameters)</td>
<td>(Randall et al., 2007)</td>
</tr>
<tr>
<td>Heterogeneity</td>
<td>Unstructured</td>
<td>Structured, semi-structured</td>
<td>(Haak, 2013)</td>
</tr>
</tbody>
</table>
Based on these aspects, the implications of the paradigm shift towards customer-centricity in the field of product individualization become clearer. However, the specifics of services in the field of customer-centric individualization have not been considered yet. Major obstacles for the lacking dispersion of customer-centric individualization in the service domain are seen in three areas (cf. Sachse et al., 2014b):

- **Complexity towards the customer:** In product-centricity, product alternatives are not considered during the configuration process (Weinmann et al., 2011). The decision for a specific product to be configured must be made before using the configurator. In complex environments, such as financial services, consumers usually are not aware of all service types and their appropriate combination according to their personal needs. Even if so, consumers probably would not understand the relevant configuration parameters and their effects. This prevents the use of the product-centric individualization in complex application domains. As a result, a major challenge towards customer-centric service management is to manage (i.e., hide) complexity for the customer (see Section 2.2.4).

- **Need for formalization:** If the customer cannot adequately describe the desired product he can only describe himself and his subjective needs instead. This requires a formalized set of information about the client that is hard to capture because of high abstraction and fuzziness. This information is captured in a customer profile containing the relevant customization data. Attributes of the customer profile depend on the specific domain (solution space) and a given intention for the use of the profile (Kundisch, Wolfersberger, Calaminus, & May, 2001).

- **Selection and bundling of elements:** If the individualization process is not focused on a specific product it can be open towards alternatives that cater to the same need. So, the individualization process is extended by the tasks for product selection and product bundling. This is especially relevant in the service domain where individualization takes place via service-bundling. As mentioned before, relevant service-individualization concepts are almost exclusively focused on expertized users and not yet on consumers (see Section 2.3.5).

These facts document that the specific aspects of customer-centricity and service orientation have a profound impact on existing individualization approaches and service management processes. Hence, distinct research is justified. These given particularities must be considered to design a service individualization approach within the field of complex services for lowly expertised consumers - as it is the stated goal of this work (see Section 1.2.1). The integrated concept that is further on introduced is called “Customer-centric Service Management.” It is elaborated in detail in the remaining chapter.
Definition of Customer-centric Service Management (CSM):

Customer-centric Service Management describes the IT-supported process and its underlying principles for service individualization by self-directed customers in the phase prior to service consumption. It usually takes place in complex domains and regards to less expertized consumers.

This definition incorporates some constitutional aspects which directly refer to the findings of previous chapters:

Self-Service Technology: CSM aims at enabling the customer to individualize services on his own. First, this anticipates self-directed clients that want to perform this task on their own instead of delegating it to intermediaries. Second, it points out the role of IT as a crucial element of this approach that provides the required functionalities.

The notion of CSM as a process: CSM in the context of this work describes the process of service individualization performed by the customer. It covers all essential tasks that are necessary to create an individualized service solution for the customer.

The notion of CSM as a methodology: As diverse as the term Service Management is used in literature, as broad is the notion of CSM. CSM does not only describe the process that is performed by the customer, but it also covers the conceptual underpinnings such as models and methods that allow the correct implementation and execution of this process. For this work, both notions are relevant. The proper implementation of CSM is subject to Chapter 3, the process as perceived by the customer is subject to Chapter 4.

Focus on individualization: Although SM consists of two major phases (design-time and run-time), only the phase of service selection and individualization (before service consumption; during design-time) is within the scope of this work. This is a limitation of this work. Future works might broaden the scope of CSM to incorporate also the run-time phase. For the moment, CSM covers customer’s activities during the pre-purchase phase and every related activity by other stakeholders.

Service domain: The particularities of services differentiate CSM from known individualization concepts and technologies that mostly refer to physical goods.

The role of complexity: The focus on complex services narrows down the scope of CSM to a specified area of high interest and relevance. Furthermore, complexity inevitably refers to the customer: a high level of perceived complexity generally indicates a low degree of expertise by the customer. This is particularly the case in B2C and C2C scenarios where customers are referred to as consumers and domain knowledge cannot be assumed.

3.1.2 Generic Process for Customer-centric Service Management

CSM is an approach, which intends to enable customers to individualize services on their own. This means that, on the one hand, customers have to take over certain “management” tasks from the vendor, on the other hand, customers have to incorporate technical tasks into their processes since self-service is by definition IT supported. In this regard, CSM is
placed on the intersection of customer-, business- and IT-processes. Thus, a holistic service management process as perceived by the consumer during the design time phase is the intended outcome of this section.

The following methodology is applied to derive the CSM process:

1. **Identification and analysis of reference SM-processes**: Generic customer-, business- and IT-processes in the field of SM are evaluated.

2. **Model analysis**: Each process will be described in a structured way. Associated application systems will be analyzed too.

Step 1. and 2. have already been conducted in Section 2.4 to summarize the status quo of SM. A further step is added in this section that identifies the relevant tasks.

3. **Assessment of relevant tasks**: The aspects that are relevant for CSM are evaluated based on the following criteria:
   - **Visibility**: The task either has to be done by the consumer or its output is visible towards the consumer at a certain stage during the self-service process.
   - **Necessity**: The task must be essential to the individualization process. Administrative tasks like documentation may improve the process but are not strictly necessary.
   - **Relevancy**: The task must meet the criteria from the definition of CSM (see Section 3.1.1) such as the focus on design time phase and the focus on services.

The intention of the methodology is to derive the essential phases and activities that are vital for customers to individualize services on their own. At the same time, this reference process represents the functional requirements towards IS that must be implemented for the proposed concept of CSM.

Table 3-2 summarizes the related SM processes from all considered perspectives (see Section 2.4) and lists the identified activities based on the methodology above.

<table>
<thead>
<tr>
<th>Process Model</th>
<th>Goal</th>
<th>Relevant Activities for CSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales and Advisory Process (see Section 2.4.2.2)</td>
<td>Find and instantiate a suitable solution for a specified customer need by bundling standardized (service) elements.</td>
<td>Relevant phases for CSM are the analysis, concept, and offer phase. Especially the following tasks within these phases refer to CSM: 2c. Determine target situation 3a. Generate solution concept 3b. Present solution concept 3c. Adjust solution concept</td>
</tr>
<tr>
<td>Service Lifecycle Management (SLM) (see Section 2.4.2.1)</td>
<td>Meet the expected outcome for the service user efficiently and effectively for the provider.</td>
<td>CSM is placed in the operations phase from a providers’ perspective.</td>
</tr>
<tr>
<td>Service Composition Process (see Section 2.4.3.1)</td>
<td>Meet the functional requirements by composing atomic services.</td>
<td>1. Presentation of single service 2. Translation of the languages 3. Generation of composition process model 4. Evaluation of composition service</td>
</tr>
</tbody>
</table>
Product Configuration Process (see Section 2.4.3.2) | Combination of functionalities into a composite solution that is personalized to clients’ needs. | 1a. Laddering  
1b. Offering  
1c. Matching  
1d. Bundling  
1f. Linking  
3a. Select  

Consumer Decision Process (CDP) Model (see Section 2.4.4.1) | Find a rational and economical solution considering the given needs and requirements of the customer. | CSM is placed within the pre-purchase phase from a client’s perspective.  

<table>
<thead>
<tr>
<th>Phase</th>
<th>Activities</th>
<th>Description</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Evaluation/ Setup</td>
<td>Service Modeling</td>
<td>The necessary preconditions to enable CSM.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Customer Modeling</td>
<td>The description and evaluation of the elements of the solution space.</td>
<td>Service Composition Process (IT Persp.)</td>
</tr>
<tr>
<td>1. Profiling</td>
<td>1a. Initiation</td>
<td>The setup and explanation of the composition tool.</td>
<td>Generic Advisory Process for Banks (Business Persp.)</td>
</tr>
<tr>
<td></td>
<td>1b. Analysis</td>
<td>The elicitation of clients’ needs, requirements and constraints for the given configuration purpose.</td>
<td>Generic Advisory Process for Banks (Business Persp.)</td>
</tr>
<tr>
<td>2. Selection</td>
<td>2a. Laddering</td>
<td>The selection of pre-defined service elements that meet the specified requirements.</td>
<td>Product Configuration Process (IT Persp.)</td>
</tr>
<tr>
<td></td>
<td>2b. Matching</td>
<td>Linking and converting customer attributes to the corresponding service attributes.</td>
<td>Propose-Critique-Modify Service Configuration (IT Persp.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brining together the requirements from the customer-side with the offerings from the provider side. Identifying appropriate services to combine.</td>
<td>Propose-Critique-Modify Service Configuration (IT Persp.)</td>
</tr>
</tbody>
</table>

Table 3-2: Extraction of relevant activities for Customer-centric Service Management

In a next step, the relevant activities that are listed in Table 3-2 must be brought into a logical order. The information flow among the activities determines the correct sequence. The result is a reference process of CSM that is described in Table 3-3. Moreover, this process serves as a functional reference for software systems that implement CSM into self-service systems.

The reference process consists of six phases that must be passed during each iteration and a preliminary setup phase which must be passed once during deployment.
<table>
<thead>
<tr>
<th>Table 3: Reference process of CSM and its tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>During the period of conducting research for this work, experts within the research consortium provided additional insights which put the currently abstract process of CSM in the context of practical application scenarios. Their specific knowledge and background shaped the process of CSM from a stakeholder’s perspective. Depending on the applied viewpoint, the generic CSM process could also be understood in the following ways:</td>
</tr>
</tbody>
</table>
CSM as Meta-Advisory

One aspect that repeatedly confused some recipients is the focus on the pre-purchase phase. Many people (especially professional salespeople) are not aware that the purchase and decision process of the customer begins even before he has entered a branch or made a decision for a product. Figure 3-1 helps to elaborate this point by showing the client process and linking the level of product specificity to the corresponding stages of the process.

The term “meta-advisory” has been coined during that time. The belief that in the context of complex service ecosystems a consumer needs advice about the right form of the advisory was elaborated. The notion, that between need recognition and the decision for a specific provider or product the consumer must first decide for a service category, was subsequently agreed on. Hence, the service category level was named the meta-level (an advisory service that helps the customer to find appropriate advice).

![Figure 3-1: CSM as meta-advisory](image)

CSM as Self-Advisory

In the field of complex services, traditional intermediaries are increasingly becoming disintegrated by new players and services. For instance, from the perspective of a bank's client advisor, it seems plausible that the customer may soon become self-reliant and can substitute every task of an advisory by other sources (e.g., via FinTechs). From their perspective, clients will advise themselves on their own one day. Although this notion of “self-advisory” is wrong by definition\(^\text{22}\), it moves the focus on future business processes which rely on customers who perform even complex information and decision tasks without traditional salespersons. Two process variants illustrate this scenario: first, a process where the customer itself will perform any decision and configuration tasks (Figure 3-2). Second, a hybrid advisory process which embraces a consultative process where a pre-

\(^{22}\text{Advice is always conducted in interaction with a third party. Self-information and decision making would be a more appropriate term for this process.}\)
informed customer will enter a personal advisory session and might bring relevant information and a pre-profiling with him (Figure 3-3). In either case, the CSM process will become relevant as a precondition for future business processes.

![Figure 3-2: Self-advisory process](image)

![Figure 3-3: Hybrid-advisory process](image)

### 3.1.3 CSM-Framework

CSM is an interdisciplinary approach that incorporates a multitude of concepts and elements. As an initial step of the design phase, the building blocks of any CSM-implementation must be identified and structured.

Schackmann & Link (2001) provide a generic model to structure the facets of CSM. They introduce a framework for “Mass Customization of Digital Products in Electronic Commerce.” It can be adopted for this work, due to its focus on consumers and digital products. They justify the need for an inclusive framework by the various challenges that occur by implementing “Mass Customization for digital products.” Such challenges are (cf. Schackmann & Link, 2001):

- Adequate design of the customer interface to obtain relevant information
- Deriving customers’ requirements from the obtained information
- Suitable form of representation for information and “digital products”
- Matching between customer demand and market supply

Their framework can serve as a base for this work since it is focused on “digital goods” too. However, they do not explicitly address services with their model (they refer to information instead). Furthermore, it is a very high-level framework which lacks implementation specific information entirely and requires further clarification (see Figure 3-4).
The framework of Schackmann & Link (2001) consists of the following elements:

**I. Customer model**: The customer model is the distinctive element compared to product-centric configuration and brings the customer perspective into the individualization process. Customers must capture the necessary information for individualization through an elicitation tool. The vaguer the requirements are, the more challenging the elicitation process is. Gathering this information can be done in several ways. Defining a generic structure of a customer model for a given purpose is another challenge in this regard. The customer model is subject to Section 3.2.

**II. Service model**: The service model is a structured description of the elements in the solution space. It is the counterpart to the customer model and must be semantically compatible. The service model touches fields like service description languages, service ontologies, service evaluation and service repositories. Service models are subject to Section 3.3.

**III. Composition logic**: Since customers and services are described in a structured format, both sides must be matched to calculate a customized solution. Section 3.4 covers this process and looks at service composition, service selection, and service bundling.

The framework of Schackmann & Link (2001) is originated in the field of recommender systems. To adopt it for the purpose of this work - as a sophisticated configuration toolkit for services - it must be ensured that it applies to the field of configuration toolkits too. According to Scheer (2003), configuration tools share the following generic structure:

- **Database**: The database represents all predefined modules for the configuration process and the specification of the customer. The first describes the solution space, the second one the problem space. Scheer makes a distinction between the generic product model, which should be a taxonomy of the product modules and their interrelations among each other, and the customer-specific product model, that describes a desired instance of the solution space according to the customers’ specification.

- **Configuration function**: The configuration function embodies the process to derive a specific instance based on the customer-specific product model from the generic product model.

- **Configuration dialog**: Scheer describes the configuration dialog as the interface between the client and the prior elements of the configuration system.
Similar models can be found in other research domains too, e.g., for cloud service brokerage and recommendation mechanisms (cf. Gui et al., 2014) and consumer decision support systems (cf. Al-Qaed & Sutcliffe, 2006). Since all of these models confirm the basic structure of Schackmann & Link’s framework, it hence serves as an appropriate model that outlines the structure of the following chapters. Section 3.2 deals with the customer model, Section 3.3 introduces the service model, whereas Section 3.4 covers the composition logic.

3.2 Customer Model

The shift from product-centric to customer-centric individualization requires a new component in the information landscape: the customer model. It is a distinctive element compared to product-centric individualization that incorporates the customer perspective into the configuration process. The entire following section is devoted to the customer side of CSM.

In digital businesses, the customer must inevitably be represented by data to enable co-creation, as an essential part of the service provision process. Thus, the question arises, what must be known about the customer to propose and implement an individualized solution for him? This knowledge is the foundation for the content of a formal customer model. In this section, these questions are answered on a generic level. Moreover, a methodology for adopting it to a specific domain is given. Finally, also the instantiation process, namely profile elicitation, is described with the overall intention to provide a concept for applying customer modeling to the application context of CSM. However, first, this work examines the deficits of today’s customer models in light of customer-induced individualization of complex services based on an empirical experiment.

3.2.1 Deficits of Customer Models for Customer-centric Service Management – an Empirical Evaluation

Customer models, in terms of structured forms that capture customer data, do exist for decades. They are used in a plethora of application scenarios - financial advisory is one of them. From a customer’s perspective, the CSM process starts with the elicitation of his needs and requirements. The new thing is that the process is now carried out by the customer himself. In this regard, the elicitation process can be referred to as “self-profiling.” Inevitably, the following question arises: why can current customer models not be used for the purpose of CSM? An empirical analysis in the domain of financial services looks for answers to this question.

The quality of financial advisory is a reoccurring topic, not just since the financial crisis in the year 2008 (Bussmann & Plenge, 2011). Banks need to control the quality of their customer advisory process to minimize risks for their clients and themselves. The legislation requires the financial industry to ensure high quality during this process. Thus, “consultation minutes” have been established. They capture the customers’ prerequisites towards the counseling session and document its outcomes. These templates deliver a standardized approach towards customer advisory and are often required by the regulator.
For instance, in Germany, minimum requirements have been defined by financial supervision. Based on these demands, standardized templates have been designed (see Table 3-4). These templates serve as a customer model for service individualization in the field of banking services today.

<table>
<thead>
<tr>
<th>Type of information</th>
<th>Direction of information flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Data</td>
<td>Input data</td>
</tr>
<tr>
<td>Income and expenditure</td>
<td>Input data</td>
</tr>
<tr>
<td>Assets and liabilities</td>
<td>Input data</td>
</tr>
<tr>
<td>Occasion of the consultation</td>
<td>Input data</td>
</tr>
<tr>
<td>Investment goals</td>
<td>Input data</td>
</tr>
<tr>
<td>Investment horizon</td>
<td>Input data</td>
</tr>
<tr>
<td>Other concerns</td>
<td>Input data</td>
</tr>
<tr>
<td>Readiness to assume risk</td>
<td>Input data</td>
</tr>
<tr>
<td>Risk-bearing ability</td>
<td>Input data</td>
</tr>
<tr>
<td>Knowledge and experience</td>
<td>Input data</td>
</tr>
<tr>
<td>Recommendation</td>
<td>Output data</td>
</tr>
<tr>
<td>Justification of recommendation</td>
<td>Output data</td>
</tr>
<tr>
<td>Further information</td>
<td>Output data</td>
</tr>
</tbody>
</table>

Table 3-4: Elements of a standardized consultation protocol from a customer perspective (cf. Verbraucherzentrale Bundesverband, 2012)

Having such a dedicated template for financial advisory at hand, leaves the question why it is not used for self-profiling yet (e.g., via an online form)? If all necessary information can be captured in a standardized way on a few pages, why is there still a need for a personal consultation? An empirical experiment is conducted to examine this question and to identify deficits.

Research Questions and Hypotheses

Concerns about the applicability of consultation protocols for self-advisory purposes raise the following questions:

- **Q1: What kind of information can reliably be given by the consumer?** It is hypothesized, that consumers have difficulties in understanding banking terms and in providing (numerical) facts about their financial situation reliably and correctly. Not having this information at hand may prevent self-profiling in typical self-service situations (i.e., during online research or mobile interaction) in many cases.

- **Q2: Do customers prefer certain question types over others in this application context?** Open-ended questions may be suitable for chat-situations but can be hardly captured in online forms. It is hypothesized that the customer prefers certain question types like choice-based questions. Other types of questions, like numerical or textual input, should be avoided for reasons of effort and reliability instead.

- **Q3: Which purpose does the collected information serve?** Rising regulation and compliance requires financial service providers to safeguard against liabilities concerning erroneous consultation. At this background, it is hypothesized that in many cases not the interest of the customer is the primary goal. Instead, a limitation of
risk exposure for the intermediary is intended. This helps to prevent risks but does not deliver a higher solution utility.

- **Q4: Is self-profiling as simple as transferring a consultation template to an online form?** The last and overall hypothesis assumes that it is not practical to simply put existing profiling templates online. Instead, a different approach for customer profiling is needed. Accordingly, a new concept for customer modeling in the context of CSM is required.

**Experiment setup**

To answer these questions and investigate the hypotheses, an experiment among a group of students (n=29) is conducted during the summer semesters in 2013 and 2014. Figure 3-5 outlines the experiment design.

![Figure 3-5: Experiment design for the evaluation of consultation template from banks](image)

Pre-anonymized consultation minutes of one German and three Swiss banks\(^\text{23}\) were handed out to the students. Two out of these four templates have been randomly assigned to each participant. The participants were asked to envision themselves in a real-world advisory situation where the provided information would have an actual impact on their future financial situation (i.e., misstatements lead to disadvantages or wrong recommendations).

None of the question fields had actually to be answered. Instead, the participants were asked to assess each question on a three-point scale:

- **Y(es):** “Yes, I can easily and with certainty respond to this question.”
- **D(ifficult):** “It is hard for me to answer this question on my own. I would have to do further checks, look up information, invest some substantial amount of time and effort.”
- **N(o):** “No, I cannot answer this question without further help, or I would not be certain about the correctness of my answer.”

\(^{23}\) The forms have been anonymized (“unbranded”) via image editing before being handed out to the participants.
Additionally, a short meta-questionnaire about the given consultation template was given to measure the perceived experience of the participants. The structure of the consultation minutes for each provider is summarized in Table 3-5.

<table>
<thead>
<tr>
<th>Type of contained information</th>
<th>Bank 1 (Leading Swiss Universal Bank)</th>
<th>Bank 2 (Leading Swiss Universal Bank)</th>
<th>Bank 3 (Leading German Universal Bank)</th>
<th>Bank 4 (Leading Swiss Universal Bank)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Data</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Income and expenditure</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assets and liabilities</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Occasion of the consultation</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment goals</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Investment horizon</td>
<td></td>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>Other concerns</td>
<td></td>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>Readiness to assume risk</td>
<td>Y</td>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>Risk-bearing ability</td>
<td></td>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>Knowledge and experience</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Recommendation</td>
<td></td>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>Justification of recommendation</td>
<td></td>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>Further information</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Y = contains that type of information

*Table 3-5: Content of consultation minutes by the sample banks*

**Findings**

The question difficulty, as perceived by the participant, is measured based on a calculated difficulty index. The index represents the fraction of responses that had difficulties in answering a question of a group (answer “D” or “N”) about all replies. An index of 1 means that each participant had difficulties answering this question type. An index of 0,5 means that one out of two times a participant had difficulties to answer a question of this kind. 0 means no difficulties at all. The actual difficulty index per question group reaches from scores of 0,0 to 0,75.

<table>
<thead>
<tr>
<th>Type of contained information</th>
<th>Difficulty Index Bank 1</th>
<th>Difficulty Index Bank 2</th>
<th>Difficulty Index Bank 3</th>
<th>Difficulty Index Bank 4</th>
<th>Overall Difficulty Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal data</td>
<td>-</td>
<td>0,292</td>
<td>0,000</td>
<td>0,000</td>
<td>0,097</td>
</tr>
<tr>
<td>Income and expenditure</td>
<td>0,444</td>
<td>-</td>
<td>-</td>
<td>0,033</td>
<td>0,239</td>
</tr>
<tr>
<td>Assets and liabilities</td>
<td>0,648</td>
<td>0,591</td>
<td>0,308</td>
<td>0,552</td>
<td>0,525</td>
</tr>
<tr>
<td>Occasion of the consultation</td>
<td>0,028</td>
<td>-</td>
<td>0,077</td>
<td>-</td>
<td>0,053</td>
</tr>
</tbody>
</table>
Regarding hypothesis 1 (Q1), questions that heavily utilize banking terminology (like in “Assets and liabilities,” “Investment goals,” “Risk bearing abilities”) are among the highest difficulty scores of all. Thus, customers may have difficulties speaking the language of banks, i.e., using finance semantics. In contrast, questions that capture the view of the customers (like in “Personal data,” “Occasion of the consultation”) are amongst the most comprehensible question types in the experiment.

Regarding hypothesis 2 (Q2), a prevalence towards multiple-choice and open-ended text questions exists (see Appendix 2). The highest difficulty score applies to numeric questions. This may have its cause in the inability of the customers to provide these data at the moment of interaction. Even good knowledge is usually just an estimation that causes uncertainty. However, open-ended questions cause difficulties in collecting input data and in automatic data processing.

Hypothesis 3 (Q3) is proven based on an analysis of each question regarding their purpose (see Appendix 2). Much of the gathered information does not directly serve the purpose of the customer to find an individualized solution. Instead, much information serves to reduce the risk for the provider and to meet regulatory requirements. Interestingly, the questions with regulatory- and bank purposes have a higher difficulty score than questions that simply capture customer requirements (cf. hypothesis 1).

Among all question groups, the overall calculated difficulty index is 0.371. This means, 37% of all questions could not be answered with certainty by the participants. This proves the overall hypothesis H4 via a qualitative analysis. Depending on the interpretation, a score of 37% indicates a high potential for optimization, since one out of three questions can hardly be answered. From a practical point of view, a score closely to 0% is desired. In an onboarding-scenario, for example, any user must be able to respond these questions with a reasonable amount of effort. Worse numbers will raise the bounce rate and might affect brand perception.

These results are consistent with earlier studies that document several shortcomings of these traditional minutes (Verbraucherzentrale Bundesverband, 2012): the German reference protocol is neither in its practical implementation to record the conversation flow complete and correct, nor does it improve reproducibility and traceability of the recommendation.
Implications: Biases and Limitations

The qualitative insights of this experiment have been refined during subsequent group discussions. This discussion also exposed the restrictions and limitations of the experiment:

A post-experiment group debate with the participants revealed an overestimation regarding their actual ability to answer questions. The meaning of some questions that are believed to be answered correctly could not be explained upon request by the participants. Being able to put a mark on a form does not necessarily mean that the customer is able to answer a question correctly. Especially the semantic discrepancy between actual meaning and the recipients understanding has been identified as an issue. The findings above have not been adjusted at the background of this bias.

Another recurring aspect during group discussion is the bad user experience. The user experience of traditional consultation templates is far behind today’s customer expectation, making them impractical for self-service use due to low acceptance.

Furthermore, the existing templates are failing in capturing comprehensive customer needs. Banks classify customer needs either as financing needs (loans, credits) or investment needs. Many participants had neither of those needs but instead asked for advice regarding money management or international payments. This shows a discrepancy in the scope of providers and customers regarding the problem space.

Asking for personal data was no issue at all because users were used to this kind of data request in everyday online interaction. However, upon reflection afterward, data security and privacy turned out to be an issue. Sensible information that is passed on in a personal consultancy session is seen even more critical in an online scenario. The actual readiness among participants to provide facts about personal income and expenses in online-onboarding scenarios is much lower than the measured data indicates.

Finally, the significance of this experiment is limited by the homogeneous and not representative sample group (master students of business information systems at a German university). Therefore, the findings are used only as indicators for the further examinations.

3.2.2 Overview of Customer Modeling Approaches

Since the early days of information processing, the notion that the user is basically a set of personal data has been prevailing. Essentially, the same conception applies for personal interaction: although less obvious, every business transaction requires the client to share some necessary amount of information with the company. This is especially true in the service industry due to customer co-creation (see Section 2.1.1). The difference between the digital and the physical world is following: in the digital interaction, the client usually is explicitly asked for that essential information, e.g., through forms (online profiling). In personal interaction, a substantial amount of customer information and reaction can be implicitly elicited, e.g., by observation of a salesperson. In both cases the key to success is keeping the effort of the client during this process as low as possible (Sward, 2007). In the online context, this factor is referred to as “simplicity” or “user experience” (UX). In the physical context, this is known as “convenience” or “experienced advisory” (Sward, 2007). Although these two forms of customer interaction differ in many
aspects, it shows the overall importance of customer-derived information for business purposes.

This field of interest is nothing new to research. The concept of using personal data for commercial or technical purposes can be found in several academic disciplines. This is reflected by the variety of related terms and definitions.

**User Profile:** A user profile is a snapshot of the client that contains “a collection of information that describes the customer” (G. Adomavicius & Tuzhilin, 1999) and is “used by a product or service to deliver customized capabilities to the user” (Petersen, Bartolomeo, & Pluke, 2008). The term user profile is mainly applied in digital contexts, for instance in electronic commerce (D. Adomavicius & Tuzhilin, 2005). Almost synonymously the term “customer profile” is used that dominates in non-digital application areas. Profiles are defined by their application context, e.g., product customization or recommendation (D.-R. Liu, Lin, Chen, & Huang, 2001; Petersen et al., 2008). The amount of stored information may vary widely. User profiles in online social networks, for example, contain plentiful and unstructured data, like photos, locations and chat messages. User accounts for authentication purposes, in contrast, may only contain login credentials.

**Avatar:** Whereas profiles are a snapshot of user data, avatars represent the user by a graphical portrayal. Avatars are very common in virtual worlds such as games, chat rooms or forums. They are a means to virtual human-to-human interaction. The user usually controls the avatar directly (Fink, 1999; Salvador et al., 2009). More recently, avatars have also been applied as humanoid interfaces for chatbots and artificial intelligence (Angga, Fachri, Elevenita, Agushinta, & others, 2015).

**Persona:** Personas are archetypes built after observation of potential users. Each persona is built upon a fictional character for the purpose of user experience design and requirements engineering. Every persona represents an existing social group of interests. Thus, a persona contains demographic and social characteristics as well as behavior, intentions, and desires. The character is usually described as a narrative story to make its attributes more comprehensible to humans (Goodwin, 2011; F. Long, 2009).

**Digital Identities:** A trending topic in the context of personal data are digital identities. An identity is “a collection of individual information or attributes that describe an entity and is used to determine the transactions in which the entity can rightfully participate” (Wladawsky-Berger, 2016). This definition applies to physical and digital contexts alike and refers to individual entities, legal entities, and assets. Digital identities become important because the plethora of user profiles can nowadays be linked on behalf of the user to an integrated view that enables new services and interaction scenarios (White & Briggs, 2012; World Economic Forum, 2016).

At the background of this work, (user) profiles are an appropriate concept for the given goal of CSM. User profiles capture person-related information for a particular purpose in a (semi-)structured format. In the context of CSM it represents the intentions and requirements of the user regarding the expected solutions. The term user profile, customer profile and customer model are used synonymously further on in this work.

Ntwanga et al. agree with that view and add another relevant aspect to this work: “A customer profile is a snapshot of who your customers are, how to reach them and why they buy from you. In short, a customer profile is a collection of information that describes
the customer” (Ntawanga, Calitz, & Barnard, 2010). Defining and capturing this “information that describes the customer” is a non-trivial two-step process. First, there is a subprocess called **Customer Modeling** that defines the structure about what to ask the client. Second, there is a **Customer Profiling** phase that conducts the client interview on an individual basis. Customer profiling is about instantiating a profile for a specific customer (Section 4.3). Customer modeling is about defining the generic data structure based on given objectives (Section 3.2.3); (see Figure 3-6).

![Figure 3-6: Scope of customer modeling vs. scope of customer profiling](image)

### 3.2.3  Generic Approaches to Customer Modeling

#### 3.2.3.1  Classification of Customer Models

A customer model “contains explicit assumptions on all aspects of the user that may be relevant to the dialog behavior of the system. These assumptions must be separable by the system from the rest of the system’s knowledge” (Wahlster & Kobsa, 1989). Customer models can be classified along several dimensions. A comprehensive analysis is provided by Mertens & Höhl (1999, p. 9).
**Purpose of the model:** User models for selection purposes incorporate user preferences to identify and evaluate entities of a given solution space. Models for presentation purposes control the dialog flow and information provision to adapt to the recipient. These adaptive concepts either regard the use of a system, or the problem-specific presentation of the domain (Mertens & Höhl, 1999, p. 9).

**Object of the model:** Regarding the subject of the user modeling, it is necessary to distinguish whether the operator alone determines the determinants of the task ahead or if he – in the sense of an intermediary - represents the recipient. Wahlster and Kobsa (1989) call the latter on an “Agent Model.” Especially in a business context, the user often does not equal the recipient of the processing results. Besides a single customer, the receiver may also be a group of people or abstract entities such as employees or organizations (Mertens & Höhl, 1999, p. 9f.).

**Customization:** According to the degree of customization, user models either adapt to needs of individual users or recipients, or they try to reduce complexity and combinatorics of such systems by introducing stereotypes (grouping) (Mertens & Höhl, 1999, p. 10).

**Type of information:** Models that are primarily based on hard facts, are associated with a relatively low implementation complexity as they are empirically detectable (descriptive information such as age and gender) and objectively measurable. Capturing and processing soft information, such as goals and preferences, is usually a demanding task for developers (Mertens & Höhl, 1999, p. 11). Soft facts as a part of user models are often criticized for posing problems that are not solved yet: Woywod (1997) for example believes that due to the complexity of cognitive thought processes its mapping in a model is hardly feasible in practice. Unlike hard facts, there is open room for interpretation which runs the risk of a false valuation (design defects).

**Changeability:** If a model is constant during a session it is called static. If it changes in the meantime, it has a dynamic character (Mertens & Höhl, 1999, p. 11). Ntawanga (2010) broadens the temporal dimension of changeability to cover the whole customer lifecycle.

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**Figure 3-7:** Classification of customer models according to Mertens & Höhl (1999, p. 9) (shaded boxes show the focus of CSM – see Section 3.2.4)

## Characteristics
- **Purpose**: Selection, Recipient
- **Object**: Customer, Role, Organiz, Group
- **Customization**: Individual, Group
- **Type of Information**: Soft Information, Hard Facts
- **Changeability**: Static, Dynamic
- **Retrieval**: Implicit, Explicit
- **Insightfulness**: Transparent, Nontransparent
- **Validity**: Long-term, Short-term
- **Knowledge Acquisition**: Manual, Self-Learning

## Occurrence
- **Selection**: Presentation, Domain, System
- **Recipient**: User
In this context, static (or factual) information include facts like demographics about the user. Dynamic (or behavioral) information describe the constantly changing behavior or mood of the user (Ntawanga, 2010).

**Retrieval:** Implicit models observe the user and draw conclusions from its behavior (Usage Modeling). Although additional inputs are avoided in this way, the models are relatively uncertain. In systems that gain the information explicitly, the user usually must state factual or static information via question forms. They are relatively easy to implement and more transparent since the user knows what information is processed (Ntawanga et al., 2010). However, the problem is that they distract the user from its original goals: either he must describe the situation ex-ante, or evaluate the information presented ex-post. To make matters worse, meaningful feedback mechanisms need to be very complex (Mertens & Höhl, 1999, p. 12).

**Insightfulness:** If the user can view the stored data about him and their regarding interpretations, then there is a transparent model. Psychological aspects recommend hiding at least some conclusions from the user (implicit modeling). For example, if a user can see and modify his valuation in a sales support system, this could lead to vanity and terminological misunderstandings that result in an unrealistic classification (Mertens & Höhl, 1999, p. 12).

**The validity of the model:** Long-term user models store previously captured user data and must - in contrast to short-term models - not be rebuilt and entered each time. Long-term approaches offer advantages regarding customer loyalty due to the better service. However, they are opposed by legal restrictions and privacy concerns. Even if it is possible to realize long-term user models in anonymous form, it should be noted that the preferences of the user may change over time (Mertens & Höhl, 1999, p. 12).

**Knowledge acquisition:** For the acquisition of knowledge, it is necessary to determine whether a system automatically develops its models or whether the provider wants to control the knowledge-image and its inferences manually. Automatic approaches may rely on technologies such as machine learning. For practical application, it is desirable to reveal new insights based on self-developing systems. However, the upfront investment may be substantially larger (Mertens & Höhl, 1999, p. 13).

The classification above illustrates the variety of customer models that do exist in academia and practice. The typology of the model must be carefully aligned to the intended application scenario. Besides these structural definitions of the model given above, special attention must be paid to the contained data within the model. Hence, generic methods for defining the data structure of a customer model are introduced further on.

### 3.2.3.2 Customer Modeling Approaches

Customer modeling is “the process of developing a profile using relevant and available information to describe the characteristics of an individual customer and to identify discriminators from other” (Ntawanga et al., 2010).

Customer modeling has its origin in AI research that was conducted during the late seventies (Woywod, 1997). Originally focused on adaptive software systems, its goal is to enable systems that adapt their looks and functionality to the needs of users (McTear, 1993). To systematically achieve this goal, modeling methodologies have arisen.
There are three categories of customer modeling approaches according to Furness (2001): predictive modeling takes already existing information about a single user into account to predict future customer actions. Descriptive modeling takes data among all customers into consideration to understand what kinds of customers do exist. Customer segmentation is an example of descriptive modeling. Lastly, statistical modeling uses statistical methods to discover and validate model defining characteristics. In practice, all three approaches are overlapping and are usually used in combination.

All three kinds of customer modeling share a common reference process for customer modeling (Furness, 2001).

1. **Objective phase**: The first step is, to set business objectives for the customer modeling. These objectives may be, e.g., increased cross-selling, improved customer retention, better risk management or product individualization.

2. **Data gathering phase**: As a second step, requirements towards the data are derived based on the objectives. Gathering, operationalizing and pre-processing this data is a prerequisite for the following phases. Model building is always based on existing knowledge. Therefore, data must be available.

3. **Model building phase**: Model building takes place as a three-step process. First, the available data is split into a training set and a test set. Second, based on the training set, the components of the desired model are interfered. Third, the fit of the designed model is evaluated based on the test set. This whole process can be iterated until a desired quality of the model is achieved.

4. **Evaluation phase**: In the case of predictive modeling, the models are compared to the actual user behavior after the model has been put into use.

5. **Usage and improvement phase**: Once built, a model is typically deployed into an operating system. These systems should have a function to monitor the performance of the models and thereby enable further improvements of the model based on actual customer behavior and outcome data.

Customer modeling is a subfield of conceptual modeling which itself is a subfield of scientific modeling. The main goal of conceptual modeling is “the collection and the formal definition of knowledge about the field and whose system needs to perform the functions assigned to it” (Olivé, 2007, p. xi). Accordingly, in the context of CSM, the goal of a customer model is to formalize the needs, requirements and auxiliary information that is necessary to perform customer-centric service individualization.

The quality of a conceptual model (and accordingly of a customer model) depends on several factors such as a correct syntax, correct semantics and practical applicability (Lindland, Sindre, & Solvberg, 1994). Table 3-7 shows a formalized enumeration of quality attributes that describe conceptual models (cf. Tantan, Boughzala, Lang, & Feki, 2017).

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completeness</td>
<td>The model covers every relevant aspect of the given domain reality.</td>
</tr>
<tr>
<td>Correctness</td>
<td>The syntax (concepts, relations, and constraints) and the semantics (domain entities) represent the current state of the field.</td>
</tr>
<tr>
<td>Minimalism</td>
<td>The goal of the model is achieved with the least amount of data (no redundancy, no negligible data).</td>
</tr>
</tbody>
</table>
### Expressiveness
The model uses an appropriate notation for its representation and serves a defined purpose.

### Readability
Reading the model and reconstructing the underlying domain reality is kept simple.

### Self-describing
The model describes its inherent structure.

### Scalability
A sufficient generalization of the model allows its application to a large number of cases.

### Normality
The data structure of the model allows persistent storage that reduces redundancy and improves data integrity.

<table>
<thead>
<tr>
<th>Table 3-7: Quality attributes of conceptual models (cf. Tantan et al., 2017)</th>
</tr>
</thead>
</table>
| Customer models are a vital field of interest in IS research. **Research activities** are often driven by practical demand to support the digitalization of formerly physical services: there are proposed user models for a plethora of application scenarios such as assisted living (Fredrich, Kuijs, & Reich, 2014), collaborative learning (Luna et al., 2015) and museum visits (Kuflik, Wecker, Lanir, & Stock, 2015). However, the terminology of customer models, respectively user models are often used undifferentiated and misleading in this regard which makes a structured analysis hardly practical.

A more fertile branch of research is the area of user metamodels and user model integration. For instance, the General User Model Ontology (GUMO) aims at providing a general top-level ontology for user models (Kleinsmith et al., 2005). GUMO proposes a distinct markup language (UserML) and its own user model service (u2m.org). It purely focuses on the technical representation of the information via predicate syntax but falls short in providing methodologies that foster the application in non-academic contexts. The GUMO-project has been stopped meanwhile. Another approach is the 3GPP Generic User Profile, which is a “collection of user-related data which affects the way in which an individual user experiences services and which may be accessed in a standardized manner” (European Telecommunications Standards Institute (ETSI), 2004). Despite its broad definition, it is a technical concept that is solely focused on profile sharing among telecommunication providers. Newer attempts, such as Abel et al. (2013), often build upon existing customer models (i.e., social media) to avoid the cold-start problem. They take an integrative approach and propose **cross-system user models**.

To the best knowledge, the requirements towards customer modeling that are posed by CSM are unique and not solved so far. These distinct requirements and the specifics of CSM towards customer modeling are elaborated in the next section.

### 3.2.4 Customer Modeling in the Context of CSM

#### 3.2.4.1 **Generic Properties of CSM-oriented Customer Models**

The previous Sections 3.2.2 and 3.2.3 introduced the theoretic fundamentals of customer modeling: they presented the different types of customer models, the generic modeling process, and criteria for “good” customer models. This body of knowledge is now adapted to the **specifics of CSM**.
First, the classification framework by Mertens & Höhl (1999) from Section 3.2.3.1 allows defining the characteristics of customer modeling in the context of CSM. CSM has particularities in the areas summarized below in Table 3-8.

<table>
<thead>
<tr>
<th>Model Dimension</th>
<th>Specifications of CSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>The customer model serves a selection purpose, according to the given framework. The individualization in the pre-purchase phase heavily relies on matching and bundling activities to select appropriate services out of the solution space (see Section 3.1.2).</td>
</tr>
<tr>
<td>Object</td>
<td>CSM models solely refer to the customer that receives the service solution. In most cases, the recipient of the individualization is also the user of the system (self-service).</td>
</tr>
<tr>
<td>Customization</td>
<td>The CSM model describes an individual user – not user groups or segments.</td>
</tr>
<tr>
<td>Type of information</td>
<td>Needs and requirements that are captured during CSM are highly subjective and therefore belong to the category of soft information.</td>
</tr>
<tr>
<td>Changeability</td>
<td>The information is static throughout a user session. However, dynamic information in the sense of behavior data is also considered during CSM.</td>
</tr>
<tr>
<td>Retrieval</td>
<td>The information is retrieved explicitly during an elicitation frontend. This is done before service recommendation (ex-ante).</td>
</tr>
<tr>
<td>Insightfulness</td>
<td>The gathered information and thus the instantiated customer model is transparent to the user.</td>
</tr>
<tr>
<td>Validity</td>
<td>The information is used only once for the calculation of the solution proposal. So, the CSM model serves a single-session use.</td>
</tr>
<tr>
<td>Knowledge acquisi tion</td>
<td>The model structure is defined manually apriori.</td>
</tr>
</tbody>
</table>

Table 3-8: Specifics of customer models in the application area of CSM

Second, the particularities of CSM have an impact on the desired qualitative attributes of the customer model (see Section 3.2.3.2). Divergent qualities of customer models that are of particular relevance in the context of CSM are summarized in Table 3-9.

<table>
<thead>
<tr>
<th>Quality Criteria</th>
<th>Specifications of CSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimalism</td>
<td>In a CSM-scenario, the customer model is filled with information that the customer must explicitly enter. Thus, data minimization is an important requirement during the elicitation phase. Reducing the amount of required information leads to better user experience and reduces perceived complexity. Hence, it directly affects two key determinants of customer-induced service individualization (see Section 1.1.5).</td>
</tr>
<tr>
<td>Expressiveness</td>
<td>The purpose of the customer model is very focused: to enable customer-induced service composition. Containing the right information for that given purpose is an essential prerequisite for the overall utility of the model.</td>
</tr>
<tr>
<td>Readability</td>
<td>The attributes and their relationship to the real world are a critical factor for the model quality. However, the readability criteria may be the most subjective factor regarding the customer model. In a CSM scenario, the perspective of the customer is more significant than any others. The service attributes from a customer perspective will surely differ from the factors that experts will recognize, but the knowledge about these sophisticated factors and their practical implications is hardly existent for consumers.</td>
</tr>
<tr>
<td>Self-describing</td>
<td>The attributes of the customer model must be understood and be clear to non-expertized consumers. The elements must be self-descriptive to that demanding target audience. The semantic qualities of the model are a...</td>
</tr>
</tbody>
</table>
fundamental challenge: a model that speaks the language of the customer is believed to reduce complexity to a degree which makes CSM usable at all.

Table 3-9: Qualitative specifics of customer models in the application area of CSM

### 3.2.4.2 Consumer Decision Making in the Field of Complex Services

Before the required data for CSM can be formalized and structured, an excursion into the world of consumer decision making is indispensable. Consumer decision making has been a focal interest of economics and consumer research for decades (e.g. Bettman, Luce, & Payne, 1998; Tversky & Kahneman, 1986). Its practical importance is expected to rise even further, due to trends such as consumerization and consumer-centric ecosystems (see Section 1.1). Any economic transaction in B2C and C2C markets starts with the (purchase) decision of a consumer.

A decision is generally defined as choosing an option from a certain number of alternatives that differ in their properties (attributes). Purchase decisions differ from other types of decisions because they take place in the context of a market. Buyers and sellers are acting for a price. They explicitly assign a fungible, monetary value to the product. Buying decisions can be assigned to the decision under uncertainty since it is not sure whether the hoped-for consequences actually occur (Moser, 2007, p. 32f.). Another way of systematizing purchase decisions is proposed by Kroeber-Riel and Weinberg (2003). They classify four types of purchase decisions: extensive, limited, habitualized and impulsive purchase decisions. They differ regarding their degree of mental control (cognition), their degree of emotional activation (affection) and their degree of automatic reactions (reaction) (Kroeber-Riel & Weinberg, 2003, p. 368ff.).

Early scientific models assumed the consumer to be a rational decision maker that strives for the most “economically rational” alternative (Peterson, Kerin, & Ross, 2014). This assumption was quickly questioned by researchers that pointed out the insufficiencies that can be observed in the real world. Subsequently, theories like Bettman’s et al. (1998) contingency theory emerged. It postulates that consumers do not always have well-defined preferences and that depending on the type of purchase decision that is made, different decision-making strategies were applied. These strategies do not necessarily have to be rational or optimal.24

Reasons that purely rational decision making of consumers is hardly found in practice is caused by reasons such as cognitive overload. Today’s markets are so diverse that consumers are moving on the verge of being constantly overwhelmed. Checking every offer leads to an information overload quickly. Finally, information overload may cause „consumer failure to develop a correct interpretation of various facets of a product/service, during the information processing procedure. As a result, this creates misunderstanding or misinterpretation of the market” (Turnbull, Leek, & Ying, 2000). This effect is called confusion. Negative reactions are the consequence and should be avoided. If not, information, that "in itself" is a valuable resource, can become an invaluable stressor (Moser, 2007, p. 8ff.). This issue may become even more relevant in complex service domains.

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24 Relevant decision-making strategies for CSM, such as the multiplicative strategy, are covered in detail in Section 3.3.3.1 at the background of service evaluation.
(see Section 2.2.2). To cope with information overload and other deficits of decision making, such as high effort, negative emotions, and justification of choices, consumers regularly apply *heuristics*. However, heuristics are often oversimplified rules-of-thumb or cognitive shortcuts that may deliver suboptimal results (Moser, 2007, p. 33ff.).

The field of consumer’s decision making is a distinct field of research that covers a plethora of further topics which would exceed the scope of this work. For instance, persuasive communication strategies such as advertising or expectation management. In return, other aspects of decision making that are of interest for this work are not sufficiently researched yet. An example is “non-comparable choices” – the decision among products that refer to a similar need but might not be comparable by objective standards (Moser, 2007, p. 50).

### 3.2.4.3 Formalization of the Information for Consumer Decision Making in CSM

Customer models serve a given purpose. In the case of CSM, it is to identify and combine the most appropriate services for a given customer need. From an IS-perspective, the model must capture an excerpt from reality that describes the essential aspects of the problem that the computer needs for processing. Analytically, the reality that CSM is placed in can be divided into two realms: First, the current situation and their inherent demands represent the *problem space* (also phenotype space; describes “as is”). Second, the available options and the according functions represent the *solution space* (also genotype space; “to be”) (Euzenat & Shvaiko, 2013; Legner & Löhe, 2012; Salvador et al., 2009).

Within the problem space, identifying that “essential” part of the information that describes the demands of CSM is the major challenge of customer modeling. Again, knowledge of the field of psychology delivers a starting point: Literature agrees on two major factors that determine consumers decision-making process (cf. Moser, 2007, p. 32f.): goals and context values.

In the context of CSM, these two factors outline the basic elements of a customer model on its most generic level. First, goals represent the *intention* that a customer has. They describe the domain of interest and the functional requirements towards the expected solution. Second, context values are factors that become relevant depending on the given domain. For service selection, these values are primarily the perceived customer *needs*. In other words, the intention describes what a customer expects from a solution; the needs describe how the customer wants it (cf. Moser, 2007, p. 32f.).

Similar definitions are found in IS research too. Kobsa (2013) conducted research on user modeling in dialogue systems and named three general categories of explicit user data that must be contained in user models for interactive applications: 1. the objectives of the respective user, 2. the plans with which the user wants to reach his goals, and 3. the knowledge or beliefs of the user within the scope of the application. Number 2 and 3 of his model are both subtypes of context variables (from a psychological perspective) (see also Mertens & Höhl, 1999).

In management literature, Christensen et al. (2007) propose a concept for outside-in customer segmentation which also agrees to this conception. They say, “the consumer has a

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25 An overview of heuristics that influence customers decision making is given in Appendix 5.
different view of the marketplace. He simply has a job to be done and is seeking to “hire” the best product or service to do it (C. M. Christensen et al., 2007). In their regard, a job is a “fundamental problem a customer needs to resolve in a given situation.” It is described by an intention that is made up of an object and action verb and by contextual attributes.

This duality between intentions and needs is consistent with other fields of research: for instance, in requirements engineering functional- and non-functional requirements are distinguished (M. Chen et al., 2013). In this context, intentions are functional specifications and customer needs are non-functional specifications. In psychology, the Rubicon model of action phases that explains peoples’ motivation also differentiates between the “what” and the “how” during the process.

Further on, both elements will be formalized to derive a generic (i.e., domain-independent) template for the intention and needs compartments of the customer model. After that, a methodology for instantiating this template for a specific domain is given and exemplified.

**Modeling of Intentions**

Intention recognition occurs when „an individual senses a difference between what he or she perceives to be ideal versus the actual state of affairs” – thus an intention always refers to a delta between the current state and the desired situation (Blackwell et al., 2005, p. 72). An intention is an action that a person plans to carry out in order to achieve an anticipated outcome (n/a, 2017). Hence, at the background of a problem- and solution space, a customer’s intention serves as a selector to narrow down the solution space to a meaningful subset.

The classification of consumer intentions can be done either from the top-down or from the bottom-up. Via a **top-down** analysis, the existing solution space is deconstructed into subsets based on their functional properties (“intention mapping”). In contrast, a **bottom-up** approach assembles the problem space by collecting intentions based on real-world occurrences. The first approach is preferred if comprehensive domain models already do exist. The second one is applied if there are none. Bottom-up analysis has the additional benefit to be based directly on the semantics that is used in practice (by the corresponding target group). This facilitates practical adoption which is important in a consumer setting. Therefore, the bottom-up analysis is applied further on in this work.

Intention modeling in the context of CSM faces two broad challenges. First, the varying granularity of intentions and goals. Second, the semantic fuzziness and heterogeneity of the terminology as stated by the consumer.

**Granularity level:** Bagozzi (2007) describes the core of decision making as a **chain of causes and constraints** (see Figure 3-8). Decision making is a deterministic process that consists of “goal desire → goal intention → action desire → action intention” (Bagozzi, 2007). This (not exhaustive) process shows several stages and thus different levels of granularity that do exist regarding intentions. For instance, the goal level describes the direction a consumer is willing to take, while the action level defines his undertaking to get there. Each level starts with a **desire** – a vague perception of a longing or hoping for an expected result. The desire is followed by an **action** - a specific activity that is conducted by the consumer. This Decision Core describes the transformation process from problem space to solution space via constraints and relationships. It does not solve ambiguous requirements, i.e., when several similar alternatives exist for a particular desire.
Table 3-10 lists some examples of consumer intentions which differ in their level of granularity. It shows that intentions could vary highly in factors such as their temporal or functional scope. There is no known existing model that objectively determines different granularity levels of intentions throughout the transformation process from desires to actions. However, this aspect is important for CSM, since the consumer intentions are the functional selector for the appropriate services. The intentions must directly relate to a service to be usable in a CSM scenario.

<table>
<thead>
<tr>
<th>Consumer intention</th>
<th>Description of intention granularity</th>
</tr>
</thead>
<tbody>
<tr>
<td>“I want to live a happy life.”</td>
<td>Very abstract intention that covers a large time span. It allows a wide subjective interpretation and is hardly measurable. It represents an overall goal that must be narrowed down to take any actions.</td>
</tr>
<tr>
<td>“I would like to be financially independent.”</td>
<td>A domain-specific intention (financial services) that is more specific regarding the desired situation. This intention must be further clarified to take any actions.</td>
</tr>
<tr>
<td>“I want to invest money.”</td>
<td>Intention that is linked to an action. A subsequent action is clearly stated. This intention emphasizes the “what” – no longer the “where” is the focus.</td>
</tr>
<tr>
<td>“I want to buy ten shares of the stock AAPL.”</td>
<td>Precise intention that can directly be carried out as an action without further clarification. This intention does relate directly to a product and already is beyond the scope of services classes.</td>
</tr>
</tbody>
</table>

Table 3-10: Exemplary granularity levels of consumer intentions

Based on the observations in Table 3-10, the qualitative requirements towards consumer intentions at the background of CSM are the following:

- **Domain-specific function:** An intention should state “what” must be done. It describes a functional requirement towards a service and thus, can usually be related to a specific business domain (e.g., financial services).

- **Service-related:** Although an intention should relate to a business domain, it should not be over-specified. Especially, it should not relate to a particular product or provider. CSM is settled in the pre-purchase phase and thus should focus on the service level (see Section 3.1.2).

- **Call to action:** An intention should state an action that the customer wants to commit. It should not represent an abstract goal that leaves plenty room for subjective interpretation.

**Semantic disambiguation:** Intentions can be expressed in several ways. As elaborated above, an intention should ideally be a “call to action.” However, in reality, the language of the customer is more ambiguous: the semantics are diverse and intentions can be stated
in different forms. Table 3-11 shows examples of intentions which are expressed not only action-based but also goal- and problem-oriented.

<table>
<thead>
<tr>
<th>Consumer intention</th>
<th>Reference point of intention</th>
</tr>
</thead>
<tbody>
<tr>
<td>“I want to optimize my expenses.”</td>
<td><strong>Action-based:</strong> The user describes the action he is willing to take.</td>
</tr>
<tr>
<td>“My expenses are too high.”</td>
<td><strong>Problem-oriented:</strong> The user describes the problem that he recognizes.</td>
</tr>
<tr>
<td>“I want lower expenses.”</td>
<td><strong>Goal-oriented:</strong> The user describes the desired situation he wants to achieve.</td>
</tr>
</tbody>
</table>

Table 3-11: Expression of customer intentions based on different reference points

A personal intermediary might understand all three expressions in the same intended way. An information system that relies on a formal description might not. On the way to a formalized customer model, the syntax and semantics of the intentions above differ highly. At this background, for the purposes of CSM, the definition of Christensen et al. (2007) is applied that defines the **syntax of an intention** as the conjunction of an **object** and an action **verb** (e.g., “transfer money,” “benchmark portfolio”). Optionally, a **subject** can be added to make up complete intention sentences (e.g., “I want to optimize my expenses.”). This equals the action-based description approach and is chosen for three reasons: first, the action-based wording captures the customer perspective, i.e., it emphasizes the role of the subject in the intention. Second, it is a clear call to action, that was identified as a qualitative property of a good intention. Third, the action-based expression is an imperative to the system that conducts CSM. Commando-based human-computer-interaction is a proven and tested interaction style that has become common practice.

Regarding the semantic disambiguation, aspects like synonyms or double negatives must be taken into consideration too. However, the effects of these factors are minimized by relying on the formal syntax introduced above. Additionally, with the further evolution of natural language processing in information systems, the semantic challenges might become less relevant.

**Modeling of Preferences**

Preferences are expectations that are expressed in the context of a certain entity. Thus, preference modeling for service individualization must take the particularities of services into account. “How” the consumer perceives the solution is much more important for services than it is for physical goods, due to high customer involvement during value co-creation. The subjective perception of services must be formalized to be later on reliably structured, elicited and processed. In the application context of CSM, there are hardly any objective measures that can be applied to describe the non-functional requirements of the customer.

26 Christensen et al. (2015) also mentions contextual factors as a third aspect. They are covered separately on page - 89 -.
Terminology

To clarify preference modeling, the fundamental terms in the context of preferences such as “need,” “want,” and “value” must be defined first. Most of them are used indifferently in everyday life and academia, raising the necessity for a formalized classification.

According to Kotler (2011, p. 9) needs “are the basic human requirements such as for air, food, water, clothing, and shelter.” Needs do exist long before any product development or marketing activities have taken place. Some needs are unconscious; others can hardly be articulated. Kotler and Keller (2011, p. 10) therefore further classify needs into five categories: 1) Stated needs (e.g., a customer wants a reliable smartphone.) 2) Actual needs (e.g., a customer wants a smartphone whose battery power is high, not ruggedized hardware.) 3) Unstated needs (e.g., a customer expects constant software updates from the vendor.) 4) Delight needs (e.g., a customer would like the vendor to implement an excellent camera.) 5) Secret needs (e.g., a customer wants his friends to see him with the latest technology.)

Needs become wants once they are “directed to specific objects that might satisfy the need” (Kotler & Keller, 2011, p. 9fE). Wants for specific products that are backed by the ability to pay for them become demands.

Needs are requirements that intrinsically drive the customer to take actions and make decisions to generate utility for him. Utility is a concept that is defined as a tradeoff between benefits and sacrifices (Woodruff, 1997). Value is the consumer's overall assessment of utility (Zeithaml, 1988) (see also Section 4.1.1). Value is often operationalized and measured as attribute-based desires that influence a purchase. These desires are also called preferences (Woodruff, 1997).

Preferences are relevant for CSM because they describe discriminators that explain why consumers choose one alternative over another. This is essential information during the service composition process since this information enables service selection and matching.

Dimensions of a preference model

Preferences are “statements that express closeness or distance towards problems, or products” (Fridgen, Schackmann, & Volkert, 2000). Thus, preferences are inevitably defined in the context of a certain product, respectively a given purchase decision. The buying decisions of consumers directly depend on the underlying consumer preferences. These preferences usually vary across different markets (Köhler, Wöhner, & Peters, 2016).

According to the definitions above, preferences are derived from fundamental human needs and values. To develop a generic model of consumer preferences, it is necessary to understand those foundations, i.e., existing need- and value classifications. Plenty of research has been conducted in this fields already:

Numerous models do exist, that try to classify customer’s needs, desires, values and so on. The most popular one might be Maslow's Hierarchy of Needs (Maslow, 1943). It differentiates between physiological needs on the most fundamental level and safety, love/belonging, esteem and self-actualization on the higher levels. According to the Changing Minds Project (Changing Minds Project, n.d.), a plethora of alternative classification models of human needs do exist that serve various purposes (see Table 3-12 for a brief excerpt).
<table>
<thead>
<tr>
<th>Model</th>
<th>Dimensions</th>
<th>Focus of the model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maslow’s Hierarchy of Needs (Maslow, 1943)</td>
<td>• Self-actualization</td>
<td>Fundamental human needs and</td>
</tr>
<tr>
<td></td>
<td>• Esteem</td>
<td>their inherent hierarchical order.</td>
</tr>
<tr>
<td></td>
<td>• Love/Belonging</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Safety</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Physiological needs</td>
<td></td>
</tr>
<tr>
<td>Max-Neef’s Fundamental Human Needs (Max-Neef, Hopenhayn, &amp; Hamrell, 1991)</td>
<td>• Subsistence</td>
<td>Ontology of fundamental human</td>
</tr>
<tr>
<td></td>
<td>• Protection</td>
<td>needs.</td>
</tr>
<tr>
<td></td>
<td>• Affection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Understanding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Participation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Leisure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Creation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Identity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Freedom</td>
<td></td>
</tr>
<tr>
<td>Glasser’s Five Needs (Glasser, 1998)</td>
<td>• Survival</td>
<td>Psychological factors that determine</td>
</tr>
<tr>
<td></td>
<td>• Love/Belonging/Connection</td>
<td>the life of human beings.</td>
</tr>
<tr>
<td></td>
<td>• Power/Significance/Competence</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Freedom/Autonomy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Fun/Learning</td>
<td></td>
</tr>
<tr>
<td>Acquired Needs Theory (McClelland &amp; Burnham, 2003)</td>
<td>• Achievement</td>
<td>Classification of people according to</td>
</tr>
<tr>
<td></td>
<td>• Affiliation</td>
<td>types of needs that affect them most.</td>
</tr>
<tr>
<td></td>
<td>• Power</td>
<td></td>
</tr>
<tr>
<td>Packard’s Eight Hidden Needs (Nelson, 2008)</td>
<td>• Emotional security</td>
<td>Classification of needs that are</td>
</tr>
<tr>
<td></td>
<td>• Reassurance of worth</td>
<td>common targets in consumer advertisement.</td>
</tr>
<tr>
<td></td>
<td>• Ego gratification</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Creative outlets</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Love objects</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Sense of power</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Roots</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Immortality</td>
<td></td>
</tr>
</tbody>
</table>

Table 3-12: Models of human needs (excerpt from Changing Minds Project, n.d.)

The models listed above are generic models from several research disciplines that analyze the psychological facets of human needs. They have a cross-domain focus, i.e., they are independent of business domains or industries. Although these models are based on sound theories and have a proven epistemic value, their scope is too broad for this work. The needs have no direct reference to the product attributes. They can hardly address the actual scope of CSM – i.e., why do consumers choose one product over another for purchase or usage? A more sophisticated model that addresses this question is based on the Consumption Value Theory by Sheth, Newman, and Gross (1991). The **Customer Perceived Value model** builds on the concept of customer value and takes the inevitable tradeoff of every decision in contrast to available alternatives into account. Each choice offers the consumer a particular benefit and comes with specific disadvantages (sacrifices). Consumption Value Theory specifies why consumers choose to buy or not to buy a product, or why they choose one brand over another (Sheth et al., 1991).

The components that influence the perceived customer value are shown in Figure 3-9.
The Customer Perceived Value model distinguishes into benefit and sacrifice components. The benefit side describes what the user gets from a service. This may either be attributes (qualities) or outcomes (benefits) (cf. Woodall, 2003). The sacrifice side defines what he has to give in order to use the service. In practice, the differentiation between both sides is less strict. For example, a minimized sacrifice can actually be perceived as a benefit by the customer (e.g., a product that is offered free of charge). Furthermore, the Customer Perceived Value model is well suited for the context of CSM, since it emphasizes the subjective nature of service attributes (perceived value vs. objective product parameters). That is because the underlying Consumption Value Theory is universal – it is “applicable to choices involving a full range of product types (consumer durables, consumer nondurables, industrial goods, and services)” (Sheth et al., 1991).

Each component of the Customer Perceived Value model is described further on:

**Functional value**: The functional value represents the perceived utility of a service that results from its capacity for utilitarian or functional performance (Sheth et al., 1991). It is not to be confused with the functional requirements towards a service. Functional value describes, how the customer perceives the outcome of a service and the subjective utility he gets from obtaining the service. Functional requirements in contrast, objectively describe the value-creation process from a neutral perspective. The type of functional value depends heavily on its domain. In practice, this is reflected in the naming of the dimension: for example, in the context of financial services, there is an economic value, in the context of learning services, there is an educational value. In literature, the functional value is also referred to as performance value (O’Cass & Ngo, 2011).

**Emotional value**: The emotional value refers to the feelings or affective states that are aroused or perpetuated by a service. These are feeling such as security, comfort, or excitement (Smith & Colgate, 2007).

**Social value**: Social value refers to the utility of a service resulting from its “image and symbolism in association or disassociation with demographic, socioeconomic, and cultural-ethnic referent groups” (Smith & Colgate, 2007). Factors, such as reputation or exclusiveness, determine the social value.

**Relationship value**: The relationship value refers to the interaction between the customer and the service provider. It is the perceived utility that results from the ability of the service provider to interact with the customer in the right form, frequency, and intensity (Ulaga, 2003).
**Epistemic value:** Epistemic value is a service’s ability to arouse novelty, curiosity and satisfy a desire for knowledge (Sheth et al., 1991).

**Price:** The price defines the sacrifice a customer must make to use a service. It describes the cost that is associated with service consumption (Ulaga, 2003). The price is usually defined as the monetary sum a customer has to pay, but it is perceived in terms of free, cheap, or expensive. However, more recent business models increasingly facilitate alternative forms of revenue such as personal data or referrals. The price component can refer to the value price or the fair price: the value price relates to a price that justifies the benefits of purchasing a service. The fair price refers to customers believing they are paying a fair price for a service (O’Cass & Ngo, 2011).

**Time:** Time is the sacrifice a customer must make on a temporal basis. It describes the perceived discrepancy between the time of service provision and the desired time of service consumption, respectively the moment when a service result is present (Woodall, 2003).

**Effort:** Effort describes the amount of non-monetary resources, respectively the resources that do not belong to the revenue stream of the provider, that a customer must invest prior to or during service delivery. It describes the perceived customer involvement during service co-creation (O’Cass & Ngo, 2011; Woodall, 2003).

**Risk:** Risk is the perceived sacrifice that the actual outcome of a service might negatively diverge from the desired situation. Risk consists of two components: uncertainty and consequences. Uncertainty refers to any outcomes of service consumption that are potential, unpredictable and uncontrollable. In the context of risk, consequences are negative outcomes that result from unintended actions (T. Chen, Chang, & Chang, 2005).

**Inconvenience:** Inconvenience describes the negative deviation of the perceived user experience from the desired situation. It results from the service inherent characteristics to “create and deliver a hassle-free purchase and consumption experience” (O’Cass & Ngo, 2011). It refers to factors such as process and interface design.

The model above outlines a generic model of consumer’s preferences for the application scenario of service selection. It represents the data dimensions that must be included in a customer model for CSM in its most basic form. These dimensions can be further specified to provide additional meaning. An example for a supplementing view on customer preferences is the Kano model (Kano, Seraku, Takahashi, & Tsuji, 1984). It classifies three types of product attributes that influence customer satisfaction: there are basic needs, performance needs, and excitement needs (see Figure 3-10). According to Kano, the preference components can be assigned to these classes to enhance the customer model semantically. For example, “must-be requirements” are hygiene factors (cf. Herzberg, Mausner, & Snyderman, 1959) that can be neglected as differentiators during service selection (since these qualities must be contained by every alternative nevertheless).
The Customer Perceived Value model is a blueprint for every customer model in the context of CSM. What is still missing in this model, is the instantiation of domain-specific occurrences of the factors within the Customer Perceived Value model. This is subject to Section 3.2.5.

Model Extension with Customer Context

Minimalism is an important requirement for the CSM customer model. The intention- and need-dimension are essential to execute the service composition process correctly. Having a minimalized model has various advantages, such as speeding up the elicitation process and reducing potential sources of errors. However, such a model excludes additional information about the customer that might provide surplus value or can be used for functional extensions of the CSM concept.

The CSM customer model is a very focused model with a defined scope. This is in sharp contrast to the currently dominating paradigm of customer profiling: business-driven approaches aim for a holistic view of the customer that captures every facet that potentially could result in business value. In IS research, this purpose belongs to Customer Relationship Management (CRM). CRM involves the establishment and consolidation of long-term profitable customer relationships through coordinated and customer-specific marketing, sales and service concepts using modern information and communication technologies (Hippler, Hubrich, & Wilde, 2011, p. 18). CRM assumes that more information leads to a better understanding of the customer which helps companies to do better business. Hereby, classical CRM applications follow an inside-out approach that puts the interests of the company at the center of attention (Wittwer, Reinhold, & Alt, 2017b).

Figure 3-11 shows an overview of typical elements of a customer profile in CRM systems. The CSM customer model only addresses a partition of that entirety. It refers to the field “potential data” within Figure 3-11.
The quality of CSM could theoretically benefit from extra data in addition to consumers’ intentions and preferences. Whereas the typical CRM profile encompasses rather static and inside-out information on the customer, current research suggests the consideration of rather dynamic information that is contributed by consumers themselves (Wittwer et al., 2017b). This information is referred to as customer context and they might be derived from different data sources such as social media. One aim of the customer context is to complement the understanding of the customer by providing further information to business processes. This approach could also be adapted to the service individualization process.

Customer context is an emerging research topic. Wittwer et al. (2017a) define customer context as customer-centered and dynamic data, originating from various sources that refer to a person (i.e., customer) and his respective environment. A conceptual model of customer context is provided by Nemoto et al. (2015). They identified two differentiating factors that classify context: first, the dynamics of the contextual factors (change cycle of elements). Second, the scope of where the elements are embedded (individual vs. global). Along these factors, they define four dimensions of context data: 1) environment attributes (contextual elements embedded in the environment around the customer), 2) customer attributes (prior experiences of the customer, e.g., knowledge, skills, and relationships), 3) customer states (elements depending on the customer, e.g., health, emotions), 4) environment states (environment surrounding the customer, e.g., season, location) (Nemoto et al., 2015). Despite this formal classification, in practice, contextual information is often referred to as “miscellaneous” or “undefined” information that is not strictly necessary for the given intention, but that might become useful in future. It is the intention of this section to raise awareness for potential future extensions of CSM: customer models that additionally incorporate customer context.

![Figure 3-11: Typical elements of a customer profile in CRM applications (Neckel & Knobloch, 2015, p. 63f.)](image-url)
At the background of CSM, contextual information might be used for two purposes. Either to improve the quality of the result or to enable new functions: the quality of the generated solution can be increased by interpreting contextual information as constraints to the solution. E.g., existing services could be included in a solution proposal. Also, the user experience during the elicitation process could be improved by providing personalized default values or by reducing the elicitation steps (implicit elicitation). Several functional improvements based on contextual data are conceivable. For example, by adding a temporal dimension to the solution bundle that suggests a sequence or workflow among the services. Also, an automated signing and deployment of services based on pre-existing master data are possible.

These potential extensions are deliberately left out from further consideration. This work focuses on the core of CSM and only makes references to future extensions or optimizations.

### 3.2.4.4 Customer Model Elicitation

The previous section introduced the generic structure of a consumer model for CSM. Every single user interaction requires an instantiation of that model with the data of that specific user. The elicitation process to collect the relevant information and fill the model is subject to this section.

Every mass customization transaction (regardless of goods or services) is characterized by the high intensity of information flow between the customer and the provider (Frank Thomas Piller, 2002). “Every transaction implies information and coordination about the customer-specific product design and is based on direct communication between the customer and the supplier” (Frank Thomas Piller, Möslin, & Stotko, 2004). This process is called elicitation. The customer must interact with the provider to share specific information to define and translate his needs and desires into a formal product specification. The meaning of the elicitation process is often far beyond the mere exchange of information – it is an act of co-creation and joined collaboration. Often, the elicitation interface is the initial, and thus crucial, touch point between the customer and the provider (Frank Thomas Piller et al., 2004).

Within advisory scenarios, special requirements do apply to the elicitation process (Blecker, Friedrich, Kaluza, Abdelkafi, & Kreutler, 2005a). These requirements apply for CSM too:

- **Interactivity:** The process of information gathering should be carried out interactively, for example via dialogue. At the same time, the system should take care of conflicts or sources of defects.
- **Dialog sequence:** Only relevant questions should be asked during the profiling process. Therefore, the sequence of the dialogue must be dynamically determined.
- **Presentation of the results:** In elicitation setting that provide real-time results to the user, the suggestions should be supplemented by explanations that are comprehensible to the user. Also, the quality of the recommendation should be disclosed to the user.

---

27 The term „profiling“ is also regularly used in this context with the same meaning.
There are two main forms of elicitation: explicit and implicit elicitation. **Explicit** elicitation asks the user to actively enter the required information, e.g., through forms or questionnaires. It is a relatively simple method that is very common in practice and is used, e.g., to establish initial customer profiles for new visitors. **Implicit** elicitation, in contrast, gathers information about the user in nonintrusive ways, e.g., via observations or data analytics. Explicit elicitation gives the user full transparency and control over the system, implicit elicitation provides higher convenience and can process more heterogeneous data (Eirinaki & Vazirgiannis, 2003; Ntawanga, 2010). In the context of CSM, the focus is purely on the explicit elicitation approach, since it is the customer who alone directs the individualization process (customer-induced) and no third-party system.

The „ways and procedures to obtain user requirements“ are referred to as ** elicitation techniques** (Yousuf & Asger, 2015). Elicitation techniques focus on the logic of asking questions – they do not focus on aspects such as interface design (e.g., GUI elements). Elicitation techniques have been researched in the field of requirements engineering for a long time (cf. Kotonya & Sommerville, 1998). Yousuf and Asger (2015) classify the requirements elicitation techniques into the following classes: there are traditional techniques (e.g., interviews, document analysis, questionnaires), contextual techniques (e.g., observation, ethnography), collaborative techniques (e.g., prototyping, joint development, brainstorming, requirements workshops) and cognitive techniques (e.g., card sorting, protocol analysis). All of these techniques are hardly formalized and rely on less structured data. These techniques cannot be applied directly in self-service scenarios.

This work focuses on structured and formalized elicitation techniques that can be implemented in SSTs such as configuration toolkits. Appropriate concepts and models can be found in the domain of recommender systems.

In the field of recommender systems, the elicitation approach is distinct into dialog-based recommenders and critique-based recommenders (Loepp, Hussein, & Ziegler, 2014). Dialog-based recommenders elicit user preferences and generate recommendations by asking the user a series of questions (Mahmood & Ricci, 2009). Critique-based recommenders rely on user feedback towards the given recommendation, such as ratings or skipping items (L. Chen & Pu, 2012). In recommender systems, the “cold start problem” is a recurring issue: either the user, the items, or the underlying system may be unknown when a new recommender system is deployed. The “user cold start problem” is of particular relevance for this section since a system cannot provide personalized recommendations until sufficient user information is collected. To handle this issue, the design could either rely on (not personalized) defaults or the user must first pass a complete elicitation run (Chang, Harper, & Terveen, 2015).

An overview of appropriate elicitation techniques within the field or recommender systems that meet the requirements stated above is given in Table 3-13.

<table>
<thead>
<tr>
<th>Elicitation technique</th>
<th>Functional description</th>
<th>Applicability</th>
</tr>
</thead>
</table>
| Rating                | • The user assesses or evaluates items regarding quality, quantity or a combination of both | • Hardly demanding for the user; Does not ask for much concentration  
• Depending on the application scenario, there is a high chance that the user must rate items he has not seen yet. Thus, a significant portion of users may fall into the “unknown” category. |
### Ranking
- The user evaluates the relationship between two or more items.
- Results in an ordinal sequence or hierarchy of the items.
- Preferable to ranking, when the goal is to categorize items.
- Preferable to rating, when the goal is to choose an item.
- Provides consistency in the evaluation.

### Representative-based Elicitation (N. Liu, Meng, Liu, & Yang, 2011)
- The user selects from a set of representatives.
- The given representatives serve as templates that represent a multidimensional combination of latent factors.
- Delivers elicitation results very quickly and is often used for initial user profiling (cold start problem).
- Recommendations are hardly personalized and need further refinement.

### Choice-based Elicitation (Loepp et al., 2014)
- The user iteratively chooses between two alternatives.
- Comparison extracts latent factors from a matrix of user ratings.
- Dialogues can either be generated automatically to maximize the distance between the latest factors, or they can be manually defined (decision trees).
- Provides good results even with little present information about the user (cold start problem).
- Interactive user control with automatic recommender techniques.

### Group of Items (Chang et al., 2015)
- The user evaluates a group of items instead of individual items.
- Ratings contain overlapping information.
- Relies on the definition of suitable clusters.
- Same application scenarios as rating.
- Effort and time are reduced for the user in comparison to rating.

### Pairwise preference elicitation (Bledaite & Ricci, 2015)
- Combination of ratings and pairwise preferences for requirements elicitation (as in choice-based elicitation).
- Slider is used in the interface, that must be dragged towards one of the two choices.
- Pearson correlation between the choices is calculated.
- Requires fewer comparisons than choice based elicitation.
- Quickly delivers recommendation results, if the number of preferences is significantly lower than the number of items (cold start problem).
- Decorrelation helps in gaining additional insights into users’ preferences.

### Scenario-based elicitation (Haumer, Heymans, & Pohl, 1998)
- Requirements elicitation is based on captured real-world scenes, or validation through the animation of formal specifications.
- Provides additional information to the user that may provide background and contextual knowledge.
- Elicitation process takes longer due to the introduction and presentation of the chosen scenario.

### Users unknown preference elicitation (Neidhardt, Schuster, Seyfang, & Werthner, 2014)
- The user selects a set of pictures, instead of answering questions.
- Pictures reflect typical behavior or requirement patterns.
- For users who do not know their needs and are unable to express themselves.
- Provides excellent user experience but sacrifices exactness and transparency.
- Quickly delivers recommendations (cold start problem).

| Table 3-13: Overview of elicitation techniques for self-service scenarios |
| --- | --- |
| **Ranking** | - The user evaluates the relationship between two or more items.  
- Results in an ordinal sequence or hierarchy of the items.  
- Preferable to ranking, when the goal is to categorize items.  
- Preferable to rating, when the goal is to choose an item.  
- Provides consistency in the evaluation. |
| **Representative-based Elicitation (N. Liu, Meng, Liu, & Yang, 2011)** | - The user selects from a set of representatives.  
- The given representatives serve as templates that represent a multidimensional combination of latent factors.  
- Delivers elicitation results very quickly and is often used for initial user profiling (cold start problem).  
- Recommendations are hardly personalized and need further refinement. |
| **Choice-based Elicitation (Loepp et al., 2014)** | - The user iteratively chooses between two alternatives.  
- Comparison extracts latent factors from a matrix of user ratings.  
- Dialogues can either be generated automatically to maximize the distance between the latest factors, or they can be manually defined (decision trees).  
- Provides good results even with little present information about the user (cold start problem).  
- Interactive user control with automatic recommender techniques. |
| **Group of Items (Chang et al., 2015)** | - The user evaluates a group of items instead of individual items.  
- Ratings contain overlapping information.  
- Relies on the definition of suitable clusters.  
- Same application scenarios as rating.  
- Effort and time are reduced for the user in comparison to rating. |
| **Pairwise preference elicitation (Bledaite & Ricci, 2015)** | - Combination of ratings and pairwise preferences for requirements elicitation (as in choice-based elicitation).  
- Slider is used in the interface, that must be dragged towards one of the two choices.  
- Pearson correlation between the choices is calculated.  
- Requires fewer comparisons than choice based elicitation.  
- Quickly delivers recommendation results, if the number of preferences is significantly lower than the number of items (cold start problem).  
- Decorrelation helps in gaining additional insights into users’ preferences. |
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- Elicitation process takes longer due to the introduction and presentation of the chosen scenario. |
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- Pictures reflect typical behavior or requirement patterns.  
- For users who do not know their needs and are unable to express themselves.  
- Provides excellent user experience but sacrifices exactness and transparency.  
- Quickly delivers recommendations (cold start problem). |
Most of the elicitation techniques listed above qualify for the use in a CSM scenario. However, some techniques are better suited than other ones. Factors that determine the suitability are quick elicitation results (handle the cold start problem), transparency about the elicited information and their meaning and direct influence of the customer. Thus, choice-based elicitation, group of items and pairwise preference elicitation are proven techniques that can be applied for CSM.

3.2.5 VOC-OE – A Methodology for Bottom-Up Customer Modeling

The previous sections take a generic view on customer modeling. They derive universal concepts and models for CSM, regardless of application scenarios or business domains. To transfer this body of knowledge into practice, it must be initialized first. A methodology for this process is developed in this section. Finally, an example of this process is given at the case of the financial services industry.

The proposed methodology is a hybrid approach. It combines ontology engineering from the field of IS research with the Voice of the Customer technique from the area of marketing. Accordingly, the merged methodology is called Voice of the Customer-driven Ontology Engineering (VOC-OE). It represents a core element of CSM.

![Figure 3-12: Voice of the Customer-driven Ontology Engineering (VOC-OE)](image)

Figure 3-12 shows the integrated model that is explained further on. It is based on the ontology engineering methodology (Section 3.2.5.1) and is supplemented by the Voice of the Customer approach (Section 3.2.5.2).

3.2.5.1 Ontology Engineering

Definition of Ontology
The purpose of the customer model is to capture all necessary information that is required to perform customer-induced service composition. As elaborated before, the information depends on the given objective and the application domain. For this reason, the generic customer model (see Section 3.2.5) needs to be instantiated first, before it can be applied to a specific (service) domain. This process is a central aspect of CSM and by no means a trivial task.

What is needed, is a “formal, explicit description of concepts in a domain of discourse” – an ontology (Noy & McGuinness, 2001). An ontology represents a “shared conceptualization” (Studer, Benjamins, & Fensel, 1998) that serves as a mean for structuring and exchanging data. Its characteristics do define an ontology best (cf. Guarino, Oberle, & Staab, 2007):
• **Ontologies provide conceptualization:** A conceptualization is “an abstract, simplified view of the world that we wish to represent for some purpose.” It contains “the objects, concepts, and other entities that are assumed to exist in some area of interest and the relationships that hold among them” (Genesereth & Nilsson, 1987).

• **Ontologies provide a formal, explicit specification:** A specification is a language that refers to the elements of the conceptualization. It consists of vocabulary and symbols. It must be formal (i.e., readable by machines) and explicit (formal description of the inherent meanings) (Guarino et al., 2007).

• **Ontologies are shared:** In order to be useful, conceptualizations need examples that allow third persons to understand the mindset of the ontology designers. Thus, sets of examples (approximations of conceptualizations) or meaning postulates (e.g., explicit formal constraints) should be provided to ease access for others. Besides providing lower burdens, it also ensures that the ontology is used by others in the intended way (Guarino et al., 2007).

An ontology provides a “common understanding of the information structure among humans or computers and enables the reuse of domain knowledge” (Wicaksono, Schubert, Rogalski, Ait Laydi, & Ovtcharova, 2011). An ontology in combination with individual instances of its inherent classes constitutes a knowledge base. In practice, the differentiation between where an ontology ends and a knowledge base begins is diffuse. A further characteristic of ontologies is that there is no definite “right” or “wrong” way of representing the domain of discourse. Multiple variants of an ontology can serve the same purpose well. In practice, there are “better fitted” and “worse fitted” ontologies (Noy & McGuinness, 2001).

**Fundamentals of Ontology Engineering**

The process of creating a (domain specific) ontology is called ontology engineering. It creates an appropriate knowledge base, grounded on a creation process that is structured and reproducible (e.g., Fogliatto, da Silveira, & Borenstein, 2012). Several distinct ontology engineering approaches do exist in the literature (see Figure 3-13).
First, there is no correct way to model a domain—there are always viable alternatives. Second, ontology development is necessarily an iterative process. Third, concepts in the ontology should be close to objects and relationships in the domain of interest.

### Ontology Engineering 101 Methodology

Further on, the Ontology Engineering 101 methodology by Noy & McGuinness (2001) is briefly described. This is no recommendation for this specific approach—other ontology engineering approaches might be appropriate as well for the given purpose.

Noy & McGuinness (2001) state three fundamental rules that outline their ontology design process. First, there is no correct way to model a domain—there are always viable alternatives. Second, ontology development is necessarily an iterative process. Third, concepts in the ontology should be close to objects and relationships in the domain of interest.

---

**Figure 3-13: Comparison of ontology engineering methodologies (Iqbal, Murad, Mustapha, & Sharef, 2013)**

The previous methods can be classified as manual approaches because the analytic work is done primarily by humans. Besides that, there are also (semi-)automatic engineering approaches, which build ontologies to a high degree without human interaction. This is usually referred to as ontology learning (e.g., Velardi, Faralli, & Navigli, 2013) – whereas ontology engineering usually refers to the manual method. Ontology learning is also applicable to CSM, but due to the high automatization and need for sophisticated models should be used in a more mature stage. Non-manual approaches rely on assumptions and model-derivatives, which make their output hard to appraise.

Although the variety of structured ontology engineering methodologies might suggest differently, the process of creating an ontology is always unique to some extent. It varies in detail and many individual assumptions must be made to adopt it for the given purpose and domain (Noy & McGuinness, 2001). The above-listed ontology engineering methods have only minor differences in their functioning and the tasks they include. Thus, in practice, the choice of a suitable method relies on other factors, like documentation and software support. In this respect, Stanford Universities Ontology Engineering 101 method is a prevalent approach, because it is well described, widely accepted and is backed by a sophisticated software named “Protegé” (Stanford University, 2016). For that reasons, Protegé and the Ontology Engineering 101 methodology are applied in this work too.

<table>
<thead>
<tr>
<th>Methodologies</th>
<th>Type of development</th>
<th>Collaborative construction</th>
<th>Reusability support</th>
<th>Degree of application dependency</th>
<th>Life cycle</th>
<th>Strategies for identifying concepts details</th>
<th>Methodology support</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUNEp</td>
<td>Stage based</td>
<td>No</td>
<td>Yes</td>
<td>Application semi independent</td>
<td>No</td>
<td>Middle-out strategy</td>
<td>Insufficient details No</td>
</tr>
<tr>
<td>METRONTOLOGY</td>
<td>Evolving prototype</td>
<td>No</td>
<td>Yes</td>
<td>Application independent</td>
<td>No</td>
<td>Middle-out strategy</td>
<td>Insufficient details No</td>
</tr>
<tr>
<td>KBES IDEFS</td>
<td>Evolving prototype</td>
<td>No</td>
<td>Yes</td>
<td>Application independent</td>
<td>No</td>
<td>Middle-out strategy</td>
<td>Insufficient details No</td>
</tr>
<tr>
<td>Ontolingua</td>
<td>Modular development</td>
<td>No</td>
<td>Yes</td>
<td>Application independent</td>
<td>No</td>
<td>Not clear</td>
<td>Insufficient details No</td>
</tr>
<tr>
<td>Common KADS and KACTUS</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Application independent</td>
<td>No</td>
<td>Top-down strategy</td>
<td>Insufficient details No</td>
</tr>
<tr>
<td>PLENIUS</td>
<td>Guidelines</td>
<td>No</td>
<td>No</td>
<td>Application independent</td>
<td>No</td>
<td>Bottom-up strategy</td>
<td>Insufficient details No</td>
</tr>
<tr>
<td>ONIONS</td>
<td>Modular development</td>
<td>No</td>
<td>No</td>
<td>Application dependent</td>
<td>No</td>
<td>Not clear</td>
<td>Insufficient details Yes</td>
</tr>
<tr>
<td>Mikrokosmos</td>
<td>Guidelines</td>
<td>No</td>
<td>No</td>
<td>Application dependent</td>
<td>No</td>
<td>Rule-based strategy</td>
<td>Insufficient details No</td>
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<tr>
<td>MENSULA</td>
<td>Guidelines</td>
<td>No</td>
<td>No</td>
<td>Application dependent</td>
<td>No</td>
<td>Concepts Graphs (CG)</td>
<td>Insufficient details Yes</td>
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<td>SENSUS</td>
<td>does not mention any preference</td>
<td>Yes</td>
<td>Yes</td>
<td>Application semi independent</td>
<td>No</td>
<td>Not clear</td>
<td>Insufficient details Yes</td>
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<tr>
<td>Cyc methodology</td>
<td>Evolving prototype</td>
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<td>Yes</td>
<td>Application independent</td>
<td>No</td>
<td>Not clear</td>
<td>Some details No</td>
</tr>
<tr>
<td>UPON</td>
<td>Evolving prototype</td>
<td>No</td>
<td>Yes</td>
<td>Application independent</td>
<td>Yes</td>
<td>Middle-out strategy</td>
<td>Some details No</td>
</tr>
<tr>
<td>101 method</td>
<td>Evolving prototype</td>
<td>No</td>
<td>Yes</td>
<td>Application independent</td>
<td>No</td>
<td>Developer's consent</td>
<td>Some details No</td>
</tr>
<tr>
<td>On-To-Knowledge</td>
<td>Evolving prototype</td>
<td>No</td>
<td>No</td>
<td>Application dependent</td>
<td>Yes</td>
<td>Middle-out strategy</td>
<td>Some details No</td>
</tr>
</tbody>
</table>

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- 94 -
The methodology is a seven-step process which is summarized in Table 3-14. For a full reference of the methodology see Noy & McGuiness (2001) and Stanford University (2016).

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Determine the domain and scope of the ontology</strong></td>
<td>• Definition of the domain, purpose, target users, stakeholders, potential queries and answers for the ontology</td>
</tr>
<tr>
<td><strong>2. Consider reusing existing ontologies</strong></td>
<td>• Check, if existing sources can be extended or refined, before creating a new ontology.</td>
</tr>
<tr>
<td><strong>3. Enumerate important terms in the ontology</strong></td>
<td>• Gathering of all relevant information that should be explained in the ontology (in natural language, without any classification yet)</td>
</tr>
<tr>
<td><strong>4. Define the classes and the class hierarchy</strong></td>
<td>• Application of a top-down, bottom-up, or hybrid approach for finding classes and define the class hierarchy</td>
</tr>
<tr>
<td><strong>5. Define the properties of classes - slots</strong></td>
<td>• Describe the internal structure of the classes and concepts</td>
</tr>
<tr>
<td><strong>6. Define the facets of the slots</strong></td>
<td>• Description of the value type, the number of the values (cardinality), allowed values and other features of the values the slot can take.</td>
</tr>
<tr>
<td><strong>7. Create instances</strong></td>
<td>• Defining an individual instance by selecting a class, creating an individual of that class and attribute it with values.</td>
</tr>
</tbody>
</table>

Table 3-14: Overview of Ontology 101 methodology (Noy and McGuinness 2001)

For ontology engineering in the context of CSM, some specifics apply: unlike most ontologies, there are no physical entities described. The challenges of service description do apply (see Section 2.1.1). Moreover, the customer perspective must be captured. Therefore, an extension of Stanford Universities ontology engineering methodology is proposed that caters to the needs customer-centric profiling. This extension (VOC-OE) refers primarily to step three of the 101-methodology but also affects the subsequent steps four to six (see Section 3.2.5.2). The enumeration of important terms (step three) is only vaguely specified in the 101 methodology and often requires further methodological considerations nonetheless. For CSM, it is refined by the Voice of the Customer analysis.

Furthermore, as the last step before practical implementation, the ontology must be mapped to the customer model structure. This step as another extension of the ontology engineering process for CSM.

3.2.5.2 **Voice of the Customer Analysis**

**Methodological Considerations**

In this section, an approach for capturing the customer perspective is presented. The goal of this step is to retrieve a holistic enumeration of the needs and requirements of the customer within a given application scenario. The enumeration should represent the entire population of potential users within a given domain (problem space). The challenge is that on the one hand, the viewpoint to be taken must be customer-centric, on the other hand, customers can hardly reflect and articulate their own needs in a complex service domain. This leads to the problem on where to start this process.
Principally, two sources of information do exist where relevant information can be derived from: First, the customer himself who might be asked or observed about his needs (customer-based information). Theoretically, the customer should be the reference for all business activities (see Section 1.1.3) - thus, he is a source of unfiltered and exhaustive information that is relevant to CSM. Nevertheless, there are some deficits to this approach:

- **Insufficient Reflection:** Especially in complex service domains, customers are hardly able to reflect and articulate their own needs.
- **New needs:** Besides hidden and unconscious needs, there might also be new needs that are made up by product design and marketing, which are not known to the customer yet, but are relevant to the solution space.
- **Variation:** Needs might differ based on the selected sample and over time.

Second, the properties of the product might be the point of reference to derive information about customer needs (product-based information). The attributes and qualities of a product are well defined and can be used to obtain corresponding customer needs. Differentiating attributes of products are evident based on objective facts. This approach assumes that market demands drive product development and that any product features refers to actual customer needs. Disadvantages of this method are the applied provider-point of view and the error-prone mapping of the product attributes to the customer perspective.

Both sources of information can be potentially used for CSM, but need further efforts to deliver the desired result. Fortunately, there is a third source of information which circumvents the named disadvantages: information from marketing, such as product claims, pitches or testimonials (marketing-based information). This information source is an intermediate between customer- and product-based information that tries to build a link between differentiating product attributes and relevant and comprehensive customer needs. Marketing statements are generally well thought out. They are coined “through-the-eyes of-the-customer” in a combination of a profound knowledge of the product and the market. The language of the customer is usually applied which makes it easily comprehensible. Hence, although the provider coins marketing-based information, it imitates the voice of the customer very well.

**Voice of the Customer-Analysis**
The Voice of the Customer is a concept from the field of marketing, that is used in different meanings: 1.) VOC is a “term used to describe the stated and unstated needs or requirements of the customer” (Yang, 2008, p. 126). 2.) It is a “critical process” that accurately records customers’ input describing their needs and expectations for products and services” (Aguwa, Olya, & Monplaisir, 2017) 3.) Lastly, VOC is also a technique that “produces a detailed set of customer wants and needs, organized into a hierarchical structure, and then prioritized regarding relative importance and satisfaction with current alternatives” (Aguwa et al., 2017). This work refers to the processual-methodological definitions of VOC. The technique is also called Voice of the Customer-Analysis (e.g., Jackson & Frigon, 1998).

The origins of VOC lies in the field of market research, where it has been applied for purposes such as product development, product improvement, market planning and innovation activities (Aguwa et al., 2017; Yang, 2008). Furthermore, VOC is often utilized for quality management processes such as the integrated Quality Function Deployment (QFD) or the Critical to Quality (CTQ) concept (Aguwa et al., 2017; Griffin & Hauser, 1993). Although isolated application examples for VOC can also be found in other areas, such as ITIL (Chan, Durant, Gall, & Raisinghani, 2008), it is almost exclusively used for
product development yet. A facilitation for product selection and bundling as intended in CSM is a new application scenario for VOC to the best knowledge.

A generic **process to Capture the VOC** is presented further on. It is based on Yang (2008, p. 126ff.) and is extended concerning the scope, tool support, and analysis methods to meet the specifics of CSM. The steps of the VOC process are shown in Figure 3-14:

*Figure 3-14: Extended Voice of the Customer-Analysis*

1. **Define scope**: Each VOC analysis starts with a specific goal. This goal must be defined clearly to outline the scope of the data collection. In conjunction with OE, the scope of VOC should already be defined as an outcome of the first step of the OE methodology.

2. **Determine target customers**: There is no single voice of the customer. VOC is a collection of diverse customers’ statements. As with every empirical elicitation, a high quality of the data is desired (e.g., regarding representativeness or the number of topics). The data collection can be based on different types of customers or other stakeholders (e.g., competitors). As a rule of thumb, Yang (2008, p. 128) states, to get the 90-95% level in capturing customer needs, about 20 customers must be analyzed.

3. **Designate roles and tools**: Yang (2008) describes the VOC-Analysis process from a company’s point of view. Thus, the actors and stakeholders in the process refer to business units. He argues that from a business perspective a number of entities should have an interest in the results of VOC and thus should conduct the data collection. While this is entirely legit, an additional aspect in this regard is proposed: the evaluation of tools and available data sources that should be facilitated to ensure a high-quality analysis. Recent technologies such as big data, voice analysis or collaborative platforms offer a high potential to improve the expressiveness of the results. Thus, the tools along the process should be considered thoughtfully.

4. **Define the data to collect**: The scope of the analysis determines the type of data that must be collected for VOC. Typical classes of customer data are (cf. Yang, 2008, p. 129ff.):
   - **Solutions**: Customers describe their view on how something should work.
   - **Specifications**: Customers give product specifications such as weight, size, color, based on their own opinion.
   - **Needs**: Customers state vague and high-level qualities of products or solutions. During VOC analyses, needs are typically stated as adjectives.
   - **Benefits**: Benefits are closely related to needs and describe the value that the customer expects from a product or solution.

Additionally, Ulwick (2005, p. 15ff.) suggests some more comprehensive statement types to collect via VOC (with the scope on product development):
   - **Jobs to get done**: Customer describes the function that a product or solution is supposed to deliver.
   - **Desired outcomes**: Customer describes the end result for each job to be performed.
   - **Constraints**: Environmental, physical or mental barriers that prevent from the customer from using a product or service or restrains the product to do its job.
5. Conduct data collection: The data collection can be distinguished into manual or automated approaches. Manual data collection can take place, e.g., via focus group interviews or questionnaires. Automated approaches usually rely on existing data, e.g., complaint logs, field reports or user reviews. They utilize technology to identify and extract the relevant customer statements from the rarely structured data. An example of the automatic approach is the fuzzy-based VOC analysis by Aguwa et al. (2017) that uses rule learning and text mining.

6. Structure VOC data: The data that has been gathered during the collection phase must be structured and analyzed in order to gain further insights. Key statements and customer insights must be identified from the bulk of data. In literature, three analysis frameworks can be found for this purpose:

   a) Voice of the Customer Table (VOCT):
   This model collects and analyzes data about customers’ requirements and expectation. It consists of a customer column that identifies the customer for the data entry. This helps improve representativeness, e.g., by distinguishing between internal and external customers. The column “use” describes the present or intended use of the product. It helps to structure product attributes and to prioritize future requirements (Jackson & Frigon, 1998, p. 23ff.)

   ![Figure 3-15: Template for VOC data classification (based on Jackson & Frigon, 1998, p. 23f.)](image-url)

   **Voice of the Customer Translation Matrix**

   - Customer Comment (What Are They Saying?)
   - Gathering More Understanding (Why Are They Saying It?)
   - Customer Requirement (What Do They Want?)

   ![Figure 3-16: Voice of the Customer (VOC) Translation Matrix (goleansixsigma.com, n.d.)](image-url)

   b) Voice of the Customer Translation Matrix:
   This spreadsheet-based methodology is used to transform vague comments into concrete issues. It is a means to develop measurable customer requirements. The VOC Translation Matrix is an element of the Six Sigma toolkit (goleansixsigma.com, n.d.).

   ![Figure 3-16: Voice of the Customer (VOC) Translation Matrix (goleansixsigma.com, n.d.)](image-url)

   c) Quality Function Deployment Matrix
   This tool captures customer’s input (“What’s”) and translates them into technical solutions (“How’s”). This can be done iteratively over several stages. The tool delivers a prioritized list of customer requirements and potential solutions. It is a core component of the Quality Function Deployment (QFD) methodology and is used for Six Sigma too (Gharpure, 2008).
The analysis frameworks above provide a means to derive a list of key entities from a customer perspective. These entities have an inherent meaning and relationship to each other and thus, can be classified in the ontology. The result serves as an input for the further steps of the ontology engineering process.

VOC is a bottom-up approach. The conceptualization of the domain is built upon individual occurrences. Alternatively, top-down approaches do exist that derive the conceptualization of the domain from abstract models. An example is the concept-specification method by Schnell, Hill, and Esser (2011, p. 119ff.). Originated in the discipline of social sciences, abstract concepts such as security are broken down into constitutional dimensions, categories, and statement groups.

For CSM, a bottom-up approach is preferred, because of the better fit to the underlying problem- and solution space. There is a lower risk of identifying concepts that are not related to the application scenario, and there is a higher semantical fit to the target group (the language of the customer).

3.2.5.3 Ontology to Model Mapping

As a final step of the VOC-OE methodology, the classes and concepts of the ontology must be converted to the structure of the customer model. Subsequent phases of CSM rely on that elaborated customer model.

The model mapping has a logical and a technical aspect. In this section, the scope is solely on the logical process that maps the entities from the ontology to the structure of the generic customer model. The technical aspect refers to the activities of data modeling and is a sub-discipline of software engineering.

The structure of the ontology can vary widely due to the creative and iterative elements of the engineering process. For the context of CSM, not the structure but the inherent meaning of the ontology is important. Via model mapping, a normalization of the data structure is achieved. The result is an instantiation of the generic customer model (see Section 3.2.4.3). It consists of the following data fields that make up a customer model and that each have their own characteristics.
Model elements | Description
---|---
Dimensions | • Each entity either belongs to a dimension or is a dimension itself
• The dimensions are defined by the generic customer model (see Section 3.2.4.3)
• It has proven to be a good practice to use the dimensions of the customer model as top-level nodes of the ontology during the iterative creation process. It provides an initial structure for ontology engineering.
• Dimensions are distinct from each other, and they contain classes

Intentions | • List of functional requirements (job statements)
• Intentions can be further classified according to domain-specific models (e.g., into payment-, financing-, and investing-related intentions in the domain of financial services)
• Intentions always refer to one or more classes
• Intentions could be further annotated, e.g., by synonyms or clarification to solve unambiguity

Classes | • Classes describe the aspects customers pay attention to, and that can be used to differentiate services from each other
• Classes have a relative importance (weight) in relation to other classes
• Classes can be further divided into sub-classes, e.g., to differentiate some aspects of the classes further
• In the class hierarchy, only end-nodes should have values

Values | • Values describe the desired occurrence of a class
• Different value types exist (discrete, continuous, list of choices)
• Cardinality describes the number of values respectively defines optional and required values
• Values should be grouped according to the questions which will be presented to the user during the elicitation process (which should have additional description such as question text and labels)

Table 3-15: Characteristics of the data fields in the customer model and mapping rules

The elements above provide the data structure that describes each dimension within the Generic Model of Consumer Preferences (see Figure 3-9). In practice, each of the data fields above should be supplemented by additional meta-information like a formal description and frontend-labels that become necessary for documentation and implementation. An example is given in the following section.

3.2.5.4 Application of VOC-OE in the Financial Services Industry

The differentiating factors of services that customers perceive within the field of wealth management became subject to a bilateral project during the research phase of this work (see Section 1.3.2.1). The results serve as a conceptual underlying for a planned customer-centric service marketplace.

The structured process of classifying abstract entities such as client needs in the domain of wealth management follows the ontology engineering methodology proposed by Noy & McGuinness (2001). The most relevant aspect of the entire process is the task to enumerate important terms. There are no models available to explain, why clients choose specific services in wealth management over another. Determining the factors by creative
approaches like brainstorming has its shortcomings regarding scientific rigor. Surveying clients fall short by the lacking ability to reflect their needs in a complex, very often low-interest domain like financial services. In consequence, a bottom-up analysis of service descriptions and company statements from the providers has been chosen as the data source for this analysis. This provides advantages for a thoughtful service description coined by professionals to reflect the “language of the client.” The bias of this approach caused by the tendentious wording can be neglected given to a large number of analyzed vendors. The raw data for this task is publicly available and can be re-examined by others. The bottom-up analysis is based on a total number of 34 vendors. They fall into five categories that represent the most important providers in wealth management: banks, family offices, regulated investment advisers (RIAs), direct banks and Fintech-companies.

The extracted company statements have been classified, using the VOC-OE approach. This allows identification of a broader dimension behind the profusion of marketing statements. E.g., statements like “protect your assets” and “you have full control of your money” both belong to an overall dimension that may be named “security”. These dimensions do not describe technical service parameters – instead, they represent the client view and facilitate the language of the client. Matching these outside-in dimensions to product attributes is a separate task that is not part of the ontology engineering process but definitely must be an element of an implementation.

The analyzed companies differ in the number of offered services and the quality of their service description. In total, 918 statements have been identified that were iteratively broken down into 14 client-related need-dimensions. Figure 3-18 shows that the additional knowledge gain for further providers is nearing zero, as the curves flatten. Thus, the sample for this analysis can be considered as a representative at the time of analysis. A larger sample of financial service providers would result in a negligible improvement of the ontology. The drop in the number of needs in Figure 3-18 is due to consolidation during the iterative analysis.

![Figure 3-18: Results of the client needs analysis](image)

During the analysis process, the results have been reviewed and regularly consolidated in expert workshops (step 4-6). During these sessions, it has been found, that valid need dimensions for the client decision process must meet the following criteria:

- **Differentiating**: No “hygiene factors” must be considered that apply to all service-classes (e.g. "reliable").
• **Assignable**: A client need clearly refers to a specific service or business.
• **Understandable/Unique**: No use of marketing messages that can be interpreted in many ways (e.g., "smart").
• **Client perspective**: Client benefits must be addressed - not features or technical process description (e.g., "global network").

Furthermore, it has been found out, that consumer needs either refer to the service (service-based needs, e.g. price) or to the provider (company-based needs, e.g. global network)

<table>
<thead>
<tr>
<th>#</th>
<th>Class</th>
<th>Sub-Class</th>
<th>Value/Occurence</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Individuality</td>
<td>Individuality during Planning-Phase</td>
<td></td>
<td>Taking the whole situation of the client into consideration.</td>
</tr>
<tr>
<td>1.1</td>
<td>Holism</td>
<td>Individuality during Execution-Phase</td>
<td></td>
<td>Delivering a service with the minimal amount of process steps and information complexity for a specific client.</td>
</tr>
<tr>
<td>1.2</td>
<td>Simplicity</td>
<td>Integration</td>
<td>Embedding a service into other services of the client.</td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td></td>
<td>Flexibility</td>
<td>Ability to adjusting the service to changed circumstances.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Availability</td>
<td>Physical Availability</td>
<td>Global</td>
<td>Client wants a global reach.</td>
</tr>
<tr>
<td>2.1</td>
<td></td>
<td>Regional</td>
<td>Client wants local presence and expertise.</td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>Temporal Availability</td>
<td></td>
<td>Clients want to use services anytime.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Trustee</td>
<td>Expert</td>
<td>Client trusts a domain expert (i.e. bank adviser)</td>
<td></td>
</tr>
<tr>
<td>3.1.a</td>
<td>Crowd/Community</td>
<td>Client trusts collective intelligence.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.b</td>
<td>Algorithm/Automation</td>
<td>Client trusts computational models and algorithms.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Support</td>
<td>pro-active</td>
<td>Client wishes the service provider to take the leading role in service delivery.</td>
<td></td>
</tr>
<tr>
<td>4.1.a</td>
<td>passive</td>
<td>Client wishes the service provider to take action only if the client needs it.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Aggregation</td>
<td>Intermediation</td>
<td>One-Stop</td>
<td>Client wants the service(s) from a single vendor.</td>
</tr>
<tr>
<td>5.1.a</td>
<td>Intentional Variety</td>
<td>Client intentionally seeks for multiple vendors to fulfill his needs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1.b</td>
<td></td>
<td>Consolidation</td>
<td>Client wants an integrated view on multiple vendors and services (i.e. Cockpit).</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 3-19: VOC-OE derived customer model for the domain of wealth management (excerpt)**

Finally, Figure 3-19 shows an excerpt of the customer model-structure that has been developed during that process. Each of the dimensions refers to a dimension of the Generic Model of Consumer Preferences (Figure 3-9) and could be translated to corresponding elicitation questions (which was not subject to the project).
3.3 Service Model

Previous Section 3.2 covered the inherent structure and the content of a customer model used for service individualization. What is still missing, is the equivalent to the customer model – a model that represents the supply side. Services, respectively service models are in focus of this section. This part covers the description, classification, representation and evaluation of them. The service model in conjunction with the already introduced customer model, is the foundation for the process of service composition that is subsequently covered in Section 3.4.

3.3.1 Service Classification and Structuring

3.3.1.1 Modularity as a Guiding Principle for Services

Characteristics of services compared to their physical counterparts (goods) have extensively been elaborated in Section 2.1.1. Modularity is an essential factor amongst them. The characteristic of modularity is particularly relevant in the context of service structuring since the right granularity and the appropriate classification of the “building blocks” are necessary to structure the overall solution space.

Modules comprise two major principles: the principle of loose coupling and the principle of high cohesion (Sanchez & Mahoney, 1996). Elements of high cohesion among each other are combined into loosely coupled modules. Elements are atomic parts of the system that shall not or cannot be decomposed anymore. Elements have interdependencies that define a hierarchy or structure of a system. In an optimal state, modules consist of elements that have strong interdependencies among each other, but non-or weak interdependencies to elements of other modules. The degree of intra-modular coupling is considered as cohesion, whereas coupling describes a number of inter-modular relationships (Balzert, 2009, p. 40ff.).

The concept of modularization is essential for services and therefore for the subsequent sections. The process of designing appropriate services is referred to as service modularization (Leimeister, 2012). It is defined as a set of “activities being part of interactions between the components of service systems” (Leimeister, 2012). The intention of service modularization is the creation of an entirety of services that make up a coherent service typology.  

3.3.1.2 Service Granularity and Service Typologies

Services are encapsulated functionalities designed for the purpose of higher flexibility (Solakivi, Töyli, & Ojala, 2013) and higher quality (Wilding & Juriado, 2004). Thus, the service paradigm heavily relies on modularization. The major challenge in this context is to find the right levels of service granularity to determine the best trade-off between (de-

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28 This work assumes adequate services, that are correctly designed, as a precondition. Methodologies for service modularization are not part of this work. Further information in this field is provided for instance by Dörbecker and Bölmann (2015).
composition efforts and reusability (Steghuis, 2006). Service granularity is defined as “the scope of functionality exposed by a service” (Papazoglou & Heuvel, 2006). There is no known typology or comprehensive concept that enumerates generic granularity levels. Instead, the characteristics of each level and its contained services are of importance – accordingly, appropriate granularity levels must be derived each time individually (Glöckner, Ludwig, & Franczyk, 2016).

The principles of SDL help to illustrate this challenge (see Section 2.1.1.2): according to SDL, services are the basis of every economic exchange. On a fundamental level, everything is built upon services. Every service consists of more granular services, as well as every service can be a part of a more complex service itself (Vargo & Lusch, 2004). Accordingly, a bundle of services can be considered as a discrete service itself. Consequently, everything is a service that is made upon services and may be itself a part of a service – it is a continuum of different levels of granularity without a clear gradation in between. For the purpose of a formal service typology, things become more difficult based on that reasoning.

SDL helps to explain many phenomena of the service economy but raises new questions in return. It introduces the concept of different levels of service granularity without clarifying what defines a level of service granularity and which levels do exist (if at all). This issue is relevant for CSM because the elements that can be bundled must be clearly defined and distinct.

Recent research takes up on this problem. Subsequently, service levels have been broadly conceptualized in two dimensions - horizontal and vertical granularity:

- **Horizontal granularity** either refers to the number of functions bundled by a single service provider, or to the type of functions bundled (e.g. functionality granularity, data granularity). Horizontal granularity typically has in intra-organizational focus (Glöckner, Ludwig, & Franczyk, 2016).

- **Vertical granularity** describes the integration of functions from other service providers to achieve more complex services. Vertical granularity covers the hierarchical integration with other stakeholders and typically has an external focus (Glöckner et al., 2016).

There are also attempts to measure granularity in order to quantify and compare granularity levels (Bianchini, Cappiello, De Antonellis, & Pernici, 2014; Feuerlicht, 2011). Metrics, such as the number of state changes and the number of invoked components are used for this purpose. However, these approaches do not answer how to find distinct levels. The same applies to automatic service identification approaches, such as clustering or swarm optimization, which can hardly help in determining the appropriate granularity levels (Glöckner et al., 2016). However, these levels are necessary to structure services respectively the solution space of CSM towards a consistent service classification.

An exemplary classification of services regarding their granularity is proposed by Kohlmann (2011). He identifies four granularity layers (called "tiers") that refer to the layers of the Business Engineering Model (strategic layer, process layer, and IT layer) (Österle, Höning, & Osl, 2011):

**Tier 1 - Service cluster:** Service clusters are predefined services that encapsulate business services. Service clusters can also be market services which are offered to third parties (customers). Thus, service clusters serve as a link between business services and a companies’ value proposition.
**Tier 2 - Business services**: Business services encapsulate related services to represent tasks and corporate processes. They link IT services to a company’s processes.

**Tier 3 - Application services**: Application services capsule application-specific or independent functionalities to bridge the gap between application and business layer.

**Tier 4 - Infrastructure services**: Infrastructure services capture functionalities of software applications and serve as a technical infrastructure for all services in the layers above.

Furthermore, Kohlmann classifies services on a horizontal dimension, according to their technical function. So, business services are distinguished into process-, rule- and data-services. The third dimension of Kohlmann’s typology is “scope”. He differs between internal and external services.

![Service Granularity Typology](image)

*Figure 3-20: Service granularity typology (based on Kohlmann, 2011)*

Although Kohlmann’s typology provides a sound foundation for service classification that incorporates existing research, it has some noteworthy shortcomings in light of CSM: the focus of Kohlmann’s work is on intra-organizational SOAs, that structure the services according to business processes and -functions. However, he has hardly covered the (external) customer side. At this background, another shortcoming appears: the type "service cluster" is mainly defined by its property to be offered on the market. On the one hand, "service cluster" is a misleading term, because his tier 2 services itself are bundled "service clusters", just as tier 3 services may consist of multiple tier 4 services. On the other hand, if only service clusters are offered to the market, his third dimension "scope" is redundant. Nevertheless, this model implies that there must be a relevant distinction between internal used services and external services that are offered to the customers.

A more recent and more general approach to service classification is the Service Granularity Framework by Glöckner, Ludwig, and Franczyk (2016). It classifies services on three reoccurring levels, separated by a common mapping layer in between. Each level is defined as followed:

- The **top-provider level** is focused on vertical granularity and represents the most comprehensive services that are exposed to external consumers, i.e. the end users.
• The **middle-provider level** covers services that are internally combined out of atomic services to enable value creation and to meet the demand of users and stakeholders.

• The **bottom-provider level** again has an external focus. It holds atomic services that are demanded from external providers on a lower hierarchical level.

• The **common-mapping level** describes the connection of an upward provider’s bottom-level with the downward provider’s top-level. It contains service meta-information (e.g., descriptions, interfaces) and is of virtual nature since it does not contain services itself.

The Service Granularity Framework of Glöckner et al. (2016) allows the conceptualization of service systems and their inherent granularity.

![Service Granularity Framework](image)

Figure 3-21: Service Granularity Framework (Glöckner et al., 2016)

Both models share the same key insight which makes up a substantial underlining of CSM: there are **no objective criteria** that qualify services to have the right granularity for CSM, respectively to be “customer-centric” by a certain definition. The appropriate level of granularity is of subjective nature and depends on context criteria. According to the Service Granularity Framework, CSM must be focused on the top-provider-level. A services’ exposure to customers defines the level, which is subject to CSM. According to Kohlmann’s model, the services must meet the criteria of an external-scope.

The question, which criteria services must meet to be marketed, is out of scope for this work. For the purpose of CSM, the **external scope** is assumed as a matter of fact, that is set by providers who have decided to market a specific service. In other words, any service that is available to the customer on the market is relevant to CSM – even if they obviously might have various levels of granularity (e.g., due to different feature-widths). The fact of external exposure defines the right granularity level for CSM – there are no absolute criteria available.

### 3.3.1.3 Service Domain Representation

The principles of modularity and granularity pave the way for more refined notations. Service-centric views on economic systems raise the need for an adequate representation of those systems. A system is “created by entities (elements) and their interdependencies (relationships) forming a system’s structure”, whereas a domain “represents the classification of elements which create the system” (Kortler & Lindemann, 2011). Over time,
several notations and concepts for service domain representation have emerged that serve different purposes and target groups. An overview of service domain representation concepts is given below – example figures for each representation are shown in Appendix 4:

**Service repositories:** Service repositories, respectively service catalogs or service registries, contain a structured listing of services in a specific domain or area of interest. It provides business and technical information about these services based on a common structure (Erl, 2008, p. 476; Kohlmann, 2011, p. 81).

**Service maps:** “A Service Map (SM) is a representation of multiple abstraction layers of existing services and their relations in a service network or part of it” (Glöckner & Ludwig, 2013). Service Maps serve as a visualized construction system and structured overview of service-oriented ecosystems for the purpose of service engineering and management. Its categorization follows user-defined criteria (Glöckner & Ludwig, 2013).

**Service ontologies and service taxonomies:** A service taxonomy is a hierarchical classification of a given set of services into distinct categories as well as their underlying classification principles. Its visualization resembles a tree structure (Cohen, 2007). Ontologies are data models that represent the relationships among services within a given domain. Ontologies are formal representations that resemble network graphs (Cohen, 2007).

**Service architectures:** A service architecture describes “the functionalities of the service system [that] are decomposed into individual functional elements to provide the overall services delivered by the system” (Voss & Hsuan, 2009). The term service architecture has a broad meaning and can be seen as an umbrella term that may subsume the concepts above. Service architectures typically contain elements and their interrelationships.

**Design Structure Matrix (DSM):** A Design Structure Matrix is a methodology from the field of systems engineering for integration and decomposition tasks. Its main purpose is to model the relationships among elements in a given domain. It is capable of supporting binary relationships as well as numeric relationships that weight a connection (Browning, 2001).

**Domain Mapping Matrix (DMM):** A Domain Mapping Matrix is an extension of DSMs that allows the mapping of connections between two domains. They can be binary or numerical again (Lindemann, 2009).

<table>
<thead>
<tr>
<th></th>
<th>Service Repositories</th>
<th>Service Maps</th>
<th>Service Ontologies/Service Taxonomies</th>
<th>Service Architectures</th>
<th>Design Structure Matrix (DSM)</th>
<th>Domain Mapping Matrix (DMM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service enumeration</td>
<td>Y</td>
<td>(Y)</td>
<td>(Y)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Service description</td>
<td>Y</td>
<td>(Y)</td>
<td>(Y)</td>
<td>(Y)</td>
<td>(Y)</td>
<td>(Y)</td>
</tr>
<tr>
<td>Service classification</td>
<td>-</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>-</td>
<td>(Y)</td>
</tr>
</tbody>
</table>
Each domain representation has a different focus and thus serves a different target group. Their shared main purpose is to “provide a common language for architects, engineers, and business-decision makers and facilitate better communication within and across different disciplines and organizations” (Cohen, 2007). Depending on the application area, the focus of the concepts above differs: there are service-focused notations (e.g., reference list), structure-focused notations (e.g., hierarchies, classifications), or relationship-focused notations (e.g., ontologies, DSMs). However, almost every service domain representations above shares the same common elements: items (services), links (relationships) and structure (classification, categorization).

At the background of CSM, there is more than one suitable representation approach that could be facilitated to model the supply side respectively the solution space. An appropriate concept must catalog the services and describe their interrelationships. Service description could be provided by external sources, respectively it is subject to the service model anyway (see Section 3.3.2). Service classification is an optional feature in the context of CSM. It could be used, e.g., for simplifications and heuristics (evaluation of classes instead of single services).

For this work, ontologies were utilized for domain representation. Their advantages lie in the powerful modeling capabilities especially for relationships among the services. They allow modeling of different types of relationships and cardinalities, e.g. for attribution of constraints. Additionally, ontologies are highly formalized, and the stored information can easily be retrieved and processed by machines. All other necessary features are present too. Lastly, there are also practical reasons to choose ontologies: due to the previous VOC-OE process, a high familiarity with the technology stack, the modeling interface, the data export, and the query languages should exist.

### 3.3.1.4 Customer-centric Service Ecosystems

Networks are the dominating topology of value creation these days. The resources used in product and service provision typically, at least in part, come from other actors (Vargo & Lusch, 2015). Much has been written about virtual organizations, strategic alliances and the like that elaborate the market environment from a business perspective. From a consumers’ perspective, representing a service domain by the classification of traditional industries, causes some deficits in light of CSM. Consumers usually do not think within the boundaries of traditional sectors or industries (cf. Wind, Libert, & Wind, 2016). Often, they might not even be aware of them. Consumers might find alternative solutions to their needs in very distinct areas. Logically, what we see now, is a shift from traditional market
structures (defined by the vendors) to service ecosystems (as perceived by the participants). This raises the question which scope must be applied to capture the right services for CSM? How is a service domain defined in a customer-centric context?

In institutional theories and network theories, business ecosystems and service ecosystems have received much attention in the past. Probably the first attempt to infuse the notion of ecosystems into the field of business is James F. Moore who introduced the term business ecosystem. A business ecosystem describes the circumstance, in which a collection of heterogeneous elements interact in an environment that crosses traditional borders of several industries (Moore, 1993). A more recent and more formal definition is provided by Vargo and Lusch (2015), who recognize service ecosystems as an essential part of their (revised) SDL. Hence, they see it is a fundamental concept of today’s economy. They define a service ecosystem as “a relatively self-contained, self-adjusting system of resource integrating actors connected by shared institutional arrangements and mutual value creation through service exchange” (Vargo & Lusch, 2015). The constitutional elements of that definition are organizations and institutions. Organizations are the actors (including customers) in the ecosystems. Institutions are the rules and norms that apply to the interaction among these organizations. They see the structure of today’s economy as “resource-integrating, service-exchanging actors that constrain and coordinate themselves through institutions and institutional arrangements” (Vargo & Lusch, 2015).

According to Vargo and Lusch (2015), the starting point of any ecosystem definition is the specific positioning of one or more actors. That actor must not necessarily be a customer, but at the background of CSM, only the customer-centric view on the ecosystem is relevant for the intended purpose. This insight is a further building block of the service classification for CSM. The service domain that must be represented is a customer-centric ecosystem and not an industry by its traditional definition (e.g., finance, automotive).

The logical implications of customer-centric service ecosystems are more dynamic environments with more heterogeneous participants and more diffuse views on the actual roles of the market participants such as competitors, suppliers, customers and other stakeholders. Even the limits of the ecosystem itself become diffuse. These circumstances must be addressed by the service domain representation. For service classification with respect to CSM, three implications are seen:

- **Scope defined by the customer perspective**: The business-driven scope that defines markets based on traditional criteria must be overcome and the customer’s point of view must be represented.
- **More heterogeneous services**: Service landscapes become more diverse. Thus, service typologies will become less distinctive and implications on the service granularity occur.
- **Dynamic environment**: The ongoing convergence of formerly distinct industries and sectors and the higher paces of innovation makes the representation of the service domain more dynamic. Service classifications must be steadily kept up to date to capture the current state of the ecosystem.

### 3.3.2 Service Description Standards

Service ecosystems incorporate numerous service providers that deliver various types of services. They all need a “common language” to describe their offerings to each other and
to the customer for reasons of service discovery, service administration, and service integration. By definition, describing intangible products is more complex than describing physical goods. Hence, the main purpose of service descriptions differs from the aims of good description (i.e., describing the perceived outcome vs. describing physical product attributes). At this background, service description standards have emerged that establish interoperable and unified means of service specification among market participants (Currie & Parikh, 2006).

Elements and Classification of Service Description Standards

Defined as a “system of symbols governed by grammatical rules which associate particular sets of symbols with a meaning” (Barros & Oberle, 2012, p. 270), service description languages allow a persistent view on service’s functional and non-functional features. Additionally, they can capture operational features and constraints, like interrelationships and dependencies (Barros & Oberle, 2012; “Linked USDL,” n.d.):

**Functional features:** The functional description describes what the service does. This part covers the provided functions and features of a service that create value for the stakeholders when executed (Barros & Oberle, 2012, p. 269f.).

**Non-functional features:** How the service behaves when performed, is subject to the non-functional section of the service description. It covers the qualitative aspects of the service execution (Barros & Oberle, 2012, p. 269f.).

**Operational features:** Operational features cover aspects that are relevant to execute services correctly. They describe contextual aspects of the service provision.

These three attributes represent the generic elements of any service description. A plethora of service description standards have emerged since then. Fischbach (Fischbach, 2014) provides a comprehensive evaluation of the most important ones and identifies distinctive characteristics that differentiate existing standards:

- **Industry-specificity:** Some description standards, such as Financial Products Mark-Up Language (FpML) or Market Data Definition Language (MDDL), are developed for specific industries and closely-defined purposes. However, most standards are unspecific towards industries and sectors.

- **Type-dependency:** Services of different kinds should be consistently described and categorized by available standards. At the same time, attributes might vary for different service types. That leads to the observation that some description standards are tightly defined, e.g. Web Services Description Language (WSDL) that enables automatic exchange of Web services. Others, like Unified Service Description Language (USDL), are more generic and have an open and modular design in order to apply to all types of services.

- **Implementation:** The maturity of the description standards varies between conceptual state and broad practical application, with many nuances in-between.

- **Standardization:** Another indicator of the maturity of a language is the level of standardization. In general, standards favor practical diffusion. Although the notion “description standard” indicates a formalized standardization approach, many service description standards, such as SaaS-DL (Software as a Service Description Language), do not meet formal criteria for standardization.
Deficits of Service Description Standards

Based on a set of criteria, Fischbach identified the *Universal Service Description Language (USDL)* as the most advanced and appropriate service description standard for (business-centric) service management (Fischbach, 2014): USDL, as a representative of advanced service description standards, provides the highest expressiveness among any description standard due to its extensible design and the inclusion of evaluation and construction aspects (Fischbach, 2014). Recently, USDL has been remodeled based on Semantic Web and Linked Data principles. This intensified the modular approach of USDL since machine-readable third-party data sources can be incorporated. Further on, the project was renamed into “Linked USDL” ("Linked USDL," n.d.). Linked USDL is organized into modules. Currently, five modules do exist (Cardoso & Pedrinaci, 2015):

- **USDL-Core**: The core module contains central aspects to a service description. It consists of the “original” elements of USDL, like the involved business entities, technical and operational aspects.
- **USDL-Price**: The pricing structure and modalities are covered in the pricing module.
- **USDL-Agreement**: This module captures the service level. It contains qualitative aspects of service provision such as reliability, response time and availability.
- **USDL-SEC**: The SEC module describes security properties of a service.
- **USDL-IPR**: Usage rights and copyrights are subject to the IPR module.

USDL covers business, technical and operational aspects (Cardoso, Winkler, & Voigt, 2009). However, the customer-perspective is missing. It could be added as an extension to the standard. Fischbach (Fischbach, 2014) names the capability to capture “soft-facts” as a *deficit* of existing service description standards – a requirement that has become even more important in a customer-centric context such as CSM. Thus, existing service description standards do not consider customer-centric information yet and must be extended in this regard. There is a need for a sophisticated service model in order to perform CSM. In return, this model could be used to enhance existing description languages, such as USDL.

### 3.3.3 Customer-centric Service Evaluation

#### 3.3.3.1 Consumers Decision Making Strategies

A customer model specifies the attributes that must be reflected by the service model in order to match the problem- and the solution space. Thus, both models are their logical complements. Furthermore, as elaborated above, service models (in the context of this work) are an extension of existing service description approaches. Hence, since the concept of services is defined and their relevant attributes are clear, the most difficult aspect

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29 Linked Data is about using the Web to connect related data that wasn't previously linked, or using the Web to lower the barriers to linking data currently linked using other methods. [...]Linked Data is a term used to describe a recommended best practice for exposing, sharing, and connecting pieces of data, information, and knowledge on the Semantic Web using URIs and RDF (“Linked Data,” n.d.).
of service modeling is still left to be solved: how must the description parameters for each service be evaluated to quantify customer’s perception?

The evaluation of alternatives based on product attributes is much easier for goods than it is for services (see Figure 3-22). Physical objects are usually described by objective metrics. Most service description standards try to imitate that approach. However, as pointed out before, consumers do not base their decision on that attributes. They have a subjective view and apply biased decision strategies that influence their corresponding evaluation. Formalizing and quantifying this subjective process is the goal of this section.

![Figure 3-22: Services-goods continuum for consumer products – effects of product attributes on ease of evaluation (T. F. Schröder, 2007, p. 73)](image)

To understand the process of service evaluation from a consumers’ perspective, strategies for consumer decision making must be understood first. This requires an excursion into the field of neuroscience and psychology. The branches of Decision Science and Decision Theory cover relevant aspects. The most important models and theories in this field are briefly explained below (cf. Busemeyer & Bruza, 2014, p. 254ff.):

**Expected Utility (EU) Theory:** This theory postulates, that under the condition of uncertainty, rational decision makers prefer the alternative with the highest expected outcome. This theory is based on the four axioms of rationality, which are also known as the von Neumann–Morgenstern axioms. They define what makes a rational decision:

1. **Axiom of completeness:** For any given situation, an individual has a well-defined preference and always can decide between any two alternatives (i.e. he prefers A over B, B over A or he is indifferent between both alternatives).
2. **Axiom of transitivity:** According to the completeness axiom, individuals build their preferences consistently (i.e. if he prefers A over B and B over C, he must consequently prefer A over C).
3. **Axiom of independence:** Alternatives that are combined with an overall equal third factor are still evaluated with the same preferences as if they were standalone (i.e. if A+C is preferred over B+C, then subsequently A is preferred over B).
4. **Axiom of continuity:** In the case of a transitive situation, there is a chance that the probability of the most likely alternative is reciprocal to the likelihood of the
least likely alternative. The sum of both probabilities on the extremes is likely the same as the probability of the median alternative. In other words, the alternative in the middle is as good as a combination of the outer alternatives.

Later, the Expected Utility Theory has been advanced to the Subjective Expected Utility (SEU) theory. It introduces the condition of risk as an additional factor. In addition to the individuals’ utility function, a personal probability distribution is introduced. Both theories are rational models, that state how people should optimally decide. This requires an adequate evaluation of alternatives beforehand. How customers evaluate alternatives and make decisions afterward (independently of rationality) is subject to psychological- or descriptive models which are of particular interest for this section (cf. Busemeyer & Bruza, 2014, p. 254):

**Decision Field Theory**: Decision Field Theory (DFT) is a cognitive model that explains the phenomena of how people make decisions. Thus, it differs from rational or normative theories that prescribe what people should do to achieve optimal outcomes. DFT considers external factors that influence decision making, namely context, uncertainty and time constraints. DFT is also a dynamic model - it captures the iterative process how preferences evolve over time. This process can be modeled using mathematical/stochastic models and is called diffusion process. The diffusion process says that preferences shift over time (esp. for situations under pressure) and usually favors the alternative that is in focus at a given moment. The decision that is made is the alternative with the highest threshold value at that time. The longer the decision process takes, the higher the threshold (=certainty) becomes. Unlike other decision-making theories, DFT can explain context effects: the similarity effect is the first of them. If people have to choose between A and B and a third alternative C is added, that is very similar to A, A and C will be handled as a group. The probability of choice A lowers, in favor of choice C (this contradicts the rationality axiom of independence). A second context effect of DFT is the compromise effect. If a third alternative C is introduced, that is a compromise among the available choices A and B, the likelihood that C is chosen is significantly higher due to a combination of advantages (or minimizing of disadvantages) for the choice “in the middle”. A third effect is the attraction effect. If a choice D is added, that is similar to choice A but has some notable defectives (e.g. a very high price), the disadvantages of D makes alternative A “shine even brighter” and raises the likelihood of choice A.

Finally, DFT is a vital subject to research and currently evolves further, e.g., by using formalisms of quantum computing to improve decision scenarios simulation (Busemeyer & Bruza, 2014).

**Prospect Theory**: Prospect Theory is a descriptive theory in the field of behavioral economics. It is based on the assumption that people make decisions based on potential gains and losses, not on absolute final outcomes. The evaluation of these delus incorporates decision heuristics by the people. Prospect Theory explains decision processes in two stages:

1. During an initial editing phase, decisions are ordered by similarity and evaluated by gains/losses. Similar alternatives are grouped together and reference points are set. Every alternative that lies below a reference point is considered a loss, everyone above as a gain. This phase introduces the so-called “framing effect”.
2. In the subsequent evaluation phase, the value (utility) of every choice is heuristically determined as a product of the expected outcome and its respective
probability. For decision making, not the absolute value is relevant, but the relative differences among the alternatives.

The evaluation process that has been introduced in Prospect Theory finds further substantiation in Hotelling's Law (Hotelling, 1925). This law describes the economic rationale, that, based on the framing effect, in competitive environments businesses should develop products, that are as equal to their competition as possible. Thereby, they occupy the center of the frame as well as the maximum of one extreme. It is also referred to as the “principle of minimal differentiation”.

An examination of the theories above helps to understand the key principles of service quantification from a consumers’ perspective. Three key characteristics for customer-centric service model evaluation can be derived:

- **Relative evaluation**: Each customer-centric service attribute can only be evaluated in contrast to others. For instance, one product can only be considered as “cheap”, if at least another one is priced higher. This is the framing effect that relies on a minimum and a maximum as points of reference for every decision. Accordingly, distances between the alternatives are more important for the evaluation than absolute values are.

- **Dynamic evaluation**: Adding a new alternative requires the reevaluation of every present element at that time. The new element could replace an extreme of the existing frame, respectively it could affect the distances between the elements. Dynamics also occur due to the possibility that new frames can arise. For example, the relevance of an attribute such as “personal interaction” becomes apparent to the customer, only if other alternatives offer differentiation in the same dimension. An example would be the advent of “online interaction”.

- **Fuzzy evaluation**: Decision factors such as likelihood or expected outcome indicate a vagueness, that cannot entirely be eliminated during the quantification process. Thus, concepts from fuzzy logic must be applied to represent subjectivity and semantic indefiniteness.

### 3.3.3.2 Customer-centric Quantification Approach

This sub-section applies the key principles of customer-centric service evaluation and proposes a quantification approach that can be used to determine numerical attribute values.

Basically, there are two alternative evaluation approaches. The evaluation process might be executed either customer-based or service-based (see Figure 3-23).

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30 Binary values represent frames too. The same applies to nominal scales.
Figure 3-23: Evaluation approaches for service model quantification

**Service-based evaluation**: The service-based evaluation maps already quantified service attributes (as defined in the service description language) to the corresponding customer-centric attributes of the service model. Thus, the customer-centric attribute is a composite value from one or many service attributes. Its composition follows logical relationships between objective service attributes (parameters) and subjective customer-attributes (needs). E.g., “simplicity” may be a composition of the number of service features, the extent of service description data, and the form of customer interaction. This approach relies on assumptions and models to approximate the notion of the customer. It is an abstraction of existing values.

**Customer-based evaluation**: The customer-driven evaluation takes the user perception as the baseline. Attributes from the customer model are the leading criteria which are added to the service description. It takes the perceived qualities as the input, instead of derivatives of the service parameters. The evaluation corresponds to the decision theories and thus promises a better quality for the purpose of CSM. Thus, this approach will be utilized further on.

The advantages and disadvantages of both approaches are summarized in Table 3-17.

<table>
<thead>
<tr>
<th>Model elements</th>
<th>Customer-based mapping</th>
<th>Service-based mapping</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>• Basic idea: Fuzzy customer needs are structured and objectivized</td>
<td>• Basic idea: Existing objective properties are translated into subjective need-dimensions</td>
</tr>
<tr>
<td></td>
<td>• Analysis and decomposition of purchasing and decision-making processes</td>
<td>• Objective service attributes are translated into the customer's language</td>
</tr>
<tr>
<td><strong>Advantages</strong></td>
<td>• Corresponds to customer's language and view</td>
<td>• Service description standards already exist</td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td>• Complex methodology</td>
<td>• The selection and decision-making process of the customer (for example, the context in which a purchase takes place) is not considered</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Differentiation factors are not identified</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mapping rules are a further source of errors</td>
</tr>
</tbody>
</table>

Table 3-17: Comparison of service evaluation approaches
Model for Customer-centric Service Evaluation

The above developed body of knowledge on how customers make decisions and on which sources the evaluation process can be based is now formalized. Figure 3-24 shows a schematic of the proposed quantification model and its constitutional elements. Each of the elements is explained below.

Figure 3-24: Model for customer-centric service evaluation

**Items:** The items (=services) that belong to a specific evaluation model are determined by their common purpose, i.e. they serve the same customer intention. Although in practice this list may be dynamic, as new services constantly emerge and others dissolve, the model can be considered as static for the moment of evaluation. The granularity level of a service has no relevance, since they share the same scope, thus can be handled equally.

Practical application of the model during validation phase of this work showed a special element-type, that helps to improve the model further—a hypothetical element. Given the example of the value dimension “pricing”, every element can be easily ordered in a sequence, and distances can be objectively quantified. However, the highest expectation a customer might have is a “free” service. Even if no available service is actually free to the customer, it might be beneficial for later matching purposes to set a hypothetical reference point that represents a free offer. Thus, one extreme of the pricing need is free. Hypothetical elements like this have shown to increase profiling quality and make the evaluation more static since reevaluation for new elements can be reduced.

**Frame:** The logical sequence of elements and their corresponding distances among each other define the frame. Each element must be placed inside the frame, respectively it stretches the borders of the frame and serves as a new extreme. The scale of the frame is of little importance, as long as it is consistent. For this work, a scale from 0 – 10 (uneven number) has worked out well. Finer granularity might become beneficial for a higher number of elements, but causes challenges for manual evaluation. Placing the elements on the right spot on the frame is the most challenging part. The valuation of elements can follow different approaches:

- **Valuation by sequence:** This approach tries to bring every element in the correct order and distributes them evenly over the frame. This is done by iteratively comparing two services, as long as the correct location is determined (E.g. “Is service A more secure than service B?”). The valuation logic resembles the evaluation technique of choice-based elicitation (see Section 3.2.4.4).

- **Valuation by distance:** This valuation approach combines the valuation by sequence with a determination of distance between neighboring services. This
approach has the highest expressive quality for service valuation. However, determining the distance is highly subjective and requires sophisticated meta-scoring models for each attribute.

- **Semi-discrete valuation:** This approach subdivides the frame into named ranges (e.g. “cheap”, “moderate”, “pricy”). This simplifies valuation since services are basically grouped together and are handled the same way. It simplifies the frame by converting it into a nominal scale.

For practical adoption, the most critical aspect may be who evaluates the services based on which data source? There is no easy answer to this question. Essentially, how services are perceived can be evaluated, based on knowledge, based on data or based on subjective beliefs. This translates to three sources which are able to carry out the evaluation (cf. Ricci et al., 2011):

- **Experts:** Domain experts, who have an in-depth knowledge of the elements of the solution space, might evaluate the relative placement of the items on the frame. In conjunction with a reasoned analysis approach, this might deliver high quality of evaluation. Disadvantages of this approach are the bias to subjective evaluations and the high (mental) effort. Another issue is that experts might have difficulties in applying the customer perception or they might over-complicate the evaluation of attributes, e.g. due to rare special cases.

- **Crowd:** The “knowledge of many” has advantages over single experts’ opinions. The risk of subjectivity is minimized. Additionally, the evaluation of many describes the “average consumer” best. Contrary aspects are, that there is no proof for a better quality of evaluation by the crowd than by experts. Also, it takes high efforts to build a community that evaluates services regularly, e.g., due to lacking knowledge and low interest of the members.

- **Models:** Algorithms are a third source for service evaluation. Based on predefined models, they might use third-party data to calculate service attributes. Algorithm-based evaluation has advantages in its constant quality, its up-to-dateness and the quantity of information that can be processed. However, the quality of the underlying model is critical. The process of designing such a model is basically an externalization of expert knowledge and thus shares its same characteristics. Algorithmic evaluation needs a benchmark, to ensure correctness of the evaluation. Thus, it may be a more mature level of expert-driven valuation.

The **numerical position** of an element in the frame (for a given intention and need) represents the quantification of a customer-centric attribute within the service model. For example, on a scale from 0 – 10, a service might have a value of 10 for the need-dimension “simplicity” because an adviser takes care of everything during service provision and there is no other service on the market that is more convenient. This value in conjunction with the according need-dimension is the only information that is persistently stored in the service model for each dimension per service.
3.3.4 Exemplary Service Model for Financial Services

Goal and Scope of the Project
An initial objective of the research project, which forms the background of this work, was a classification of innovative services within the financial services industry. Therefore, over the period of three years a market monitoring has been conducted that resulted in an extensive list of FinTech services - the Banking Innovation Database (see Section 1.3.2.1). No other classification with a similar focus has existed at that time.

Besides being an important source of inspiration for that work, that database was the basis of the solution space for all prototypes and empiric analyses in the context of this research. The process of converting the datasets from the content management system into 1) a service domain representation and 2) evaluated service models that meet the requirements of CSM, is described in this section. Many learnings that have been made during the creation process have already been taken into account in the theoretical explanations above.

Service Domain Representation
The scope of the service domain is defined as follows: digital banking services that are located at the interface between customers and providers (B2C and C2C). The services have been derived in a bottom-up approach (cf. Fasnacht, 2009, p. 46ff.): news, media, and other information about innovative financial services have been the basis for generalized service classes. Refined by many research activities, such as expert interviews, workshops, innovation circles, a total of 86 services have been identified subsequently.

For the representation of the service domain, an ontology was chosen. As for the customer model, Protégé was facilitated as an appropriate tool. It offers the functionalities to render the service domain in different visual styles (tree-structure, service map; see Figure 3-25) and as a service list (see Figure 3-26).

![OntoGraf visualization of the financial services domain (excerpt: sub-tree of investment services unfolded as an example)](image)

*Figure 3-25: OntoGraf visualization of the financial services domain (excerpt: sub-tree of investment services unfolded as an example)*
Although a bottom-up approach usually starts without a predefined structure, the use of established domain classifications turned out to be very helpful. In this case, the top-level classification of banking services into financing-, investing-, payment- and cross-process services was applied (cf. Alt, Bernet, & Zerndt, 2009, p. 55ff.). With an increasing number of elements, the importance of clustering became evident, since service groups can be used as heuristics to reduce complexity. Modeling relationships among services were also part of the service map creation process. For instance, the customer needs that relate to a service where modeled as separate entities which were connected via a relationship “serves_the_need”.

With increasing size of the model, graphical representation became less effective. Alternative ways of navigation and analyses were used then, for example, SPARQL-queries. Thus, a meaningful graphical representation of the entire service domain (e.g. via screenshot) is not beneficial at this point. Therefore, an interactive browsing within the ontology is recommended to the reader (see Appendix 11-Finance Ontology).

**Service Model**

The domain representation focuses on the entirety of services and their relationship among each other. The service model, in contrast, focuses on the properties of the individual elements.

During the research project, a non-technical and non-formalized description was already available for all financial services (e.g., functional description, workflow description) due to the Banking Innovation Database. The formalized service model for CSM however, was created during the process of domain representation.

In an ontology-based representation, the description dimensions of the service model can be easily annotated as custom attributes of any ontology class. Figure 3-27 shows an example of the customer-centric service attributes for a service in Protégé. This makes up the service model in this example. Again, an interactive examination of the service models via an ontology-creation tool is recommended (see Appendix 11-Finance Ontology).
The valuation of all customer-centric service attributes within the service model has been done in a three-step process:

1. **Identify services that form a frame**: The initial step is the identification of all services that are alternatives to each other (from a customer’s point of view). In this project, a simplified approach was chosen. All services which belong to the same business domain are compared among each other. For example, all payment services build a frame - financing services build another one. A more precise way would be to compare services that provide the same functionality, i.e. refer to the same customer need. But this means a significantly higher evaluation effort with an unclear additional benefit.

2. **Define service model attributes**: Based on the customer model (see Section 3.2), the customer-centric service description attributes are transferred into the format of the ontology. Normalization of attributes, data types, and value ranges are important aspects of that task.

3. **Frame and evaluate the services**: The second step creates the frame that represents customer’s perception. It was started with the services, which represent maximum characteristics. These represent the endpoints of the frame. All other services were arranged relatively to each other within the resulting continuum. The assessment process was based on the assessment of two experts who had worked in the double-blind method. The tool for this assessment was a simple spreadsheet that represents a matrix which connects dimensions of the customer model (Figure 3-28).
<table>
<thead>
<tr>
<th>Dimension</th>
<th>Occurrence</th>
<th>Definition</th>
<th>Valuation (Donation-based)</th>
<th>Valuation (Reward-based)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Valuation 1</td>
<td>Valuation 2</td>
</tr>
<tr>
<td>Value_Fees</td>
<td></td>
<td>Requirements of the customer on the costs and conditions of the solution.</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Value_Speed</td>
<td></td>
<td>Requirements of the customer on the speed of the solution.</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Execution_Speed</td>
<td></td>
<td>Requirements of the customer on the speed of execution.</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Interaction_Speed</td>
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<td>Requirements of the customer on the speed of interaction.</td>
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<td>8</td>
</tr>
<tr>
<td>Setup_Speed</td>
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<td>Requirements of the customer on the speed of setup.</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Personal_Interaction</td>
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<td>Requirements of the customer on personal interaction.</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
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<td>Interaction via a computer.</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Mobile_Interaction</td>
<td></td>
<td>Interaction via mobile devices.</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Hybrid_Interaction</td>
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<td>Requirements of the customer on the hybrid interaction.</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Value_Simplicity</td>
<td></td>
<td>Requirements of the customer on the simplicity of the solution.</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>

*Figure 3-28: Valuation spreadsheet for double-blind assessment*
3.4 Service Composition Logic

3.4.1 Matching Markets

The core function of markets is to bring together participants from the buyer and seller side. Markets match demand with the offer, requests with supply, needs with reliefs. Until recently, the notion of marketplaces was limited solely to commodities by many economists. In so-called “commodity markets”, matches between demand and supply are determined by price alone. In contrast, many aspects of daily life are represented by more complex markets with more sophisticated matchmaking mechanisms: the application of students for university, dating communities, and the selection of services among available alternatives. These markets are referred to as “matching markets” (A. E. Roth, 2015, p. 5f.). Many of the world’s biggest companies are matchmakers: Facebook, Google, Alibaba, Tencent and so on. The same applies for some of the most exciting Start-Ups these days, like Airbnb, Spotify and Uber. They all connect members of one group that looks for something that another group offers (Evans & Schmalensee, 2016a, p. 1).

The concept of matching markets and its underlying principles of market design has been introduced by Alvin E. Roth who was awarded the Nobel Prize for his work (A. E. Roth, 2015). Unlike commodity markets, matching markets suffer from an abundance of opportunities. Since price is no longer the only relevant criteria, it is illusory to evaluate every given alternative for a vast number of offers. Thus, matchmaking becomes a new challenge in today’s markets.

Matching is “choosing things in life, that also must choose us” (A. E. Roth, 2015, p. 4) - thus, a bilateral fit must be ensured. To add further complexity, markets must follow rules and matching must take contextual information and technical restrictions into consideration. The underlying logic that runs a market is the phenomenon of efficient allocation of supply and demand. Adam Smith attributed this overwhelming logic behind markets as the “invisible hand” - nowadays the logic is demystified and captured by algorithms (A. E. Roth, 2015, p. 4ff.). For the field of service composition, the matching logic is subject to this section.

![Figure 3-29: Matching markets for services](image-url)
This section is settled in the field of matchmaking in service markets at the background of (a) service economies and (b) customer-induced composition. It focuses on the correct allocation between supplier- and buyer side (respectively service models and customer-models) for the individualization of services. Thus, the process of matching is of particular interest but embedded in the overall concept of service composition. The logic is examined from three perspectives: from a technical point of view that lays the foundation for composition algorithms and configuration systems (Section 3.4.2), from a business perspective that defines constraints for useful service bundles (Section 3.4.2) and from a customer perspective that introduces the particularities of customer decision making into the matchmaking process (Section 3.4.2.3).

3.4.2 Service Composition Approaches

3.4.2.1 Definition and Classification of Service Composition

The models introduced in the previous sections 3.2 and 3.3 contain descriptive information about consumers’ requirements (demand side) and the available elements in the solution space (supply side). Lastly, in this chapter, the composition logic specifies how these components can be matched to meet the given requirements. This chapter defines the process of service composition, explains its characteristics, names its functional tasks and finally shows how it can be implemented.

Service composition covers the identification, selection and combination of particular services into an overall solution (Tambouris et al., 2004). Thereby, service composition can be distinguished either into static composition, or into dynamic composition (see Figure 3-32). Both views can be sub-divided further on. Unfortunately, static and dynamic composition have ambiguous meanings in literature. The static composition either describes the service compilation before execution or use (“Design Time”), or it describes the service bundling from a functional point of view (Xiong et al., 2009). In contrast, the dynamic composition is either the compilation during execution (“Run-Time”), or the compilation of a workflow among different service elements (cf. Menadjelia, 2013; Wagner, Ishikawa, & Honiden, 2011). The dichotomy between process- and functional orientation is also agreed on by Gordijn et al. (2001) who additionally introduced the term “value-oriented” as a synonym to functional-orientation. According to their definition, a value-oriented view on service composition is focused on either goals or values.31

Both forms - static and dynamic composition- can also be referred to as service orchestration and service choreography. Orchestration hereby describes the compilation performed by a central authority (e.g. a single customer or supplier), whereas choreographed services do not follow any central order. Choreographed services structure themselves autonomously (Bucchiarone & Gnest, 2006).

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31 This differentiation is concordant to Section 3.2.4.3.
Covering every named aspect of service composition in detail would go beyond the scope of this work. Considering the applied understanding of CSM as described in Section 3.1.1, service composition further on regards only a specific subset of its entirety. Thus, service composition in the context of CSM means a static composition process done by a single instance (centralized organization) – respectively the process of a self-directed customer managing services himself.

The following example helps to clarify the distinction above. Service composition means the combination of several individual service components to one integrated service bundle (e.g. financial products for buying property) under functional aspects. However, it does not mean the combination of services in a certain sequence (e.g. a strategy to pay property debts off). The service composition is further on considered as done by a centralized instance (the customer). Hence, decentralized composition processes (choreography), like agent-based approaches, are not of interest. However, although a central instance does the composition, this does not necessarily mean that the components of the solution space must be provided by a single vendor (in most cases, they will incorporate many vendors).

This specific aspect of service composition still lacks research yet. Cardoso et al. (2012) say, “research [in the field of service composition] has been mainly done from a technical perspective by aggregating software-driven services”. Existing research in that field mainly refers to service architectures (e.g. SOA), service descriptions (e.g. USDL, WSDL) and process models (e.g. BPMN, BPEL) (Cardoso et al., 2012). Thus, the research focus is limited to technical interfaces for integrated information systems in homogenous environments so far.

### 3.4.2.2 Existing Service Composition Approaches

The concept of service composition aims at the creation of a service bundle that is tailored to the specific needs of a user or client. Offering service bundles is a promising strategy
for companies to deal with heterogeneous customer demand, to meet dynamic market conditions and to strengthen their competitive advantage. Although the effects of service bundles are well researched in marketing yet, the knowledge about the actual process of service bundling is much more limited (Kohlborn, 2010).

“Service bundle” is a term from the field of economics (business perspective). From a technical point of view, the corresponding concept is that of service networks. A Service Network (SN) is a collection of entities (people, providers, information) that provide a particular service (usually over the Internet) to achieve a common value proposition through their association (Cardoso et al., 2012; Ifm and IBM, 2007). In this context, also the term Service Value Network (SVN) is used. SVN are a dynamic and flexible web of enterprises and customers „who reciprocally establish relationships with other peers for delivering an added-value service to a final customer” (Razo-Zapata & Leenheer, 2012, p. 45ff.).

Table 3-18 provides a brief overview of existing service composition approaches from IS research that either refers to Service Networks or Service Value Networks. It is based on the overviews by Barros & Oberle (2012, p. 51ff.) and Razo-Zapata et al. (2011). Table 3-18 analyzes each service composition approach based on the following factors regarding their relevance for CSM:

• **Target audience:** Who is the intended user of that approach? Is the approach usable by less experienced users, respectively by consumers? (see Section 1.1.5)
• **Service scope:** Which type of services are covered by that approach? Is it suitable for e-services? (see Section 1.1.1)
• **Service ecosystem focus:** Can the approach be used in dynamic and interoperable environments such as (customer-centric) service ecosystems? (see Section 1.1.3)
• **Composition features:** Which composition phases are covered by the approach? Does the approach cover the required tasks of CSM? (see Section 3.1.2)

The investigation reveals some deficits of the existing service composition approaches in light of CSM:

• Most approaches have a B2C focus and the customer is an inherent part of the service composition process. However, only a few approaches support service composition conducted by end users with little domain knowledge (consumers). Existing approaches are usually toolkits for skilled users or experts.
• Existing methods of service composition (cf. Akkermans et al., 2004; Baida, 2006; Gordijn, 2008) usually require a specified customer demand to generate service bundles (cf. Kohlborn, 2010). With the exception of Serviguration and e3value that offer an iterative approach to sharpen customer’s requirements, no approach takes care of the practical constraint, that customer’s requirements are often undefined and vague.
• The methods are not functionally comprehensive and integrated as required for CSM (see Section 3.1.2). Most of the approaches are limited to functional aspects of service composition and leave out the non-functional aspects.
• The scope is mostly on technical services (usually Web services). Rather than on bundling and configuration, the focus is on the workflow between the services in those cases.
Many approaches cannot be clearly assessed with respect to their ecosystem focus. However, there are service composition approaches that explicitly state their inter-organizational focus.

These conclusions are not absolute and no final statements since an in-depth analysis of the approaches are not possible in most cases. Many of the analyzed approaches are described at an abstract and conceptual level. The approaches are often insufficiently specified within the research papers. They are specified by random examples and not in a formalized way. They have an unclear maturity level and some seem to be work in progress or have been abandoned meanwhile.

There is no approach that meets all requirements based on the underlying criteria. At the same time, however, there are already solutions in all areas. The integration of these approaches, in particular in the light of the specifics of CSM described above, will be described further on.

Some aspects of the analyzed approaches will be referred to again in the remaining part of Section 3.4. For example, the e3services approach by Razo-Zapata et al. (2012) and its predecessor Serviguration (Baida, 2006) provide with the propose-critique-modify (PCM) problem-solving method an advanced approach to generate alternative SVN for given customer needs. Their functional tasks are referred to subsequently. In contrast, these approaches are too unspecified in their original form to be applied for CSM without any further refinement.
<table>
<thead>
<tr>
<th>Service composition approach</th>
<th>Description</th>
<th>Target audience</th>
<th>Services scope</th>
<th>Service ecosystem focus</th>
<th>Composition features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Based Planner (MBP)</td>
<td>Deterministic planning of service execution that considers dynamic context factors to meet complex composition goals.</td>
<td>For expertized users (“Plan-ners”)</td>
<td>Focus on (technical) Web services</td>
<td>Not specified</td>
<td>Run-time focus (sequence of service execution)</td>
</tr>
<tr>
<td>OntoMat-Service</td>
<td>Generates plans for executing services based on customer choices</td>
<td>For (semi-)expertized users</td>
<td>Focus on (technical) Web services</td>
<td>Not specified</td>
<td>Run-time focus (configuration of service flows)</td>
</tr>
<tr>
<td>METEOR-S</td>
<td>A composition framework based on Semantic Process Templates (SPTs) to allow inter-organizational process execution. It uses semantic web techniques for service discovery.</td>
<td>For skilled users (“Template Designers”)</td>
<td>Focus on (technical) Web services and business services.</td>
<td>Dynamic inter-organizational scope.</td>
<td>Run-time focus (design of data flow). Focus on functional features and QoS-attributes.</td>
</tr>
<tr>
<td>Value-Based Composition (VBC)</td>
<td>A framework based on a value model, a value-meta model and an architecture of value-added service broker for dynamically composing services.</td>
<td>For service end-users.</td>
<td>E-services and commercial services</td>
<td>None</td>
<td>Design-time focus (Unfortunately, many essential aspects remain unclear in their work)</td>
</tr>
<tr>
<td>Serviguration</td>
<td>Approach for service bundling that incorporates distinct ontologies for demand and supply side and for the composition process. Additional dependencies describe interactions among service providers.</td>
<td>Considers customer’s needs, but is meant to be used by providers.</td>
<td>E-services and commercial services</td>
<td>Designed for multi-supplier environments. Inter- and intra-organizational focus.</td>
<td>Selection and combination of services</td>
</tr>
<tr>
<td>DynamiCoS</td>
<td>Framework that aims at supporting service composition on demand and at runtime for the benefit of service end-users</td>
<td>For service end-user. However, they need a clear idea which services they need.</td>
<td>Distributed Software Applications</td>
<td>Not specified</td>
<td>Covers service lifecycle: service discovery, selection and composition.</td>
</tr>
<tr>
<td>u-service</td>
<td>Service bundling approach based on customer context and on service complementarity to enhance service effectiveness</td>
<td>Customer involvement primarily via observation of QoS-attributes.</td>
<td>Not specified</td>
<td>Not specified</td>
<td>Design-time and run-time focus</td>
</tr>
<tr>
<td>e3services</td>
<td>A framework to achieve SVN composition by means of the propose-critique-modify (PCM) problem-solving method and a Fuzzy Inference System (FIS). e3services is the successor of Serviguration.</td>
<td>Considers customer’s needs, but is meant to be used by providers.</td>
<td>E-services and commercial services</td>
<td>SVN scope. The model distinctions between customer, broker and service supplier.</td>
<td>Selection relies on service bundling at design-time</td>
</tr>
</tbody>
</table>

Table 3-18: Service composition approaches and their deficits in the context of CSM
3.4.2.3 Phases of Service Composition

Service composition covers the identification, selection and combination of distinct services into an overall solution (Tambouris et al., 2004). The first phase of this process, service identification, refers to the discrete description of each individual service. This procedure has been subject to Section 3.3. The remaining phases, service selection and service bundling, are subject to the following sections.

![Figure 3-31: Phases of service composition according to Tambouris et al. (2004)](image)

In a software-supported service individualization setting like CSM, the underlying logic of composition is usually not within the line of visibility towards the customer. Thus, primarily a technical point of view is applied in the following part. However, some **key points** regarding customers’ decision making have been identified before, that must be considered for the implementation of service composition. As a repetition, these recognized aspects are:

- **Framing**: Consumers’ decisions are framed within a range of given alternatives that are a result of their relative evaluation strategy applied before.
- **Fuzziness**: Due to limited domain knowledge, inexperienced consumers state their requirements in natural language. This results in a vague and ambiguous specification of the solution.
- **Matching**: Important and complex purchase decisions require a multiplicative decision strategy. Thus, a multitude of factors are considered that can be conflicting. Instead of filtering out elements that meet all objective criteria, the goal is to find the alternatives that match the requirements best.
- **Bundling**: Because of the solution engineering process, the individualization takes place by bundling of atomic services.

Next, Section 3.4.3 covers the selection phase, and Section 3.4.4 the bundling phase of service composition in the context of CSM. The phases, as well as the activities within each phase, are outlined by the generic CSM-process previously defined in Section 3.1.2.

3.4.3 Service Selection Phase

3.4.3.1 Laddering Task

A key challenge in configuration settings, that incorporate less-expertized users, is the semantic gap. Consumers speak their “own language” that differs from business- and technological terminology. The task of translating between both sides is subject to the concept of laddering.
For the implementation of this translations task, respectively for semantic service composition, Poole, Smyth, & Sharma (2008) name three essential types of machine-understandable information that must be available: ontologies, data, and theories.

**Ontologies** are a formal specification of the meaning of data or symbols in information systems. They enable interoperability of (distinct) information sources on a semantic level (Poole et al., 2008). In semantic service composition, ontologies mainly represent the dimensions contained in the customer- and service model, as well as their respective relationships with each other.

**Data** is “information about a domain that is produced from sensing” (Poole et al., 2008). Thus, it is derived from real-world observations. This data may be customer statements and their respective (formalized) meanings, as shown in the Voice of the Customer approach (see Section 3.2.5.2). In semantic service composition, two kinds of data do exist: first, training data that is already observed. Second, new data that is predicted by theories. Data serves as the foundation for all theories and predictions (Poole et al., 2008).

**Theories** make predictions about new cases and are usually based on existing cases. Data and computations are required to make predictions. Predictions can have many forms, e.g., probabilistic predictions, range predictions, definitive predictions or qualitative predictions. The quality of a theory is determined by their usefulness, by their accuracy of prediction and by their plausibility or elegance. The source of theories is another relevant aspect. Often, popular theories or theories stated by authorities are used, even if their quality is not proven by evidence yet (Poole et al., 2008). In application scenarios for semantic service composition, theories may describe the quantification of customer- and service model attributes and the relationship between customer- and service model attributes. Therefore, the laddering must be formalized in theories that are grounded in data and documented in ontologies.

Many aspects of laddering have been elaborated before in Section 3.3.3, especially the quantification of customer- and service attributes. The link between the semantically diverse dimensions in the customer- and service model must already be made during profiling- and service evaluation phase – hence, linking these attributes is not the subject of ladders in a CSM-context.

### 3.4.3.2 Matching Task

If it is the case that today’s service economy increasingly resembles the characteristics of matching markets (cf. Section 3.4.1), matching will soon become one of the most central functions between businesses and customers.

**Definition of Matching**

Even in a thematically focused field like IS research, there is a wide range of understandings for the term “matching”. From a business model perspective, matching is regarded to matchmakers in multisided platforms (cf. Evans & Schmalensee, 2016a). From a technical standpoint, matching covers a broad range of aspects such as (semantic) service

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32 Theories are also referred to as hypotheses, laws, or models – depending on their maturity and acceptance (2006, p. 564).
discovery, service classification, service substitution and qualitative service recommendation. The technical understanding is applied to this section.

In the field of Web services, matching can be defined as “identifying, for a certain Web service, some other existing services that meet certain criteria intrinsic to the characteristics of that service” (Q. A. Liang & Lam, 2008). This definition relates to matching, as a means of service substitution. A better-suited definition of service matching in the context of CSM is provided by Platenius et al. (2013): “Service matching compares the specification of a service request to the specification of a provided service to determine their interoperability.” They continue to add, “Service requests can either stem from service discovery (i.e., the user requests a specific service) or from service composition (i.e., the service is requested by a human or composition algorithm in order to be incorporated into a composite service). However, in both use cases, service discovery and service composition, the requests are similar and thus, they can be reduced to the same matching problem”. This work relies on that definition of matching which describes matching as the process to find and ensure an optimal fit between customer- and provider side.

**Matching Schemes**

Matching relies on the capability of machines to understand and process service descriptions and requirements. Thus, matchmaking requires flexible and rich metadata and efficient matching algorithms (Yao, Su, & Yang, 2006). These logical and technical concepts behind matchmaking are referred to as matching schemes, which can be classified as follows:

**Logic-based reasoning:** Logic-based reasoning is a method for problem-solving based on logical axioms. It provides a precise formal language that enables a reasoning system to interpret situations in an unambiguous way (Flasiński, 2016, p. 67ff.). Three forms of logical reasoning can be differentiated (Menzies, 1996): deductive reasoning determines the correctness of a conclusion for the rule, founded solely on the correctness of the premises. Inductive reasoning derives a rule, based on a number of observations. Abductive reasoning tries to interfere a precondition based on existing rules and conclusions. In the context of service composition, logic-based reasoning is a less suited matching approach, because it only evaluates in right or wrong. It does not consider the gradients between (fuzziness).

**Semantic schemes:** Semantic schemes are based on a formal service description, for example, via ontology languages such as OWL-DL. They allow automatic interference of logic for machine-based reasoning. Recent approaches also incorporate unstructured service descriptions, e.g., consumer reviews to derive formal terminology. Also, hybrid approaches, that combine content-based information retrieval and logic-based reasoning, have emerged (Klusch, Fries, & Sycara, 2006). Semantic matching either applies matching rules or utilizes matching engines. Matching engines usually determine the similarity between service inputs and outputs (Q. A. Liang & Lam, 2008). The semantic scheme is often used for finding service substitutes, i.e., to replace failed services. It is the only approach, which also processes unstructured data, like the natural language of consumers (hybrid approach).

**Categorization-based schemes:** Unlike semantic approaches that rely on common ontologies to match services, categorization-based schemes use domain ontology extraction and categorization. It is a complementary approach to matching rules and matching en-
Q. A. Liang & Lam, 2008). This approach can be applied in heterogeneous domains but is primarily used for finding equivalent (Web) services, not for matching customer requirements. Thus, it has limited potential in the field of CSM.

**Qualitative schemes:** The approaches above see service matching as the process to find services which are similar regarding their functional properties. Non-functional properties, respectively qualitative attributes have hardly been considered yet. In qualitative matching schemes, the concept of Quality of Service (QoS) is regularly applied. However, QoS measures only performance attributes that are usually focused on technical notions of quality, such as latency or jitter. Thus, QoS usually refers to technical services such as streaming, communication, and infrastructure services (Abdelmaboud, Jawawi, Ghani, Elsafi, & Kitchenham, 2015).

**Fuzzy matching/approximate matching:** Logic-based reasoning and semantic schemes evaluate services only to the binary states “match” and “no match”. They fall short in determining the most appropriate service. The ranking of services in order of their suitability or the determination how much a service fulfills the requirements is subject to fuzzy matching. By determining approximate matches, derivations from the state of an exact match can be quantified. The need for fuzziness results from three sources: incomplete knowledge, variational scope, heuristics and simplifications (Platenius, 2013).

The classification above is based on a literature review. In practice, increasingly hybrid approaches can be found that combine the benefits of multiple matching schemes. The same applies to this work: it combines aspects of semantic matching with qualitative schemes and fuzzy approaches.

**Generic Matching Algorithm**

In the context of CSM, service matching is done by application systems. Thus, the matching task must be further formalized, down to the level that describes what this software does (algorithm level). Yao et al. (2006) provide a generic matching algorithm which they utilize for semantic service matching. In their proposed four-step algorithm, matches are not only classified per categories, but they are also ranked regarding their similarity between need and offer. This approach applies to dynamic and open environments and works efficiently. In this regard, Yao et al. (as well as other sources) refer to the customer- and provider side as “request”, respectively “advertisement”.

The concept of matching filters must be introduced first to understand the logical matching process. During each step of the matching process, it is highly unlikely that always a perfect match is found. Thus, “flexible matches” must be supported, i.e., matches that recognize the degree of similarity. Matching filters describe that degree of similarity for a given pair of the service request and service advertisement based on logical and syntactic similarity (Klusch et al., 2006). These matching filters come from set theory. Service attributes, such as functionalities, are considered as elements of a set. Five degrees of similarity are defined by Yao et al. (2006):
### Logical Matching Filters

<table>
<thead>
<tr>
<th>Rank</th>
<th>Formal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Exact match</td>
<td>$A \equiv R$</td>
<td>Advertisement $A$ is equivalent to the request $R$.</td>
</tr>
<tr>
<td>II. Plug-in match</td>
<td>$R \subseteq A$</td>
<td>$R$ is a sub-concept of $A$. This means, advertisement $A$ requires less input than specified in request $R$. $A$ provides every functionality that is demanded by $R$ and even beyond.</td>
</tr>
<tr>
<td>III. Subsume match</td>
<td>$A \subseteq R$</td>
<td>$R$ is a super-concept of $A$. Every aspect of the advertisement $A$ is contained in request $R$.</td>
</tr>
<tr>
<td>IV. Intersection match</td>
<td>$(A \cap R \subseteq \bot)$</td>
<td>Request $R$ and advertisement $A$ share some common elements.</td>
</tr>
<tr>
<td>V. Fail</td>
<td>$(A \cap R \subseteq \bot)$</td>
<td>Request $R$ and advertisement $A$ share no common elements.</td>
</tr>
</tbody>
</table>

Table 3-19: Logical matching filters (cf. Yao et al., 2006)

These five types of matching results are listed in order of decreasing similarity. This means, they are ordered by how relaxed the matching works, respectively according to the size of results that are returned (Klusch et al., 2006). It is a qualitative matching approach. Based on these matching filters, the single steps of the matching algorithm by Yao et al. (2006) can be explained:

1. **Profile matching**: According to the terminology of Yao et al. (2006), structured service descriptions and user requirements are referred to as “profiles”. The stage of profile matching determines if a request profile can be classified as an instance or a direct subclass of an advertisement profile. Thus, matching is done by determining how good a requested service fits into the service category of an advertised service. If the result is evaluated to “Fail”, the service belongs to a different (logical) domain. Thus, there is no need for following matching activities. In this case, there is no match at all.

2. **Input parameter matching**: As a second step, the fit between the preconditions and input parameters of the advertised service in light of the requested service are determined. As an example, an advertised payment service has the input parameters name of the account holder and account number ($AdvInput = \exists hasInput.accountName\cap \exists hasInput.accountNumber$). The requested service has the input parameters, name of account holder, account number and payment message ($ReqInput = \exists hasInput.accountName\cap \exists hasInput.accountNumber\cap \exists hasInput.message$). The result of input parameter matching would evaluate into a plug-in match, since $AdvInput$ subsumes $ReqInput$.

3. **Output parameter matching**: How good the requested outcomes respectively functional demands are, satisfied by the advertised service, is determined in the third phase. It is the counterpart to input matching. E.g., a payment service requests the outcome payment complete and payment notification ($ReqOutput = \exists hasOutput.paymentComplete\cap \exists hasOutput.paymentNotification$). While the advertised service offers the outputs new account balance, payment complete and payment notification ($AdvOutput = \exists hasOutput.accountBalance\cap \exists hasOutput.paymentComplete\cap \exists hasOutput.paymentNotification$). This leads to a subsume match.

Between input and output matching is a difference, which Yao et al. (2006) refer to as “satisfy-direction difference”. For input matching, it is preferable if the request is subsumed by the advertisement (plug-in match). Thus, the provider gets all the input he...
needs (besides not necessary input options). For output matching, the opposite is true: if advertisement output subsumes request output, every output that is needed (and even more) is provided. A one-step matching algorithm could not reflect this difference (Yao et al., 2006).

4. Non-functional attribute matching: The phases above focus on functional aspects of service matching. Qualitative properties of services are considered in the last step. Unfortunately, Yao et al. (2006) fall short on this point and suggest a matching, based on the same generic matching filters named before. The author of this work disagrees at this point. As noted in earlier sections, qualitative properties cannot be handled like elements in set theory. A non-functional attribute like security is an inherent characteristic of every service - but to a very different degree for each individual service. Thus, non-functional attribute matching must not be based on qualitative scales (like matching filters) but must be numerically quantified (e.g., via a matching score).

There is a consensus in academia that matching- and selection algorithms could be implemented in numerous ways. One of the highest degrees of freedom hereby lies in the selection of similarity metrics (cf. G. Adomavicius & Tuzhilin, 2005; Herlocker, Konstan, Terveen, & Riedl, 2004).

Current State of Matching in Practical Applications

Regarding the implementation of matching processes for the purpose of CSM, a purely theoretical perspective seems insufficient. There are a lot of recent insights from practice, that have not diffused into the scientific body of knowledge yet. Thus, a practical excurse is added to this section.

No other industry is said to be as advanced in finding the best matches (for subjective needs) as the online dating industry. What people explicitly say they want from a partner and what they are implicitly looking for, is analyzed and computed by dating platforms on a large scale (Kelly, 2013). Match.com is the largest dating site in the world with more than 19 years of experience (Match.com, 2016). Continuous refinement of the algorithm is a core activity of their business. Their user profiles are not only based on 15 to 100 explicit questions that must be answered by the user in the form of an essay, but also meta-data is taken into account for matching purposes. Match.com sees implicit parameters, such as the used vocabularies or the geographical distance between the users, as key factors for a high matching compatibility. Also, the divergence between what users say they are searching for and what they are actually interested in is taken into account for continuous optimization of the result.

In contrast to other dating sites, the purpose of the algorithm from HowAboutWe.com is to get people into real offline dates as fast as possible. “Our deepest insight is that it is difficult to predict chemistry online […] that’s why our ultimate focus is on actual dates […] that’s where the chemistry happens”, says Aaron Schildkrout, co-founder, and co-CEO of HowAboutWe (Kelly, 2013). For this reason, elicitation and matching rely primarily on activity-preferences. Despite this less extensive user profile, the development of the algorithm was an iterative process for the company. “We actually launched HowAboutWe with a robust algorithm, which we subsequently got rid of […] It’s only after
you achieve significant liquidity in a market that you can build a useful algorithm", summarizes Schildkrout the challenges of applying matching algorithms (Kelly, 2013). Data collection based on user interaction is another central aspect of their algorithm. Instead of weighting preferences by average persons, individual values are inferred.

CoffeeMeetsBagel.com minimizes the entry threshold (cold-start problem) by relying on already available user data. Therefore, no dating-specific data is gathered. Instead, generic data from social networks are used for their dating algorithm. Despite not being perfectly aligned with the domain, the company makes good use of social data for their purposes. Having a common friend increases the probability of two users connecting by 37%. Suggestions by friends are 30% more likely to connect. „Ultimately, we believe, like Facebook does, that our members do a better job than algorithms at regulating human interactions“, said Arum Kang, CEO of Coffee Meets Bagel (Kelly, 2013). Leveraging the crowd as a vital part of the algorithm, thereby the elicitation frontend is kept simple. Matching is improved only based on binary feedback given on the site („like“ and „pass“).

A very recent example of a matching process, that relies on binary user feedback too, is Tinder.com. This dating app has its focus on user experience: it is easy to use, offers instant gratification and provides the ability to sift through hundreds of matches easily. However, the simplicity of the matching process makes for Tinder’s perception as superficial. Potentially important life-decisions are delegated to an algorithm optimized for simplicity by the user. The popularity and success of Tinder has sparked a debate that goes far beyond technical aspects of matching algorithms: social, cultural and ethical questions have arisen in the context of Tinder regarding algorithm-based matchmaking (David & Cambre, 2016; Kao, 2016; Ortega & Hergovich, 2017).

These examples deliver some practical insights regarding matching processes and – algorithms, that are relevant for every implementation with the purpose of CSM too:

• The cases above use matching to find the most appropriate “element” from the solution space. They do not on configure solution bundles based on matching. The same purpose of matching applies to other industries: configuration via matching, as proposed in this work, is a relatively new use case for practice.

• The matching algorithm is subject to continuous development. There is no such thing as “the best” algorithm. More important than the algorithm is the methodology to implement and maintain the algorithm for its continuous optimization.

• Data is critical to matching. Since simplicity and user experience are important propositions in today’s economy, only a few data can be explicitly elicited. Though, hybrid data sources, such as social media profiles, geographic coordinates or meta-data, are used. This results in deficits regarding the transparency on how the matching result is calculated. However, this aspect may be of lower importance for the dating industry than for other industries.

• There is an ongoing debate about the implications of delegated decision making in society. The increasing relevance of matching algorithms affect the lives of individuals (e.g., in online dating), the success of businesses (e.g., via product recommendations) and states of societies (e.g., via information filtering with reference to elections). People and businesses that facilitate matching algorithms in their products should be aware of the effects and implications their work could have.
3.4.4 Service Bundling Phase

3.4.4.1 Bundling Task

Business Perspective on Service Bundling

It is a fundamental feature of services that they become more valuable once they are combined with other services. This is primarily due to the fact, that service individualization is done by combining formerly distinct services. Loose services are bundled to provide an overall better customer value (see Section 2.3). Driven by digitalization and transformation towards a service economy, “the abundance of information about people, technological artifacts and organizations have never been greater, nor the opportunity to configure them meaningfully into service relationships that create new value” (Chesbrough & Spohrer, 2006).

Businesses practice service bundling for different reasons. As already mentioned, one reason is, for better individualization towards the customer. Another reason is, for higher margins. Selling bundles typically benefit the vendors. Customers usually pay a premium if they are hardly able to compare prices or cannot track their actual usage. Especially “mixed” bundling strategies positively influence customers’ purchase decisions and drive sales up by twenty percent (Derdenger & Kumar, 2012). Seemingly in contradiction to this fact is the assumption that unbundling may be a superior strategy nowadays. A report by Deloitte (cf. Wu & Kwapien, 2014) argues, that unbundling bank services could increase revenues. Offering unbundled services could improve revenues – a strategy called “segment pricing”. However, they put this assumption in the context of self-reliant customers that are able and willing to create service bundles themselves. Thus, they provide additional justification of the economic relevance of this work.

Generic Product Model

Product is „anything that can be offered to a market to satisfy a want or need“ (Kotler & Keller, 2011, p. 325f.). E-services, as defined in Section 2.1.1, are examples of such products. They are services that are directly offered to consumers in a way that is meant to provide utility. This includes the fact, that they contain every element necessary to provide a well-defined functionality. Examining these generic elements to find out what makes a service-bundle valuable, is the purpose of this section.

In this context, Riel et al. (2001) have identified five generic components of e-services:

<table>
<thead>
<tr>
<th>Element</th>
<th>Characteristics</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core service</td>
<td>• Core properties, that largely determine the functionality of the product.</td>
<td>(Riel et al., 2001)</td>
</tr>
<tr>
<td></td>
<td>• Essential element of any e-service</td>
<td></td>
</tr>
<tr>
<td>Supplementary service</td>
<td>• Add functionality that is not part of the core service (Feature)</td>
<td>(J. C. Anderson &amp; Narus, 1995), (Riel et al., 2001)</td>
</tr>
<tr>
<td></td>
<td>• Closely connected with core service</td>
<td></td>
</tr>
</tbody>
</table>

33 Similar classifications can be found in the field of marketing and product design. E.g., Homburg & Krohmer (2006) classify five product components: Core product, additional features, design and interface, basic services, and value add services.
Table 3-20: Core elements of the generic product model

Figure 3-32 shows the relationships and constraints of those elements in the context of the service granularity model. UML-notation is used to bridge the gap to the following technical examination. Lastly, the further work assumes, that the product model can be used as a generic model for solutions too. From a marketers’ perspective, what defines a generic solution for a specific need (=product), has structurally the same building blocks, that an individualized solution for a particular customer has.

Figure 3-32: Generic product/solution model

The benefit of a generic solution model lies in its universal applicability and the reduction of complexity:
Universal applicability: The model can be adapted to every service industry, respectively it even crosses their traditional borders and may be applied to broad service ecosystems. Additionally, it even helps to understand the relationships of service providers in networked economies from a customers’ perspective.

Complexity reduction: The variety of elements and their interrelationships shows the high combinatorial complexity that may result from individualized offerings. By classifying services into categories, heuristics can be applied which minimize complexity during evaluation substantially. In fact, it might be an enabler for the composition of individualized service solutions in many cases. This fact can be substantiated by theories from the field of problem-solving:

Determining Complexity in the Field of Problem Solving

The generic product model of Figure 3-32 is a graph-based representation of the (desired) solution space. Unfortunately, most problem-solving algorithms require a tree-based representation. By designating one node of this graph as a root node, it can be expanded into the necessary tree structure. However, this tree expansion is usually much larger than the original graph if not even infinite (Korf, Reid, & Edelkamp, 2001). A tree-based representation requires enumeration of all problem states. It has the highest complexity and resembles a brute-force approach to every possible state of the solution space. At the background of service composition, the existing theories refer to two major approaches how to describe the solution space:

Exhaustive composition approach: By an exhaustive composition approach all possible configuration variations must be defined in advance. The logic of this approach is a lookup-table based on a systematic enumeration of all possible combinations, where the most appropriate one is the selected one. The advantage of this approach lies in a (theoretical) high quality of the solution preset and the low implementation effort since these presets are defined by domain experts\textsuperscript{34}. In contrast, the excessive complexity prevents a practical application of this approach for larger solution spaces. The number of instructions raises exponentially. This effect is also referred to as “combinatorial explosion”. Each additional element demands a systematic reconsideration of composability with every prior element. In IS-research, this methodology is also called “brute-force search” or “exhaustive search” – it is a very general, but expensive problem-solving technique.

For example, if the solution space for service composition consists of 100 services and another one is added, the new service must be evaluated regarding its compatibility a hundred times (for each existing service). These decisions add up to the 4950 decisions already made before.

\[
\text{complexity} = \frac{N^2 - N}{2}
\]

\textsuperscript{34} Respectively domain knowledge must be manually defined somewhere else, e.g., based on user feedback. A sensible combination of elements of the solution space can only be determined if the domain knowledge has been externalized before.
This calculation assumes that all services are homogenous and there is no inherent ordering. However, according to the generic solution model, there may be a primary service (core service), and accordingly, the order becomes relevant. Under the condition of order, the following formula calculates the complexity:

\[ \text{complexity} = L^{N-1} \]

**Heuristic composition approaches:** As shown above, explicit- or brute-force approaches are only applicable for small solution spaces (especially if based on manual input). Heuristic approaches are preferred for large solution spaces. By definition, every method that simplifies the situation is a heuristic. Thus, every approach that is not an extensive composition approach is a heuristic approach. Instead of the combinatorial choice for every already existing service, the number of choices is reduced to the number of generic elements of the solution model (Figure 3-32). If a service is classified into the correct type of the solution model, the evaluation process is already done. Thus, the calculated complexity reduces to

\[ \text{complexity} = N \times k \]

with \( k \) is the number of generic service components.

However, these heuristics come with a price: the solution utility may be worse, because of oversimplification. Especially missing constraints (e.g., one service must not be used in conjunction with another service) might lower quality. However, the practical effect on utility may depend on the given field of application.

Variations and optimizations of heuristics are plentiful. Covering them would go beyond the scope of this work. Concepts like pruning (eliminating duplicate nodes), metaheuristics (branch-and-bound) and so on are subjects on their own and must be evaluated and validated individually to give meaningful advice. This field is open for further research.

**Configuration-Bundling Algorithms**

The actual process of service bundling is done by information systems that utilize formalisms and algorithms for that task. All bundling, respectively configuration tasks, share common characteristics with respect to knowledge processing. They consist of following (cf. Günter & Kühn, 1999):

- a set of objects in the application domain and their properties (parameters).
- a set of relations between the domain objects. Taxonomical and compositional relations are of particular importance for configuration.
- a task specification (configuration objectives) that specifies the demands a created configuration has to accomplish.
- control knowledge about the configuration process.

The goal of bundling- respectively configuration systems are to manage variable elements of the system and ensure their overall correctness by reasoning rules and constraints. The general form of logic/knowledge processing in configuration systems can be classified into three categories (cf. Sabin & Weigel, 1998; Wicaksono et al., 2011):

**Rule-based:** The rule-based logic derives solutions in a forward-chaining manner, by executing predefined if-then-rules. During each iteration, all rule-sets are examined and only the ones that can be applied to the next step are considered. Each rule has its own triggering context which classifies its scope of applicability (Blecker, Abdelkafi, Kreutler, &
These rules contain both, the control strategy and the domain knowledge (Sabin & Weigel, 1998). This missing separation between control strategy and domain knowledge also causes the main issue with this approach. Significant maintenance issues do arise, especially when the system becomes increasingly complex. Besides this, there are other drawbacks like knowledge acquisition and consistency checking (Günter & Kühn, 1999). Most of early configuration systems fall into this category.

**Model-based:** Model-based logic describes the indented situation to be achieved via the configuration task. It is based on the existence of a model that describes the interactions among decomposable entities. In contrast to rule-based approaches, it describes the “what” instead of the “how”. This separation enhances compositionality, reusability and robustness of this approach (Hamscher, 1994). Several sub-classes of model-based approaches do exist (Bleckert et al., 2004):

- **Logic-based models:** Based on the idea of concepts (unary predicates, classes), individuals (objects), roles (binary relations) and constructor a description logic is created. Description logics are formalisms for representing and reasoning with knowledge. They allow to build complex rules and concepts from atomic ones and use subsumption as the inference mechanism (Bleckert et al., 2004).
- **Resource-based models:** Resource-based reasoning is based on a producer-consumer model of the configuration task. Each entity in this model is characterized by the resources it consumes, processes and provides. The configuration model aims at balancing these resources in a useful manner (Juengst & Heinrich, 1998).
- **Constraint-based models:** In constraint-based systems components are characterized by their interfaces and properties. The modeled constraints usually apply to the interrelationships among the components. For instance, constraints could be an explicit “forbidden” or “required” for the combination of specified elements (Edward Tsang, 1995).

**Case-based:** Case-based reasoning assumes that similar problems have similar solutions. Configuration knowledge is usually derived and adapted from previous case records that have been bought or been used by customers before. Solution templates designed by experts could be another source for case-based configuration knowledge. Thus, case-based logic solves configuration problems by providing non-generic solution templates for specific situations, customers, regions, etc. Cases-based algorithms generally cycle through three steps: first, elicit customer requirements. Second, retrieve the previous configuration. Third, adapt the case to the new situation (Bleckert et al., 2004).

This listing captures the most prominent classes of bundling algorithms but is not exhaustive. Besides these three main groups, other types of knowledge-based configuration do exist, like concept hierarchies, backtracking, or structure-based approaches (cf. Günter & Kühn, 1999).

For CSM, all types of composition algorithms could be facilitated theoretically. However, the model-based approach is the one that seems most suitable in a CSM scenario, since it takes the former insights into consideration. For example, the generic solution model is the appropriate model to describe the target situation in a configuration scenario and can be applied to the model-based approach. The model-based approach is also used for the empiric validation later in Chapter 4.
3.4.4.2 Linking Task

The previous steps ensure that the “right” services were selected and bundled. This final step makes sure that the services were deployed in the correct way.

Linking is the process of “finding additional services needed by the suppliers that provide the service bundle” (Gordijn, Razo-Zapata, Leenheer, & Wieringa, 2012). Its goal is to solve “dependencies with other service enablers to allow the service bundle being sustainable” (Razo-Zapata et al., 2012). The focus of this step lies on the B2B dependencies that service bundles might have (Razo-Zapata et al., 2012). For example, a financial service, such as mobile payment, might rely on another service, such as a banking account, in order to function correctly.

For CSM, the linking task is of secondary importance due to the following reasons: first, e-services, that are within the scope of CSM, are usually offered as standalone services to end-customers. Thus, a good service design in regards of loose coupling and high cohesion can be assumed (see Section 3.3.1.1). As a result, no third services should be necessary for any service in a CSM scenario. Second, in customer-centric service ecosystems, B2B relationships could be neglected. From a customer’s perspective, only the relationships between him and the providers are relevant. Successful vendors will adopt this situation and, accordingly, offer integrated services. Third, linking aspects are already solved in the generic product model (see Section 3.4.4.1). For example, the role of facilitating and support services describes constraints for infrastructure services, that lie behind the line of visibility of the customer.

Thus, unlike other service composition scenarios, linking is not within the scope of CSM and will not be examined further on.

3.4.5 Service Composition for the Example of Financial Services

This section presents a prototypic implementation of the service composition logic in a CSM scenario. Again, the example of financial services is chosen. The prototype refers to the same ontology that is introduced in Section 3.2.5 and is described in Appendix 11-Finance Ontology. The example covers the selection and bundling phase of the composition process and hence describes the composition logic of the prototype. However, for reasons of practicability and technical limitations the tasks are not implemented in the strict order of the reference process described above.
The Finance Ontology contains a list of customer intentions that is stored in the sub-tree "Intentions" (Figure 3-33). In the following example, the user has the intention to "fund a business".

![Figure 3-33: Prototype: Excerpt of the ontology - structure of the intention list](image)

The eligible core services of the solution bundle are directly derived from the intention. The relationship between an intention and a core service is stored in the ontology via the relationship "isIntentionForService" (Figure 3-34). Per intention, there is at least one core service defined.

The core service is the main component of the service bundle, that will be complemented by other service matches according to the structure of the generic product model (see Section 3.4.4.1). Figure 3-34 shows the list of core services that cater to the user intention to fund a business.

Each core service is linked to a bank-specific domain. The domain is the common denominator that specifies the common value attributes between the service model and the customer model. The service is assigned to its corresponding domain via the "isSpecifiedByFinancialDomain" (Figure 3-35).

![Figure 3-34: Prototype: Modeling of the relationship between intention and core service](image)

![Figure 3-35: Prototype: Linking service and domain](image)
Subsequently, the relevant questionnaire for the profiling is determined based on the domain via the relationship “isRelevantForDomain” (Figure 3-36). Finally, the elicitation frontend is generated.

The data for the value dimensions are stored as annotations for each service. Figure 3-37 shows an excerpt of the evaluated service model for the service “Virtual Financing Advisory” as it is represented in Protégé.

After the user preferences have been elicited and quantified through the profiling interface, all necessary data for the matching task is available. The prototype uses a relatively simple and robust matching algorithm: since the user model and the service model have an identical structure, the values of all items can be represented as vectors. Cross-correlation is used to calculate the similarity respectively the distance between two vectors.

\[
\text{correlation}(x, y) = \frac{1}{n-1} \left( \frac{\sum_x \sum_y (x - \bar{x})(y - \bar{y})}{\sigma_x \sigma_y} \right)
\]

A correlation value of 1 is for total similarity between customer model and service model, a value of 0 is no similarity. When converted into a percentage, this value represents the matching score towards the user. This calculation is done for every service that was initially identified as an eligible core service.
The service with the highest matching score is the reference to the calculating of the solution bundle that is presented to the user. In this example, each service has other services linked that serve as supplementing services. This is modeled via the relationship “hasSupplementingService” (Figure 3-38). Eligible supplementing services, whose matching score is above a threshold value, are displayed to the user as a part of the solution bundle.

![Figure 3-38: Prototype: Relationship between core service and supplementing service](image)
4 Empirical Validation

4.1 Objectives

4.1.1 Customer Value of Customer-centric Service Management

Chapter 1 and 2 have pointed out the necessity for customer-centricity. They show “why” there is a need for it. Chapter 3 deals with the question of “how” the concept of CSM can be implemented and introduced. “Whether” CSM finally works in an intended way and “what” that concept means for academia and practice is still to be answered. That is subject to this chapter.

Customer-centric composition, as conceptualized in Chapter 3, is supposed to allow more complex customer interaction in self-service scenarios and thus enables the self-directed customer to make a decision and conduct individualization in complex service domains on their own. Although each core element of the concept has been validated separately before, the whole is literally more than the sum of its parts. Thus, an integrated use-case driven evaluation can deliver more insights than several analytical ones, distinct from each other, can - especially from the perspective of the customer.

Evaluation and validation of the usefulness of the proposed artifact is a central requirement of design science research (cf. Gregor & Hevner, 2013) and consortium research (cf. Österle & Otto, 2010). The improvements and contributions may be demonstrated either by proof of concept, reasoning, proof of use, or proof of value added (Gregor & Hevner, 2013). In this regard, especially customers’ perception of the proposed concept is crucial for evaluating the potentials of CSM. Since changing customer requirements are the starting point for this work, meeting and fulfilling them is the ultimate intended goal. Therefore, the evaluation of the proposed artifact will be based on the concept of “customer value” – an academic concept that has gained high relevance in practice too. According to Woodruff (1997), customer value will be the determining competitive advantage in future markets and will represent “the next major shift in managerial practice”.

In business and IS-research, customer value is a trending topic too. The term “customer value” has an ambiguous meaning and shows up in different contexts. From an organization's perspective, “value” emphasizes how high-value customers will increase the worth of an organization. From the customer's perspective, “value” considers what the customer gets from using or buying a product (Woodruff, 1997). The latter view from the demand-side will be related to further on in this chapter. Accordingly, definitions of “value” from a customer’s perspective are:

- “Perceived value is the consumer's overall assessment of the utility of a product based on perceptions of what is received and what is given” (Zeithaml, 1988).
- “The ratio between perceived benefits and perceived sacrifices” (Monroe, 1990, p. 46).

53 See also Section 1.3.
56 This is referred to as “value of the customer” or “customer lifetime value” (Parasuraman, 1997; Smith & Colgate, 2007).
• “Customer value is a customer's perceived preference for and evaluation of those product attributes, attribute performances, and consequences arising from use that facilitate (or block) achieving the customer's goals and purposes in use situations” (Woodruff, 1997).
• “[C]onsumer value [is] an interactive relativistic preference experience” which involves an interaction between a subject (e.g., consumer) and an object (e.g., product/service) (Holbrook, 2006).
• “Customer value is market-perceived quality adjusted for the relative price of your product” (Gale, 2010, p. xiv).

Based on those definitions, three reoccurring key characteristics of value are derived (cf. Woodruff, 1997):

1. **Subjectivity**: Value is a subjective construct depending on a specific point of view. To reflect the subjective customer perception, various concepts like “customer perceived value”, respectively “customer received value” have been established in the literature (Smith & Colgate, 2007).

2. **Contextuality**: Value is linked to the actual use of a product and the situation it takes place in. This embraces two aspects: first, it involves an interaction between a subject (e.g., a customer) and an object (e.g., a product). This is called interactivity (cf. Woodruff, 1997). Second, it depends on the situation the interaction takes place. This is called contextuality (in a narrower sense) (cf. Ulaga, 2003).37

3. **Relativity**: Value is characteristically defined as a ratio between two factors: the benefit side and sacrifice side. So, it is the trade-off between what the customer gives (e.g., effort, price) and what he receives (e.g., quality, utility).38

Further distinctions of value take additional aspects into consideration. For example, if the use has already taken place (“perceived value”) or if it is about to take place (“desired value”) (Maas & Graf, 2007). Furthermore, five primary forms of value for the customer have been identified by Woodall (2003): Derived value (use/experience outcomes), net value (balance of benefits and sacrifices), marketing value (perceived product attributes), rational value (assessment of fairness in the benefit–sacrifice relative comparison) and sale value (value as a reduction in sacrifice or cost).

An empirical quantification of the customer value of CSM is the focus of this section. Knowing the key characteristics of “value” is essential for developing an appropriate research model and designing the empirical validation. Further on, a corresponding experiment is described.

### 4.1.2 Formalized Hypotheses

A service individualization approach that is designed from a customer perspective within the application domain of complex services is expected to have many advantages. These

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37 Contextual value stands in contrast to “personal values”, that are beliefs across many situations and products – not a specific one.

38 However, there is no consensus whether customer value is a ratio (benefits divided by sacrifices) or a summative (benefits less sacrifices) (cf. Dellaert & Stremersch, 2005).
benefits have been mentioned in the prior sections. The idea of customer-centric composition has many predecessors, but to best knowledge has never been implemented in the described way before. The expected advantage of CSM over traditional (=product-centric) composition approaches can be proven by validating the following hypotheses.

CSM respectively customer-centric service individualization is believed to be superior to product-centric individualization from the perspective of the customer. Hence, the advantage of customer-centricity over product-centricity can be proven by delivering a higher customer value. Therefore, the main hypothesis for the empirical evaluation is:

**Main Hypothesis (MH): Customer-centric service composition provides higher customer value than product-centric composition does.**

Quantification of customer value is necessary to (dis-)prove this hypothesis. It demands an operationalization of this concept. This is the subject of the following Section 4.2.

Furthermore, it has been argued during the introduction of this work that three obstacles prevent customer-centricity in the service domain (see Section 1.1.5): utility, customer experience, and complexity. They are mandatory preconditions to the successful implementation of CSM and have a direct impact on the customer value.

**Sub-hypothesis 1 (SH1):** Customer-centric service composition provides an outcome with higher utility in contrast to the product-centric composition.

**Sub-hypothesis 2 (SH2):** Customer-centric service composition provides better customer experience in contrast to the product-centric composition.

**Sub-hypothesis 3 (SH3):** Customer-centric service composition lowers the complexity the customer must manage in contrast to the product-centric composition.

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**Figure 4-1: Hypothesis model for the empirical validation of CSM**

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39 Validating of the main hypothesis also serves as a proof of concept for CSM. Confirmation of a higher (or similar) customer value does logically imply that the concept “works” and is useful.

40 This main hypothesis of the empirical validation refers to research Hypothesis 3a in Section 1.2.3.
4.2 Conceptualization

4.2.1 Research Model Evaluation

Proper measurement of the abstract construct of “customer value” demands further conceptualization.²Regarding customer value, abundant conceptual models do exist (cf. Ho & Ko, 2008; Sauro & Lewis, 2012, p. 185ff.). Reusing already established models is good practice in scientific work, for reasons of objectivity, replicability, quantification, economy, communication, and scientific generalization (cf. Jum C & Ira H, 1994). If feasible, an application of a standardized and already established model is intended for the empirical validation for this work too.

Based on a literature review², several established models have been identified which do correspond to the key characteristics of “customer value” (see Section 4.1.1) and furthermore have a link to the domain of IS research (esp. SSTs). The identified models are settled in different research areas such as Human-Computer Interaction, marketing, business and operations. All models are within the interdisciplinary scope of service science and do embrace aspects from consumer-, business- and IS-side. As vague and ambiguous the concept of “customer value” is understood, as heterogeneous are the identified models. Unfortunately, the names of the models are sometimes misleading, so an in-depth analysis of each model is inevitable. In this respect, a brief description of selected models from Table 4-1 and their evaluation considering the validation objectives are given further on.

**Consumer Readiness Model:** The Consumer Readiness Model introduced by Meuter et al. (2005a) explores key factors that influence consumers initial decision to trial a self-service technology. It focuses specifically on situations, where consumers have to choose among self-service and other modes of delivery. This model shows that consumer readiness to try out self-services depends on the key variables motivation, clarity and ability. The consumer readiness model falls short for this evaluation in requirement “contextuality” because it is focused on the pre-usage phase. Therefore, no trade-off (relativity) and no value of the product itself can be determined.

**Consumer Acceptance Model:** The Consumer Acceptance Model by Globerson & Maggard (1991) tries to predict the acceptance of self-service technologies by consumers. It identified seven factors that influence consumer’s readiness towards self-service: convenience of use, time saved, self-control, money saved, self-image, risk and self-fulfillment. Since this model is predictive, it is not intended for in-use situations (missing contextuality). Based on this restriction, also relativity cannot be estimated. As mentioned by the authors, it is also not designed for measuring individuals, but to capture whole segments instead (missing subjectivity).

**Customer Satisfaction Model:** The Customer Satisfaction Model by Madaleno, Wilson & Palmer (2007) examines customer satisfaction for interaction scenarios based on channel integration, channel satisfaction, product satisfaction and price equity. The scope of this model is solely on integration aspects, especially in multi-channel interaction and it is

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² Conceptualization is the clarification of abstract concepts (in this case customer value) on a concrete and measurable level.

²² Based on forward and backward search for the key word “customer value” in EBSCO database in March 2014.
intended for B2B settings. Thus, this model aims at professionals and not at consumers. Therefore, it does not fit the experiments setting.

User Experience Models: There are some models in Table 4–1 that are focused on the customer value in using specific information systems. These models fall into two groups – post-study questionnaires and post-task questionnaires (cf. Sauro & Lewis, 2012, p. 188ff.). Post-task models deliver insights on a very detailed level and are executed directly after fulfilling a specific task. Examples of post-task surveys are SEQ and SMEQ. Post-study questionnaires, on the other hand, deliver feedback on a broader level. They are used for comparing general satisfaction between different products or providers. SUS and SUMI are examples for post-study surveys. Since in theory, post-study and post-task questionnaires are suitable for a scenario-based evaluation, in practice they are not. All the examined post-study and post-task models are too focused on the actual implementation of the system, instead of the general concept behind it. Therefore, they are evaluating the quality of the prototype and not the value of the scenario, what makes them not suitable for this setting.

Intention to Continued Use Model: The model of Ho & Ko (2008) examines factors determining customers continued use of self-service technologies. They identified four user-influencing key factors for keeping them using technology: ease of use, usefulness, self-control, and costs saved. Unlike the prior models, this model focuses on customer retention instead of customer acquisition. However, it is still hypothetical and not subjective or interactive, so it is hardly applicable for in-use evaluation in this work.

Technology Acceptance Model (TAM): The TAM was developed by Davis (1989) to explain how users decide whether they accept and use technology. This model derives the use of technology (attitude towards using) from two primary factors: perceived usefulness and perceived ease of use. Perceived usefulness (PU) is "the degree to which a person believes that using a particular system would enhance his or her job performance" (F. D. Davis, 1989). Perceived ease-of-use (PEOU) is "the degree to which a person believes that using a particular system would be free from effort" (F. D. Davis, 1989). TAM may be the most often used model for analyzing technology usage because of its comprehensibility, simplicity, and reliability of input variables (W. R. King & He, 2006). Due to this popularity, several iterations and modifications of this model have emerged. A further formalization of the external variables led to TAM 2 as an extension of the original model (Venkatesh & Davis, 2000). Later on, the factor ease of use was further formalized resulting in the third iteration of TAM (Venkatesh & Bala, 2008). Numerous variations of TAM do exist for specific questions, e.g., for predicting customer intention to use self-service technologies (Curran & Meuter, 2005) or for continued use of self-service technologies (S.-C. Chen, Chen, & Chen, 2009). These models are adapted to specific and narrow research questions and are hardly generalizable to other research settings. A limitation of TAM is the dependence on the form of actual implementation. It measures ease of use and usefulness for a particular system (i.e., system specific) and not for general beliefs (i.e., individual-specific) (Lin, Shih, & Sher, 2007). Therefore, a further modification of this model would be necessary for this experiment resulting in a de facto new model.

Unified Theory of Acceptance and Use of Technology (UTAUT): The ongoing evolution of TAM and the occurrence of competing models led to an integration of the main models into UTAUT. It consists of four key dimensions: effort expectancy, performance, expectancy, social influence and facilitating conditions. This model by Venkatesh et al. (2003) proved to outperform each previous model. However, UTAUT is criticized for its extent
of variables (Bagozzi, 2007) and problematic grouping and labeling of items (van Raaij & Schepers, 2008). UTAUT is also focused on expected value, not on perceived value.

**Technology Readiness and Acceptance Model (TRAM):** The Technology Readiness and Acceptance Model by Lin et al. (2007) integrates the concept of Technology Readiness (TR) (Parasuraman, 2000) into the Technology Acceptance Model. It examines consumer adoption of e-service systems. The advantage of TRAM over TAM is its applicability to marketing questions, while TAM only examines acceptance in work environments. This shifts the focus from systems towards consumers, since technology readiness is user-specific and system independent. TRAM takes the process of consumer’s self-selection decisions into account. Overall, TRAM is a suitable model for the given research question that would require only some minor modifications.

**Mass Customization Utility Model (MCUM):** The apparent dichotomy between usefulness and complexity demonstrated by TAM (and other models mentioned above) is the core of the Mass Customization Utility Model from Dellaert & Stremersch (2005). The MCUM investigates user’s perception of configuration setups for mass customization. Thus, it is the only known model that examines customer value in the specific environment of self-services and configuration tools. Based on the factors expertise, complexity and product utility, the overall utility of the mass customization approach is determined. Dellaert & Stremersch (2005) found out, that complexity has a negative effect, and product utility has a positive effect on mass customization utility. So, it also supports the assumption, that complexity is a key determinant for user adoption of mass customization. Despite being not as popular as more generic models above, it has proven high reliability and validity. It seems to be the most suitable standardized model for examining the research question. However, although the MCUM explains the utility of configuration settings, it falls short in considering the reasons why high or low utility occurs (to the extent that for example TAM 2 and TAM 3 do). For example, only the overall product utility is elicited by the probability to purchase. It seems reasonable to extend (not modify) the model in this regard to identify latent variables and to gain deeper knowledge.

**Model Assessment for Conducting the Experiment**

A variety of standardized models have been identified that refer to customer value. The decision for a specific model is based on the findings from the literature review above, which are:

- From a statistical perspective, all the mentioned models are *Structural Equation Models*. This term subsumes a class of statistical procedures for testing and evaluating causal relationships among data (Kline, 2011, p. 7ff.).

- A major distinction of these models is their *scope* of the evaluation. Some models like PSSUQ, SUS, or SUMI are very focused on the particular implementation instead of the general concept (Sauro & Lewis, 2012, p. 191f.). Especially post-study tests fall in this group. Post-task questionnaires like After-Scenario Questionnaire (ASQ), Single Ease Question (SEQ) or Subjective Mental Effort Question (SMEQ) are even more detailed. A suitable model for this work must be focused on the fundamental concept of the demonstrator, not on the quality of its specific implementation.

- Some models like Customer Satisfaction Model do not evaluate the value from the consumers’ point of view but from a third-person viewpoint or for professional users instead. An appropriate model must be based on the consumer perspective.
• The models do focus on different stages of the service lifecycle. Some models like Consumer Readiness Model are focused on customers’ intention to use a product prior to actual usage. Others, like the Continued Use Model, consider customer’s intention for the phase after having used a product. A third group evaluates the value right during or immediately after using a product. This validation belongs to the third group because of the required contextuality of value that must be determined in-use situations. For this experiment, the focus is on the prototype based evaluation and therefore on the actual usage phase.

• The dichotomy between benefits and sacrifices is found in most of the analyzed models. The models that are better-fitted for this experiment, also do entirely support the assumption that the customer value is mainly determined by the perceived utility and by complexity (as the most important sacrifice factor).

• The terminology is often used inconsistently. Factors need to be closely examined regarding their definitions and their respective measurement items. Similarly named models do sometimes drastically differ in their actual objective, scope and meaning.

Based on these insights, the most suitable of the examined models above is the Mass Customization Utility Model by Dellaert & Stremersch (2005). It considers the essential requirements for measuring customer value in a design science approach and is additionally perfectly settled in the field of mass customization. In the next section, this model will be presented in detail, and its application within the planned experiment is described.
<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Evaluated factor</th>
<th>Key influencing factors</th>
<th>Fulfilling criteria for evaluating customer value</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer Readiness Model</td>
<td>Evaluation of consumers’ readiness to choose and trial self-service technology over other modes</td>
<td>Consumer Readiness</td>
<td>Role clarity, motivation, ability</td>
<td>1. Subjectivity</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2. Contextuality</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3. Relativity</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(Meuter, Bitner, Ostrom, &amp; Brown, 2005b)</td>
</tr>
<tr>
<td>Consumer Acceptance Model</td>
<td>Prediction of consumers’ acceptance of self-service technologies</td>
<td>Consumer Readiness</td>
<td>Convenience of use, time saved, self-control, money saved, self-image, risk, self-fulfillment</td>
<td></td>
<td>(Globerson &amp; Maggard, 1991)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intention to Continued Use</td>
<td>Intention to Continued Use</td>
<td>Intention to Continued Use</td>
<td>ease of use, usefulness, self-control, costs saved</td>
<td></td>
<td>(Ho &amp; Ko, 2008)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology Readiness and Acceptance Model (TRAM)</td>
<td>Measures readiness of individuals to use and interact with new technologies</td>
<td>Use Intention</td>
<td>Technology Readiness, Perceived Ease of Use, Perceived Usefulness</td>
<td></td>
<td>(Lin et al., 2007)</td>
</tr>
<tr>
<td>Questionnaire for User Interaction Satisfaction (QUIS)</td>
<td>Assess user satisfaction with specific aspects of human-computer interface</td>
<td>User Satisfaction</td>
<td>Demographics, system satisfaction, interface factors</td>
<td></td>
<td>(Harper &amp; Norman, 1993), (University of Maryland, n.d.)</td>
</tr>
<tr>
<td>Post-study System Usability Questionnaire (PSSUQ)</td>
<td>Evaluates users perceived satisfaction with IS</td>
<td>Overall satisfaction, system quality, information quality, interface quality</td>
<td>Quick completion of work, ease of learning, high-quality documentation, functional adequacy</td>
<td></td>
<td>(Lewis, 2002)</td>
</tr>
<tr>
<td>Software Usability Scale (SUS)</td>
<td>Measures usability as perceived by a user</td>
<td>System usability</td>
<td>10 items</td>
<td></td>
<td>(Brooke, 1996)</td>
</tr>
<tr>
<td>Software Usability Measurement Inventory (SUMI)</td>
<td>Measures software quality as perceived by the user</td>
<td>Quality of Use</td>
<td>Efficiency, affect, helpfulness, control, learnability</td>
<td></td>
<td>(Kirakowski, 1996), (University College Cork, n.d.)</td>
</tr>
<tr>
<td>After-scenario Questionnaire (ASQ)</td>
<td>Evaluates users perceived satisfaction with IS (like PSSUQ on a more detailed level)</td>
<td>User satisfaction</td>
<td>Ease of task completion, completion time, supported information</td>
<td></td>
<td>(Lewis, 2012)</td>
</tr>
<tr>
<td>Model</td>
<td>Focus</td>
<td>Concepts</td>
<td>TAU</td>
<td>UTAUT</td>
<td>Remarks</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-----------------------------------------------------------------------</td>
<td>--------------------------------------------------</td>
<td>-----</td>
<td>-------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td>Technology Acceptance Model</td>
<td>Evaluation of customers’ acceptance of technology in use situations</td>
<td>Attitude toward Using</td>
<td>Y</td>
<td>Y</td>
<td>(F. D. Davis, 1989)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Perceived ease of use, perceived usefulness</td>
<td>Y</td>
<td>Y</td>
<td>(F. D. Davis, Bagozzi, &amp; Warshaw, 1989)</td>
</tr>
<tr>
<td>Mass Customization Utility Model</td>
<td>Evaluation of user utility for different mass customization settings</td>
<td>Mass Customization utility</td>
<td>Y</td>
<td>Y</td>
<td>(Dellaert &amp; Stremersch, 2005)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Expertise, complexity, product utility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unified Theory of Acceptance and Use of</td>
<td>Explain user intentions to use an information system and subsequent</td>
<td>Behavioral intention</td>
<td>Y</td>
<td>N</td>
<td>(Venkatesh et al., 2003)</td>
</tr>
<tr>
<td>Technology (UTAUT)</td>
<td>usage behavior</td>
<td>Effort expectancy, performance, expectancy, social influence, facilitating conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4-1: Comparison of customer-value-related conceptual models for the experiment
4.2.2 Formalization of the Research Model

4.2.2.1 Structural Model

The Mass Customization Utility Model by Dellaert & Stremersch (2005) is evaluated as the most appropriate standardized research model for the given research question. However, the model needs to be further formalized to deliver the foundation for the survey questionnaire, statistical analysis and finally the hypothesis model. Further on, its elements will be explained in detail and reasonable extensions are proposed.

Dellaert & Stremersch (2005) used their model to examine customers' evaluation of different mass customization configurators. In their experiment, they varied external variables like the number of modules that can be customized, heterogeneity of customization options, individual pricing and the presence of default values. They did a comparison-based analysis - comparable to this experiment. However, their experiment (and thus their insights) is based on the configuration of personal computers – therefore it has not been applied to a service setting yet.

The MCUM consists of three factors that represent the dependent variables “complexity,” “solution utility,” “mass customization utility” – and a fourth independent variable “affinity”. The complete model with its extensions is shown in Figure 4-2. Each of its elements is defined further on and modifications to the original model are justified.

![Figure 4-2: Extended Mass Customization Utility Model based on Dellaert & Stremersch (2005)](image)

**Affinity**: User expertise plays a central role in dealing with complexity (cf. M. T. Spence & Brucks, 1997) - particularly in the context of configuration tools (cf. Randall et al.,...
According to the findings of Dellaert & Stremersch (2005), affinity is believed to influence perceived complexity and solution utility. Thus, within the research model, two hypotheses do result:

- **Formalized Hypothesis A1**: Higher user affinity is believed to decrease the perceived complexity of the configuration setting. More specifically, for the domain of complex services, perceived complexity is thought to be mainly determined by the domain expertise. Technological expertise plays a minor role since most users are increasingly skilled in electronic interaction nowadays.

- **Formalized Hypothesis A2**: Because of A1, the solution utility will increase with higher affinity. Users with higher affinity can better handle the complexity of the configurator tool and can also assess the utility of the proposed solution more realistically.

**Complexity**: The central role of complexity has already been discussed in detail in Section 2.2. Complexity prevents users from using SSTs and MC toolkits. Thus, complexity is a moderator factor that affects the utility of a configurator. Complexity takes a bivalent role in the context of CSM: on the one hand, lower complexity increases user acceptance, on the contrary, increased interaction and information about the user improve the quality of the outcome. Thus, the following hypotheses are proposed:

- **Formalized Hypothesis B1**: Reduced (perceived) complexity promotes the use of configurators and thus is a necessary precondition to enable any solution utility at all.

- **Formalized Antithesis B1**: Lowering complexity decreases solution utility, because less information about the user can be captured and processed and subsequently the individualization result becomes inferior.

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43 These five items are: knowledgeable – not knowledgeable, competent – incompetent, expert – non-expert, trained – not trained

44 A test during the focus group-phase showed that the respondents could not clearly differentiate some items after their translation into German language.
Although the role of complexity is contradictory regarding solution utility, there is a clear assumption in the context of configuration utility. The user experience will be positively influenced by simplifying the configuration process.

- **Formalized Hypothesis B2:** Lower complexity increases the perceived configuration.

Dellaert & Stremersch (2005) measure complexity on a seven-point Likert scale for the dimensions complicity, difficulty, and effort. This measurement was adopted untouched for this evaluation since it showed a high reliability (coefficient alpha 0.91) and it proved a good fit during the focus group interviews.

**Solution utility:** This factor is focused on the outcome of the configuration process, i.e., the value of the proposed solution for the customer. Solution utility is also referred to as "perceived usefulness" in other models. It does not only express the satisfaction of the conducted configuration process, but it also determines customers’ intention in using the service again (Curran & Meuter, 2005).

Maximizing solution utility is a goal for every individualization approach, regardless of technologies. Concerning configurator toolkits, it determines its functional quality, and thus it may be the most important factor that determines the quality of an MC approach. Solution utility directly affects the user experience (mass customization utility) of the configuration too. If the generated outcome meets or exceeds the expectations, the prior configuration process will also be perceived more positive. Thus, a related hypothesis is:

- **Formalized Hypothesis C1:** Increased quality of the generated outcome (solution utility) will improve the user experience (mass customization utility).

Dellaert & Stremersch (2005) (cf. Ashok, Dillon, & Yuan, 2002) measure product utility using a likelihood scale ("likelihood to purchase if available"). This is a common measurement in user research and delivers reliable results (cf. Ashok et al., 2002). However, the model of Dellaert & Stremersch (2005) does not take into consideration the reasons for differences in likelihood. As shown before, a large number of models for perceived utility or usefulness do exist. Pavlou (2003) delivers a comprehensive classification of perceived usefulness which he uses in the field of e-commerce. His survey itself extends the TAM and measures utility by four variables: value, content, function and overall usefulness. These measures are adopted and extend the original MCUM. To take the service setting of this experiment into account and for terminological clarity, the factor "product utility" is renamed to "solution utility".

**Mass customization utility:** The user experience of the configuration process is measured as mass customization utility. This factor is focused on the process, not on the outcome. It captures all non-functional qualities\(^4\) of a configuration scenario.

Complexity directly influences mass customization utility and solution utility but has no reciprocal effect on them in return. Just like solution utility, mass customization utility is originally measured on a one-dimensional likelihood scale ("likelihood to use if available") by Dellaert & Stremersch (2005). To identify determinants, the MCUM is extended again: an established model for classifying value in consumers choice/decision processes is given by Sheth et al. (1991). Since the configuration is a decision process that supports customers to identify the best possible configuration, it is assumed that decision-related variables (value) will be influenced by the characteristics of mass customization and solution utility.

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\(^4\) However, the functional qualities of the configuration toolkit itself are relevant, since they do impact mass customization utility. E.g., errors in the toolkit will affect the user experience directly, since the user perceives the configuration process as erroneous.
consumers in making choices, the utility according to Sheth et al. (1991) results from functional, conditional, social, emotional and epistemic value.

4.2.2.2 Measurement Model

The MCUM is a structural equation model (SEM) – a statistical model that calculates causal relationships among factors and identifies hidden structures. Every SEM consists of a structural model, that describes endogenous and exogenous variables and their interrelationships, and a measurement model, that names latent variables and their indicators. In other words: the measurement model captures the items that can be directly measured, the structural model contains the elements that can be calculated based on the measurement model. The measurement model of MCUM comprises combined measures and objective measures.

Combined measures: The MCUM evaluates four factors, that each consist of several measured items. So, each factor is a composite metric that must be derived from the items and results in a loss of information. Dellaert & Stremersch (2005) rely on an overall score to determine the factors. That prevents biases from a posteriori aggregation by the researchers and is the closest to the real perception of the user. Another advantage of a composite score is a higher reliability of measurement that becomes better with higher correlations among the component score (Jum C & Ira H, 1994). However, that approach does not allow the examination of the reasons for the findings, respectively the factors that do influence them. For that reason, an extension of the MCUM becomes necessary. Additionally, atomic measures that can explain the composite measures are collected. These additional measures have already been introduced in the section above.

For the statistical evaluation later in this experiment, only the original factors from MCUM are used. This means, perceived complexity and solution utility are determined only by an overall score (composite measure).

The items that are additionally collected will be used to explain the findings from a qualitative perspective. The summary logic is based on the simple arithmetic mean of all values. More sophisticated methods like MANOVA do maximize the differences between levels of the independent variables. That increases the likelihood to get significant statistical results. However, these methods are hardly interpretable and therefore often criticized (cf. Abelson, 1995, p. 127f.). Thus, the simpler method (usage of composite metrics) is preferred for the analysis later in this work, as it delivers more meaningful results. Moreover, statistical factor analysis allows an evaluation of the quality of these overall measures. Therefore, Likert scale values are converted to a probability scale (0-100%).

In principle, choosing one or another approach within the MCUM is believed to have no substantial influence on the findings. Usability metrics in general, are highly correlated, regardless, if there are atomic or composite (cf. Sauro & Lewis, 2009) – this additionally justifies the use of compound measures.

Measurement scale: The items are measured on a seven-point Likert-scale. First, to be in line with the original MCUM. Second, higher point scales do mathematically deliver

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46 This is ensured prior to composition.
higher reliability, although the additional return is vanishing after seven steps (Sauro & Lewis, 2012, p. 187f.). As a third reason, a scale with an odd number provides a neutral statement for the participants. Also, the “N/A” choice off-the-scale is offered for every item. The scale labels are “Strongly disagree” and “Strongly agree” where higher numbers indicate higher satisfaction (except for the factor complexity) (Albert & Tullis, 2013, p. 140).

Question-wording: A critical aspect of the measurement model is the question text that relates to every item. The question is the interface between each individual participant and the underlying research model. Formal definitions and the structural background of the experiment can hardly be given in a question form. So, the correct, precise, and unbiased wording is critical, since results can be easily corrupted. An example is the “acquiescence bias”: the fact that people are more likely to agree with a statement then to disagree with it (Cronbach, 1946). However, the alternatives such as negative item tone or alternating tones have drawbacks themselves: they can confuse participants so that the results may not only be biased but completely wrong (especially in unmoderated settings). There is also the risk of implementing or evaluating the items incorrectly by accident. Sauro & Lewis (2012, p. 206f.) summarizes the dangers of negative or alternative tone as misinterpretation, mistake, miscoding. There is little evidence that intertwining of positive and negative tonality outweighs the disadvantages. So, strictly positive item texts are encouraged (Sauro & Lewis, 2012, p. 207).

Given these circumstances, the tried and tested approach of positive tonality is chosen. Many commonly used questionnaires follow that approach too (cf. Lewis, 1995; Lund, 2001). The resulting bias towards “positive” is systematic. Thus it applies to all datasets. Since the evaluation is based on a comparative base, the biases do neutralize among the test scenarios.

Another necessary adoption concerns the experiment setting. The questionnaire has to refer directly to the terminology the participant encountered in the experiment (i.e. speaking of “solutions” instead of “products”). Also, translation into the German language is necessary which might cause alterations to the actual meaning of words. That might bear the risk of distorting the results. In both cases, the change of wording should have no noteworthy effect on the results (cf. Sauro & Lewis, 2012, p. 232).

Based on the descriptions above and due to the adjustments made to it, the model used in this work is further on referred to as the **Extended Mass Customization Utility Model** (see Figure 4-2). However, it sticks strictly to the proven structure of the original MCUM by Dellaert & Streemersch (2005). The proposed extensions only improve clarity and measurability for the given purpose of this work.
<table>
<thead>
<tr>
<th>Construct</th>
<th>Measurement Item</th>
<th>Indicators</th>
<th>Measurement Scale</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affinity</td>
<td>Domain expertise</td>
<td>How do you self-assess your financial knowledge?</td>
<td>7-point Likert scale (disagree/agree)</td>
<td>(Dellaert &amp; Stremersch, 2005)</td>
</tr>
<tr>
<td></td>
<td>Technological affinity</td>
<td>How do you self-assess your technological affinity?</td>
<td>7-point Likert scale (disagree/agree)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Problem relevance/need</td>
<td>How relevant is the problem you have chosen for you currently?</td>
<td>7-point Likert scale (disagree/agree)</td>
<td>(Dellaert &amp; Stremersch, 2005)</td>
</tr>
<tr>
<td>Complexity</td>
<td>Complicity</td>
<td>The questions or choices were complicated and confusing.</td>
<td>7-pointLikert scale (disagree/agree)</td>
<td>(Dellaert &amp; Stremersch, 2005)</td>
</tr>
<tr>
<td></td>
<td>Difficulty</td>
<td>The questions or the choices were hard to answer or to select.</td>
<td>7-pointLikert scale (disagree/agree)</td>
<td>(Dellaert &amp; Stremersch, 2005)</td>
</tr>
<tr>
<td></td>
<td>Effort</td>
<td>The configuration was time-consuming and of high-effort.</td>
<td>7-pointLikert scale (disagree/agree)</td>
<td>(Dellaert &amp; Stremersch, 2005)</td>
</tr>
<tr>
<td>Solution utility</td>
<td>Value</td>
<td>The solution fits my requirements and the stated problem.</td>
<td>7-pointLikert scale (disagree/agree)</td>
<td>(Pavlou, 2003)</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td>The presentation of the solution and the provided information is useful.</td>
<td>7-pointLikert scale (disagree/agree)</td>
<td>(Pavlou, 2003)</td>
</tr>
<tr>
<td></td>
<td>Function</td>
<td>The solution is sound and functional.</td>
<td>7-pointLikert scale (disagree/agree)</td>
<td>(Pavlou, 2003)</td>
</tr>
<tr>
<td></td>
<td>Usefulness</td>
<td>Overall, I find the solution useful.</td>
<td>7-pointLikert scale (disagree/agree)</td>
<td>(Pavlou, 2003)</td>
</tr>
<tr>
<td></td>
<td>Likelihood to purchase</td>
<td>How likely would you use the proposed solution if available?</td>
<td>Percentage</td>
<td>(Dellaert &amp; Stremersch, 2005)</td>
</tr>
<tr>
<td>Mass customization utility</td>
<td>Functional value</td>
<td>The configuration process was without errors and flaws.</td>
<td>7-pointLikert scale (disagree/agree)</td>
<td>(Sheth et al., 1991)</td>
</tr>
<tr>
<td></td>
<td>Social value</td>
<td>The configuration process will let me do this tasks without other intermediaries in future.</td>
<td>7-pointLikert scale (disagree/agree)</td>
<td>(Sheth et al., 1991)</td>
</tr>
<tr>
<td></td>
<td>Emotional value</td>
<td>The configuration process was a pleasant experience to me.</td>
<td>7-pointLikert scale (disagree/agree)</td>
<td>(Sheth et al., 1991)</td>
</tr>
<tr>
<td></td>
<td>Epistemic value</td>
<td>The configuration process was comprehensive and provided all necessary information.</td>
<td>7-pointLikert scale (disagree/agree)</td>
<td>(Sheth et al., 1991)</td>
</tr>
<tr>
<td></td>
<td>Conditional value</td>
<td>The configuration process fits my everyday interaction preferences.</td>
<td>7-pointLikert scale (disagree/agree)</td>
<td>(Sheth et al., 1991)</td>
</tr>
<tr>
<td></td>
<td>Likelihood to use</td>
<td>How likely would you use the proposed configurator if available?</td>
<td>Percentage</td>
<td>(Dellaert &amp; Stremersch, 2005)</td>
</tr>
</tbody>
</table>

*Table 4-2: Items of the structural equation mode*
4.3 Prototype

4.3.1 Objectives and Requirements

At the background of the experiment, the prototype serves three main purposes:

1) Conducting the experiment: First and foremost, the prototype serves the purpose to run the intended experiment. Thus, it must implement the customer-centric service configurator and its product-centric counterpart for a comparative evaluation. The prototype comprises four variants of configuration tools that share the same code-base. Its distinctive properties and the scenario they are embedded in will be introduced in the subsequent Section 4.3.3.

2) Proof of work: This work propagates the concept of CSM. Up to this point, it is a theoretical construct. Although great care was taken in the derivation of the concept and its elements, the road to practical implementation bears many risks. Thus, a running implementation of CSM that works in an intended way marks a significant achievement and proofs the usefulness and correctness of the previous research.

3) Further insights and knowledge validation: Implementing a prototype requires a scientist to deal with the subject on a very detailed level. Questions about data structures, algorithms, GUI-elements and so on force him to think about every little aspect of the concept and demand a holistic view at the same time. This process raises knowledge that is beyond theoretical analysis and directly translates back into the theoretical model. It enables an iterative research process that increases the quality of the whole work. Insights that have been gained during the implementation process have shaped many of the explanations in prior sections.

Functional requirements
The functional demands of the prototype strictly follow the generic CSM process. Tasks that are essential for CSM have been identified in Section 3.1.2. These tasks are 1) profiling, 2) selection, 3) combination and 4) the presentation of the solution concept.

Non-functional requirements
Rationality: The implementation of the prototype is subject to narrow resource restrictions. Time, funding and personal resources have been limited in the research setup. Thus, established and proven technology stacks are preferred. Additionally, the implementation is an iterative design process with changing requirements that benefits from a pragmatic and agile design.

Accessibility: A diffuse sample group with unknown technological expertise and limited motivation will use the prototype. Thus, the entry barriers must be as low as possible. An implementation that is up to current standards in respect of user experience, design and technical quality is essential. By using an established technology stack, many aspects of accessibility were already considered and the users might feel familiar to it because of their adoption in other applications.\(^{47}\)

\(^{47}\) The author decided to use the Bootstrap-framework (getbootstrap.com) and to implement the application logic client-sided via JavaScript.
Minimized bias: Four variants of the configuration tool are implemented for the validation scenario. All of them should share the same technology core to avoid biases, which could occur, e.g., by introducing unfamiliar GUI elements or different description texts. A unified GUI increases the perception of one-kind-of-a-tool and minimizes the influence of the interface on the results.

4.3.2 Generic Architecture of a Configurator System

Section 3 takes a conceptual view on service composition. A prototypic implementation of a configurator system requires an additional technical perspective on these systems too. The isolated implementation of key features of CSM has been regarded before. The holistic software architecture of a configurator system is subject to this section and serves as the foundation for the implementation of a prototype in an experimental setting.

Configuration systems are “software tools that are able to construct virtual products based on specific rules for certain parts and components” (Wicaksono et al., 2011). The main elements of these systems are diversely defined: Blecker et al. (2005b, p. 893) identify two broad components of configurator systems: front end and back-end systems. Furthermore, they explicitly distinct configurator systems from manufacturing systems, although they might be highly integrated. Pearson (2003) names the inquiry platform and the user platform as the main element of a configurator system. The user platform is used for self-profiling purposes, while the inquiry platform receives the data from the user platform and processes it. This dichotomy is emphasized by Pearson to increase trust in configurator systems. Wicaksono et al. (2011) label the knowledge base as the main component of a configurator. This knowledge base, in turn, consists of the configuration logic that defines restrictions and rules and a database that contains the entire set of elements and their instances. Schröder et al. (2009) name the profiling interface, item database, matching algorithm, offer presentation and feedback components as the central parts of a profiling system. Leckner & Lacher (2003) propose a product model server, a product configuration server and a customer profile server as the key components of a system architecture for the maintenance of product models. The most exhaustive architectural analysis of configuration systems so far is conducted by Blecker et al. (2004). They identified the following generic elements for configuration systems: 1) the repository, that contains all data and knowledge, and models. 2) The knowledge acquisition component that enables experts to model and maintain their knowledge. 3) A graphical user interface (GUI) represents the configurator to the customer-side. This interface is a complex subsystem and may be dynamically generated by a generation module. They refer to this subsystem as an advisory system. 4) A dialog component performs the elicitation process. It gives input to an advisory component, that presents the output to the user. The configurator systems can also be supplemented by 5) auxiliary systems, like CRM or data warehouses.

Figure 4-3 summarizes these insights on the architecture of configuration systems into a consolidated architecture.
4.3.3 Specification and Implementation

This section documents the specifications and implementation-related considerations of the configuration system (“prototype”) and its deployment during empirical evaluation. This section does not intend to be a technical reference. It primarily aims at describing “what” has been done and not “how” it has been implemented. The components of the prototype correspond to the elements of Figure 4-3:

Profiling Component

The profiling component elicits the user needs and preferences as the input for the configuration process. The prototype comprises several profiling views that are recombined each time to achieve the different configuration variants according to the research design. These views are:

Intention view: In this view, the user must state his intention. This is done via a combination of two drop-down boxes that represent an object and a verb. This is a pragmatic way to resemble natural language. A statement sentence in the form of “I want to <verb> <object>” is formed (e.g. “I want to optimize my spending.”) (see “Modelling of Intentions” in Section 3.2.4.3). This initial statement in every scenario is crucial to determine the appropriate solution space and even narrow down the problem space. The solution space is determined by relationships that have explicitly been modeled in the underlying ontology (knowledge base). Each intention clearly leads to a service-subset of the solution space, i.e., to payment or financing services.
Figure 4-4: Profiling component - intention view (screenshot)

**Full-self-profiling view:** In this view, the customer-centric needs and requirements are elicited. Based on the identified service-subset of the solution space, only the relevant need dimensions of the generic needs ontology must be presented during self-profiling. For example, if the user states an intention in the field of payment, he must only assess eight need dimensions instead of 24. The relationship between the subsets of the solution space and the related needs has also been explicitly modeled in the knowledge base.

At this step, the profiling interface consists of question groups which include a question title, a description sentence and the question GUI (labeled slider or radio buttons). Question groups could also contain sub-groups. E.g., as described earlier, the need dimension “speed” could be attributed to the speed of the payment interaction, to the speed of money transfer or to the duration to gain access to a payment option. During focus group interviews it appeared, that most users will not ever use these detailed fields, but for some users, these less-ambiguous questions were essential to understanding the intended meaning. This effect was observed especially for participants with high analytical abilities.

Figure 4-5: Profiling component - full-self-profiling view (screenshot)

**Weighting view:** The third step lets the user weight his preferences. The importance of each need-dimension could be rated. This is implemented via slider-elements. As the default value, all dimensions are weighted equally.

**Simplified-self-profiling view:** This view aims to simplify the self-profiling process by minimizing the elicitation interface in a way that it resembles natural language expressions
of the user. A list of pre-filtered adjectives is presented to him, from which he must choose the aspects that are desirable to him and the aspects that are essential to him. This task does not only elicit the preferences; it does capture a weighting at the same time. The use of adjectives creates an instant understanding and no further explanations (which bear the risk of confusion instead of clarification) are necessary. On the contrary, there is the inherent danger that adjectives are perceived in another way than the designer of the configurator intended.

![Anforderungen](image)

Figure 4-6: Profiling component – simplified-self-profiling view (screenshot)

**Service selection view:** The product-centric approach places the services in the focus instead of the users’ needs. Thus, the main view during profiling is the service list that the user must choose from. It resembles a classical e-commerce experience where the user puts the appropriate products in his shopping cart. Each service is additionally explained with a brief description. This view contains the entire service repository. No additional guidance or constraints are given to support the user. However, in the actual implementation, the scope is limited to the relevant service subset according to the previously stated need. All other services are collapsed by default.
Simplified service selection view: The simplified service selection view relies on a pre-selection of the solution space. After the user has stated his intention, only services that directly relate to the objective are shown. Unlike the broad service selection view, not just the correct category is highlighted. Instead, only services, that directly cater to that specific need, are shown. It effectively narrows down the choices for the users to a small subset. This view is combined with a second page that shows suitable supplementing services. That relation among core service and supplementing service is again explicitly modeled in the knowledge base (according to the Generic Product Model – see Section 3.4.4.1).

Figure 4-7: Profiling component – service selection view (screenshot)

Figure 4-8: Profiling component – simplified service selection view for a core-service (screenshot)
Matching-Logic

The matching component is only used for the customer-centric configuration scenarios. The most important (and difficult) aspect of matching is to determine the right parameters that must be matched. This process is covered in detail in Section 3.2 and 3.3. Furthermore, there are plentiful ways to perform a match (see Section 3.4.3). For the demonstrator, a pragmatic matching algorithm has been implemented that is based on statistical similarity measures. Similarity functions quantify the distance between two objects that are represented by vectors (i.e., the customer model and the service model) (Wolfram Research, n.d.). The applied similarity function calculates the distance for every need-dimension between the customer model and every related service model. The calculation is based on following formula (variable $i$ represents the dimension of the customer model, variable $j$ the service model):

$$\left(\sum_{k=1}^{p}(x_{ik} - x_{jk})^r\right)^{1/r}$$

Subsequently, an overall mean value of all relevant dimensions is computed. An important adjustment is made to this calculation: for some dimensions, a deviation in one specified direction is not calculated as a divergence. For example, if a user puts a moderate emphasis on low costs, there should be no malus if a service exceeds the expectations by being offered for free. The resulting matching score is presented as a percent value. No color-coding (e.g., green for good matches) or other visual enhancements have been applied.

An essential function of the matching component is the identification of relevant services that in a first step fit the stated intention (core service) and in a second step provide useful complementary services. These constraints have been modeled in the knowledge-base (service ontology) and were derived via XML-parsing operations.
Knowledge-Base & Service Repository

The whole knowledge-base for the prototype is represented by an OWL-ontology. It is a XML-based representation that can flexibly be extended for additional description and constraints. Protégé was chosen as the application to create and manage this ontology (see Section 0). This file-based approach is easy to setup and edit.

The knowledge base consists of two major entities: the need dimensions and the service repository. These two entities and their specification have been extensively covered in Section 3.2 (customer model) and Section 3.3 (service model). A third essential element of the knowledge base are the constraints and relationships among the entities, that have already been described in Section 3.4.5. Therefore, a more detailed description of the knowledge-base can be omitted.

Offer Component

The offer component presents the generated solution concept to the user. According to the generic solution model (see Section 3.4.4.1), a solution concept consists of a core service and optional supplementary and complementary services. This essential concept is implemented for both configuration paradigms (see Figure 4-10). The assignment of the core, supplemental and alternative service is based on relationship-modeling in the knowledge-base.

![Offer component](image)

*Figure 4-10: Offer component - generated solution concept (screenshot)*

A specific characteristic of the customer-centric configuration is the matching score. An overall score is revealed to the customer as additional information to describe how good the solution component fits his requirements. By clicking on the matching score, a full disclosure of the sub-scores is presented to the user (see Figure 4-11). Each need-dimension by the user is compared to the according dimension of the service model. It increases transparency and raises comprehension.
Feedback mechanisms are intentionally not implemented in the offer component to increase the likelihood of users taking part in the subsequent post-test evaluation (i.e., to prevent click-loss).

**Variants**

Measuring customer value demands an in-use evaluation, as pointed out in Section 4.1.1. This is ensured by a prototype-based design science approach for this experiment. The concept of customer value is subjective and of relative nature. This means, it can only be evaluated in contrast to other alternatives. In this regard, the counterpart to the customer-centric configuration is product-centric configuration. A second distinctive factor that determines the value of the configuration approach is the degree of complexity (see Section 4.2). Accordingly, four variants of the configurator can be derived (see Figure 4-12).

![Figure 4-11: Offer component – disclosure of the matching score (screenshot)](image)

**Figure 4-11: Test scenarios for the prototype (configuration variants)**
These variants are based on the modules described above that are combined to distinct scenarios regarding the configuration paradigm or regarding the level of complexity:

<table>
<thead>
<tr>
<th>Variant</th>
<th>Description</th>
<th>Utilized Views</th>
</tr>
</thead>
</table>
| 1. Customer-centric/ high complexity (CC/HC) | This variant includes all features that have been elaborated in Section 3. It comprises the full extent of self-profiling and even weights the user needs. It serves as a reference implementation of CSM. | - Intention view  
- Full-self-profiling view  
- Weighting view  
- Generated solution concept |
| 2. Product-centric/ high complexity (PC/HC) | This variant resembles a pre-structured service catalog from which the user selects items. Besides showing the correct banking domain and short service descriptions, no further assistance is given during the configuration. | - Intention view  
- Service selection view  
- Solution view |
| 3. Customer-centric/ low complexity (CC/LC) | This variant simplifies the customer-centric configuration approach by building an elicitation-fronted purely based on adjectives. Via drag-and-drop, the relevant properties were selected and weighted in one integrated step. It resembles natural language and needs no formal description. | - Intention view  
- Simplified self-profiling view  
- Generated solution concept |
| 4. Product-centric/ low complexity (PC/LC) | This variant is based on a service catalog, that is dynamically narrowed down to the services that match the given user intention. Also, a distinction between core-services and suitable supplementing-services is given during the configuration process. | - Intention view  
- Simplified service selection view for core-services  
- Simplified service selection view for supplementing-services  
- Solution view |

Table 4-3: Description of the configuration variants that are implemented for the empirical validation

### Page flow

The scenarios are embedded in an official website that motivates the participant to take place in this experiment and gives necessary background information. The page flow that each user passes through the experiment, is visualized in Figure 4-13.

**Welcome page:** The Welcome page informs the visitor about the goal of this experiment (without stating the hypotheses that could potentially cause biases) and communicates the further process. Also, a disclaimer regarding the accountable researcher and a privacy policy is stated.

**Pre-test:** During the pre-test, the questions regarding the independent variable “affinity” are asked (see Section 4.2.2): the factors domain expertise, technical affinity, and relevance for the user are assessed hereby.

**Selection/assignment:** In the online experiment, each participant is randomly assigned to two scenarios (see Table 4-3). It is not transparent to the participant which scenario he must pass.
**Post-test:** During the post-test, the questions of the research model are asked per scenario (see Section 4.2.2).

**Thank you page:** After finishing the experiment, each participant receives a thank you message. Additionally, each participant can enter his email address to receive the evaluation of the experiment later.

### 4.4 Experiment Design and Empirical Testing

#### 4.4.1 Research Procedure and Experiment Design

The empirical evaluation of this work belongs to the field of user research, which is “the systematic study of the goals, needs and capabilities of users so as to specify the design, construction, or improvement of tools to benefit how users work and live” (Schumacher, 2009, p. 6). A user is someone, who wants to accomplish a goal with some technological support, e.g., a website or software, and who can be a customer, employee or someone else (Sauro & Lewis, 2012, p. 9ff.). The roots of *user research* lie in human factors engineering and its methods are originated from the academic field of psychology (Dumas & Salzman, 2006). A particularity of user research is the focus on the quantification of user behavior. For this work, summative usability testing is conducted that aims on describing the usability of an implementation by using metrics. As opposed to formative testing, which is focused on diagnostic evaluation and elimination of usability problems (Sauro & Lewis, 2012, p. 105f.).

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48 As opposed to formative testing, which is focused on diagnostic evaluation and elimination of usability problems (Sauro & Lewis, 2012, p. 105f.).
The intended evaluation has confirmatory and exploratory purposes. On the one hand, it wants to (dis-)prove the stated research hypotheses. On the other hand, it wants to find out (qualitative) factors that explain the observations and give further insights. This twofold approach is translated into a two-stage experiment: 1) during focus group interviews, the experiment is carried out in a controlled environment with intensive interaction between the participant and the experimenter. Besides qualitative insights, this phase also allows to adjust the setup for 2) the field experiment, which delivers quantitative findings (see Table 4.4).

<table>
<thead>
<tr>
<th>1. Focus group interviews</th>
<th>2. Field experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research type</td>
<td>Qualitative</td>
</tr>
<tr>
<td>Purpose</td>
<td>Exploratory</td>
</tr>
<tr>
<td>Target population</td>
<td>Affine and available persons for the research topic</td>
</tr>
<tr>
<td>Target sample</td>
<td>10 participants with heterogeneous expertise and background</td>
</tr>
<tr>
<td>Scenario assignment</td>
<td>Within-subject (one participant passes all scenarios)</td>
</tr>
<tr>
<td>Dominating evaluation method</td>
<td>Formative (the goal is finding and fixing problems within the configuration process)</td>
</tr>
<tr>
<td>Analysis</td>
<td>Qualitative reasoning</td>
</tr>
<tr>
<td></td>
<td>Statistical methods</td>
</tr>
</tbody>
</table>

Both stages were carried out successively. The insights from the focus group interviews helped to improve the subsequently conducted field experiment.

### 4.4.2 Focus Group Interviews

Focus group interviews are planned and guided discussions among a small population\(^{49}\) to obtain opinions and perceptions on a defined area of interest. Thus, focus group interviews deliver primarily qualitative feedback as a preparation for further larger scale experiments. Strengths of focus group interviews are (cf. Krueger & Casey, 2009; Patton, 1990; University of Texas, 2011):

- Discovery of interesting or unexpected ideas and views that may not have been known in advance
- Gaining in-depth information about aspects of interest
- Participants are focused on a specific topic and work in a controlled environment
- Identifying and proofing factors before launching a broad experiment

\(^{49}\) A population of typically eight to twelve persons (University of Texas, 2011).
- Observation of participants in direct interaction with the technology, also non-verbal interaction (prototype as stimulation)

These benefits do not come without a price. Focus groups demand a high level of resources and time. Moreover, the test environment may differ from real-world user settings.

**Group Composition**

There is ambiguity as, whether “focus groups” describe several interviews with single persons, or a single interview with a group of individuals. This work follows the former notion. The members of the groups are interviewed individually. Separate assessments take less time from an individual than group sessions and prevent group caused biases (shyness, opinion leaders, etc.). Even though this contradicts the “group” aspect, it is a very common practice in focus group research (University of Kansas, 2013).

A critical factor for the success of focus group interviews is the group composition. For this experiment, group members were chosen that represent the potential target group of a service configurator. They all share an affinity for this topic for different personal reasons. The technical and domain expertise of the participants is very diverse and covers the whole spectrum. As a result, the focus group consists of people who are willing to share time and thoughts on this topic but are very heterogeneous regarding their technological and financial expertise and their demographic background.

**Assignment of Participants**

The assignment of the individuals to the different scenarios took place via a within-subject design during the focus group phase. This means every participant passes through each scenario. This allows a qualitative evaluation of the prototype and the questionnaire as a preparation for the field experiment. A subjective ranking of the scenarios among each other could be carried out too by this approach.

**Experiment Design**

The interviews are performed based on a script that sticks to the elements of the research model (see Appendix 6). During the in-use experiments, free conversation is encouraged to stimulate the participants to share insights. This “Think Aloud” approach is recorded by microphone, while the screen on the computer is also captured. So, each observation can be afterward attributed to a certain view or action. During that process, questions to the researcher were allowed to increase conversation and encourage the expression of thoughts.

**4.4.3 Field Experiment**

The online experiment addresses the limitations of the focus group interviews, which are:

- The focus group is too small for generalizable findings outside of the group
- Causal effects cannot be determined
- Statistical projection is needed
- Confidentiality is compromised
Based on the qualitative insights from the focus group interviews, the field experiment has been refined. The purpose of the field experiment is to gather quantitative data for statistical analysis.

**Population and Sample Design**

The sample design requires special attention to ensure generalizability of the findings to the whole population. The listing of the accessible population is the *sampling frame* and contains all possible theoretical participants. The *actual sample* is much smaller: it is the accessible population minus non-respondents and dropouts.

CSM is an approach that meets changed requirements of customers as described in Section 1.1. The new generation of customers is often referred to as “digital natives” or “Generation Y”. These segments share common characteristics such as a high affinity towards electronic interaction. Exact definitions for these segments are missing, except the fact that they are born after the year 1980 (Thomas, 2011). Although widely applied, this segmentation is not without controversy. Skinner (2014) argues that regarding digital customers and digital banking, segmentation solely according to demographic factors is wrong – instead, psychographic factors should be considered. In a prior study among digital natives by Sachse, Alt & Puschmann (Sachse et al., 2012a), it was shown that age is not a sufficient discriminator for examining changing customer requirements. Studies do also suggest that older customers may be better targeted for innovative self-services than younger ones (Rubin, 2014). Given this fact, it seems reasonable to consider all users with a high affinity towards electronic interaction as potential users of CSM, regardless of demographic factors like age or sex. So, all online users may be potential clients. For Germany, 76.5% of the country’s population has been online in the year 2013 during the time of the experiment. These translate into over 60 Mio people in absolute numbers (Statista, 2017).

Since the experiment is conducted in an online experiment, no extensive list of the entire population is available. That is why so-called probability sampling methods$^{50}$ cannot be applied. As a remaining alternative, nonprobability sampling methods are suitable. Despite having some disadvantages over probability sampling$^{51}$, nonprobability methods like haphazard or convenience sampling are the most popular methods in social sciences and user research. These approaches take practical constraints like economic limitations and limited access to participants into account (cf. Alreck & Settle, 2003, p. 55f.). With a high number of participants, the quality of these approaches rises and becomes increasingly equal to probability sampling. For the conceived online experiment, the sample could not be selected from the population – since it is not known and not extensive. Instead, anonymous respondents independently joined the experiment. This represents a random selection process. In statistics, this process is called “simple random sampling”. It is the selection process with the highest quality regarding external validity since it is hardly biased (Starnes, Yates, & Moore, 2010, p. 211ff.). On the other hand, simple random sampling has a low statistically efficiency, thus requires a larger sample size. For an online experiment like this, the sample size is a minor issue and so Simple Random Sampling as a nonprobabilistic sampling method is chosen due to its superior statistical qualities and no

$^{50}$ For probability sampling methods, the chance of each individual to be chosen can be estimated in advance. The probability depends primarily on the absolute number of individuals in the population and the number of individuals taking place in the experiment.

$^{51}$ They have higher risk to be biased (e.g., self-selection bias) and are less suited for scientific generalization, since their representativeness cannot be measured. (Wint, Boxil, & Chambers, 2013, p. 36).
compromises. To further improve the quality of the sample, technical measures were applied to prevent users from taking part more than once\(^5\) (Trochim, 2014).

The actual experiment is based on a freely accessible and online-promoted web-prototype. So, all German-speaking Internet users represent the theoretical population. However, the accessible population for this experiment is only a fraction of this number. The experiment was announced and promoted through several channels to ensure a broad and heterogeneous sample. These channels include academic- and professional networks and external media such as finance blogs and word-to-mouth promotion.

**Sample Size Estimation**

For statistical data analysis, the size of the sample is important. An estimation of the sample size with paired means method\(^6\) results in a minimum number of \(n=64\) participants. That means, with a confidence level of 95\%, a difference as small as one point on the rating scale might be detected by a sample size of 64 participants. This is the minimum sample size to show significant differences between customer-centric and product-centric approaches (respectively between low-complexity and high-complexity approaches).\(^7\)

**Experiment Design**

There are two primary factors under consideration in the evaluation - the configuration paradigm and the configuration complexity (explanatory factors). In every experiment, there is a risk that external nuisance factors influence the results on the explanatory factor. To minimize the noise of the nuisance factors, a randomized design is chosen. Since the combination of both factors requires (at least) four test scenarios, a randomized block design is applied for this experiment. It is superior to completely randomized design approaches in the given setting. It assumes that variability within each block (=scenario) is lower than the variability of the entire sample. Thus, estimations of effects within a block are more efficient than across the whole sample and as a result, overall estimation is better too. Unfortunately, a randomized block design is prone to interdependencies between blocks (e.g., learning effects/carryover effects). To minimize this effect the order of scenarios per user can be randomly assigned and participants must not pass through every scenario (Adèr & Mellenbergh, 2008, p. 108ff.).

**Limitation/Biases**

The intention of this highly formalized sample design process is to maximize the generalizability of the findings. Whenever possible, systematic bias within the sample group was minimized. E.g., by alternating the first encountered scenarios that the participants were assigned to. This minimizes carryover effects (Sauro & Lewis, 2012, p. 63). However, user research is often far away from ideal theoretical conditions. There is a non-random bias because participants can decide on their own if they participate in this experiment or not. Ideal probability sampling, in contrast, would require to “force” participants into this experiment which is not practicable. Although some biases could occur from the sample design, the effects should be minimal and should not affect the findings that prove the general value of the CSM concept.

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\(^{52}\) This is technically ensured by using „Session IDs” provided by the web browser.

\(^{53}\) This method is chosen because a comparison between groups takes place, where not in every group are different individuals and no binary data is analyzed (cf. Sauro & Lewis, 2012, p. 4).

\(^{54}\) See Appendix 7 for full calculation and interpretation of the estimation.
Assignment of Participants

The field experiment is conducted in a modified between-subject design. The assignment of participants is a random selection process. The process is not managed and driven by the participants and the sample cannot be defined in advance. This effect relates to external validity. Instead of passing only one scenario, each participant passes two randomly assigned scenarios. Although this raises the risk of biases because of learning effects and shifting expectations, it doubles the theoretical number of participants, thus improving the reliability of the results. Furthermore, the mentioned bias effects can be quantified and evaluated later on. For statistical analysis, the field experiment is handled like a pure between-subject design ("A/B Test").

4.5 Data Analysis and Results

4.5.1 Qualitative Results

The data and the feedback that was collected during the focus group interviews are presented below. The data analysis is structured according to the interview template.25

Qualitative Results Regarding Perceived Complexity

![Complexity Index](image)

Figure 4-15: Qualitative evaluation of perceived complexity26

The factor complexity is a central determinant and in focus of this experiment. Therefore, attention is given to the perceived complexity by the participants and how this value differs between the four scenarios. Figure 4-15 shows the distribution of the focus group participants within five levels of perceived complexity (=quintiles). Each scenario shows a distinct allocation of the testers.

For both configuration paradigms, the low-complexity variants are perceived as expected: they have a lower complexity score than their high-complexity counterparts. Additionally, the customer-centric variants have in average a lower perceived complexity index than the product-centric variants. The high-complexity customer-centric variant 1. (CC/HC) is

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25 The structure of the focus group questionnaire, in turn, closely follows the hypotheses model and the SEM. The number of the focus group participants is n=10.

26 Since the questionnaire uses different metrics to measure the construct of perceived complexity (Likert-scale and percentage), a normalized index value is calculated. It divides all participants into quintiles (five segments). The left side in the graph represents low scores (i.e. low perceived complexity), the right side represents high scores (i.e. high perceived complexity).
seen almost equally as the low complexity product-centric variant 4. (PC/LC) regarding perceived complexity. The feedback from the participants of the focus group interviews helps to interpret these observations:

**Scenario 1. CC/HC**: The participants, in general, welcomed the simplicity of this scenario. It was attributed as easy and convenient. Nevertheless, it turned out that, particularly analytical-minded persons questioned the wording of some terms and were confused. For example, it was not clear to them what “transparency” means during the configuration process. For other users, however, there was no ambiguity in the same wording. Even after being asked about it, they felt confident in understanding the dimension right. It turned out that the labels on the slider elements may be more important for the user than the name of the dimension itself or its brief additional explanation.

**Scenario 2. PC/HC**: As expected, this scenario was the least accepted of all, regarding perceived complexity. Almost all participants had difficulties in using this specific configuration variant – some even skipped it entirely. The number of choices was overwhelming and confusing to the users, although some showed interested in exploring new services within their actual scope. Nevertheless, this configuration approach is considered as not practical at all, due to the high complexity. A participant summarized: “Anyone who understands this, does not need such a tool at all.”

**Scenario 3. CC/LC**: This scenario was received exceptionally well regarding complexity. Some participants stated that they cannot image to make the configuration process any simpler. It is very intuitive, and the participants finished the configuration session within a short time. However, the ambiguity of wording still poses a problem to some testers.

**Scenario 4. PC/LC**: This variant finds its place between the other scenarios. It is considerably easier for the participants than PC/HC and the presented choices where within the mental abilities of the most user. The guided multi-step configuration process helped to break down the decision-making process into digestible chunks. It turned out, that a pro for the product-centric approach is the familiarity of most users with checkbox-based GUIs. Unlike the customer-centric approaches, the user must only make binary choices. That makes the interface less ambiguous. In contrast, some users showed tendencies to feel confident to set a checkmark but actually may not fully comprehend the alternatives and consequences of their choice.

**Qualitative Results Regarding Perceived Mass Customization Utility**

![Figure 4-16: Qualitative evaluation of perceived mass customization utility (experience)](image)

The perceived Mass Customization Utility describes the user experience during the configuration process. Figure 4-16 shows a higher experience score for both customer-centric
scenarios. Interestingly, both variants of customer-centric configuration do not differ considerably in this aspect. The product-centric scenarios show higher variance regarding their perceived experience. The statements of the participants might help to explain these results:

**Scenario 1. CC/HC:** This scenario provided the best user experience and was attributed as a “convenient decision support”. It shows improvements over the product-centric approaches in every aspect. There were large differences regarding the effort that users put into the configuration process. Some participants entered their first intuitive feeling in the front end, others adjusted the slider several times (only by some pixels sometimes). The interface proved to be well balanced and equally suitable for quick results and conscientious configuration. Some testers did not even notice the "more"-button to have a look on the extended subdimensions. Most participants agreed that this scenario provides the right amount of required information for the given purpose.

**Scenario 2. PC/HC:** As the overwhelming complexity indicates, the experience of this approach is the worst of all variants. Some users did not know what to do, and some of them quit during the configuration process. Users that tried to finish the configuration were always in doubt if their selections made sense.

**Scenario 3. CC/LC:** This variant is the most progressive one amongst all. However, the user experience does not notably differ from the other customer-centric approach. The most important observation during the experiments was the skepticism of some participants. They implicated, that such a “simple” interface could not work well enough or it provides inferior results. It was perceived by them more like a gimmick than a serious tool. For others, its simplicity and intuitivity shows an evolutionary progress over the high-complexity customer-centric approach (CC/HC). The interaction resembles a natural conversation. This variant should be consciously used for the right target group and the right setting.

**Scenario 4. PC/LC:** The product-centric configuration shows many advantages over its high complexity pendant. The pre-selection of services makes a notable difference within the guided process (core-service, supplementing services, service bundle). Although customer-centric configuration has shown superior regarding user experience, there is still potential left to improve product-centric configuration based on this variant. The participants have mentioned surprisingly little negative aspects. From a user experience point of view, it seems that this approach represents the status quo – users are used to this form of interaction and have hardly noteworthy comments.

**Qualitative Results Regarding Perceived Solution Utility**

![Utility Index Chart](image)

**Figure 4-17:** Qualitative evaluation of perceived solution utility
The purpose of the whole configuration process is to create a solution that has the highest possible customer value. Thus, the solution utility is the most important factor from a rational viewpoint. The quality of the composed service bundle is considered higher for customer-centric variants compared to the product-centric approaches. Within the participants, the variance for both product-centric approaches is higher too.

**Scenario 1. CC/HC:** The generated solution by this scenario is seen as the best among all alternatives. An objective evaluation of the value of the solution concept is hardly possible. However, if the precedent process seems compelling, participants have the feeling that the solution must be of high quality too. On the other hand, analytical participants who question the abstract wording in the previous steps, are also skeptical regarding the generated service bundle. Almost entirely, participants appreciated the features matching score and detailed matching score, because it creates understanding and transparency regarding the solution.

**Scenario 2. PC/HC:** A frequent complaint of the participants regarding product-centric configuration is, that they would not use a tool like that if they would have the required expertise. This is particularly the case for the high-complexity approach. If users are very confident in their domain knowledge, they assess their solution better. However, this mindset is risky: if the one who builds the solution is the same one that evaluates it, it will be optimistically overestimated due to psychological biases. For the other group with little or none domain knowledge, this configuration scenario is with little utility.

**Scenario 3. CC/LC:** Many participants were positively surprised, that the generated solution concepts by this approach were close or equal to the CC/HC variant. They thought the elicitation is too simple to be good. In the end, the perceived quality is lower than the high-complexity scenario (CC/HC) since the previous process influences their assessment. The observations from scenario 1 apply to this variant too.

**Scenario 4. PC/LC:** What has been said about scenario 2 applies to this approach too. Since the process experience is better than for high-complexity (PC/HC), the solution might be favored too. A categorical problem of product-centric configuration is the missing “wow-effect” in the last step. No composition logic or matching scores provide an additional benefit to the user, such as the customer-centric approaches do.

**Preference Ranking of the Configuration Variants**

After the participants had passed all four configuration variants, they were asked to rank the scenarios in order of their personal preference. Table 4-5 shows the result of that ranking.

<table>
<thead>
<tr>
<th>Rank (based on median)</th>
<th>Name of scenario</th>
<th>Average rank (arithmetic mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CC/HC</td>
<td>1,6</td>
</tr>
<tr>
<td>2</td>
<td>CC/LC</td>
<td>1,9</td>
</tr>
<tr>
<td>3</td>
<td>PC/LC</td>
<td>3,2</td>
</tr>
<tr>
<td>4</td>
<td>PC/HC</td>
<td>4,0</td>
</tr>
</tbody>
</table>

*Table 4-5: Preference ranking of configuration variants*

Every participant preferred the customer-centric approaches over the product-centric ones. Interestingly, more interviewees did favor the high-complexity scenario (CC/HC).
However, for the product-centric variants, the low-complexity approach is preferred over the high-complexity configuration.

**Limitations/Biases**

Besides the stated findings, many observations of the focus group interviews have been additionally gathered which in turn were incorporated in the prototype before the field experiment took place. The goal of this stage of the empirical validation is to observe effects and find explanations. Up to this point, the findings may not be generalizable or significant. This is subject to the quantitative analysis.

### 4.5.2 Quantitative Analysis

Before the results of the quantitative evaluation are presented, the applied statistical methods and tests are explained. Preconditions and assumptions are described for reasons of better reconstruction.

**Structural Equation Model (SEM) Analysis**

As pointed out before, the applied research model (Mass Customization Utility Model) belongs to the class of structural equation models. This term does not designate a particular statistical technique but rather refers to a family of associated procedures. In literature, terms, such as covariance structure analysis or causal modeling, are used for it too (Kline, 2011, p. 7ff.).

The primary use of SEM is for confirmatory purposes57, i.e., is the proposed model (and its underlying hypotheses) supported by the empiric data? SEM relies heavily on the researcher’s domain knowledge that makes up the research model. It adapts to their view on the domain and formalizes their beliefs (Kline, 2011, p. 13f.). In this regard, an essential activity for SEM is the a priori process of model building which is exhaustively covered in Section 4.2.

**Analysis of Variance (ANOVA)**

The statistical data analysis is conducted with the free and open-source software “R”58 and the optional package “lavaan”59 for latent variable modeling respectively SEM-analysis. The tool is instantiated with the elements of the measurement model (Table 4-2).

The statistical analysis method is an analysis of variance (ANOVA). The ANOVA test is chosen because of the following criteria:60

- The experiment gathers only continuous data (rating scales)
- Data will be compared amongst the test scenarios
- There are more than three groups (four scenarios)
- Although each user passes two scenarios within the presented experiment design, from a statistical perspective, every session is considered as different and independent. As shown later, learning effects can be neglected.

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57 Other applications are alternative model testing and model building (Kline, 2011, p. 8).
58 http://www.r-project.org/
59 http://lavaan.ugent.be/
60 Based on the decision map for analysis of continuous data by Sauro & Lewis (2012, p. 3).
The application of ANOVA is based on the following assumptions:

- **Representativeness**: The group samples are representative of their parent population.
- **Independence**: The group samples are unrelated to each other.
- **Normality**: The group samples are approximately normally distributed.
- **Homogeneity**: The variances of both groups are approximately equal.

ANOVA can be applied to compare two groups directly. If more than two samples should be compared (e.g., complexity, solution utility and configuration utility), multiple passes of ANOVA are required. Literature refers to this case as MANOVA (Multiple Analysis of Variance).

### 4.5.3 Quantitative Results

The experiment was active from May 15th until August 19th 2014. The prototype was invoked 343 times during this period. 43.4 percent (149 participants) have contributed valid results. A result is considered valid if a participant passed at a minimum the first scenario and provided answers to the subsequent post-task questionnaire. Also, test-sessions and click-throughs have been filtered out of the raw data. 72 percent of the participants conducted both scenarios.

Due to the experiment design, each valid participant delivers two datasets (= two passed scenarios). Each dataset can be considered discrete, regardless if it represents the first or the second pass of the participant. Learning effects are negligible, as an ANOVA-test proves (see Appendix B): for example, a p-value of 0.9184 for the scenario “CC/LC” shows a very high similarity between first-pass and second-pass assessments. So, participants evaluate them almost the same, regardless if they have seen another configuration approach before or not. So, a total number of 216 datasets (=n) represents the foundation for further statistical analysis. This is about four times the estimated minimum sample size for statistical relevant results (see Appendix 7).

**Results of MANOVA**

MANOVA-analysis is conducted separately for the factors “paradigm” and “complexity”. Regarding the factor “paradigm”, MANOVA answers the question “does customer-centric configuration differ significantly from the product-centric configuration on perceived complexity, perceived solution utility and perceived MC-utility?”

A computation with statistics software “R” provides the following output:

```
        DF Pillai approx F num Df den Df  Pr(>F)
as.factor(paradigm)   1.054692   3.7414      3    194 0.01206 *
Residuals           196
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

*Source 1: Results from MANOVA regarding the factor "configuration paradigm"

---

61 The prototype is not usable on some touch-based devices.
62 After that event, the logging-system generated a Dataset-ID that.
Since the p-value of 0.01206 is lower than the 0.05 significance level, the null hypothesis $H_0$, that means that perceived customer value between both configuration paradigms is equal, can be rejected. It proves that there is a difference in user perception between customer-centric and product-centric configuration. These differences can be broken down further with an ANOVA analysis.

```
Response ovrl_complexity :
  Df | Sum Sq | Mean Sq | F value  | Pr(>F)  |
  as.factor(paradigm) | 1   | 163.1   | 8.2274   | 0.004578 **
  Residuals           | 196 | 3886.4  | 19.828   |
---
Signif. codes: 0 '****' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Response usol5 :
  Df | Sum Sq | Mean Sq | F value  | Pr(>F)  |
  as.factor(paradigm) | 1   | 2727    | 2.3905   | 0.1237  |
  Residuals           | 196 | 223630  | 1141.0   |

Response umc6 :
  Df | Sum Sq | Mean Sq | F value  | Pr(>F)  |
  as.factor(paradigm) | 1   | 5496    | 4.8805   | 0.02832 *
  Residuals           | 196 | 220708  | 1126.1   |
---
Signif. codes: 0 '****' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Source 2: Results from ANOVA regarding the factor "configuration paradigm"

There is a highly significant correlation between the configuration paradigm and the complexity as perceived by the participant. This means, shifting the configuration paradigm towards customer-centric configuration, makes the use of the configuration tool significantly easier for the user from a statistical perspective.

There is no statistically significant relationship between the configuration paradigm and the solution utility. However, with a p-value as low as 0.1237 a tendency towards a correlation can be interpreted. This means although the customer-centric configuration is easier for the user, it does not provide inferior results. Quite the contrary, the (insignificant) tendency towards correlation, indicates that generated solution concepts are perceived as higher quality than manually composed service bundles have.

There is a statistical significance regarding the paradigm and the utility of the MC process. In other words, customer-centric configuration delivers a far better user experience than product-centric configuration.

The second MANOVA-analysis covers the factor "complexity". It is supposed, that the complexity of the configuration is a key element determining the user acceptance. A lower complexity reduces the barriers for using the configuration tool, whereas a higher complexity might provide better configuration results. The null hypothesis $H_0$ assumes that different levels of complexity do not have an impact on any value dimension as perceived by the user.
The p-value of 0.515 might seem surprising at first, since the alternative hypothesis $H_1$ is rejected. This means there is no significant relation between complexity of the configuration process and the perceived value. Again, an ANOVA-analysis provides further insights:

The p-value which indicates a tendency towards correlation, it does not meet the criteria for statistical significance. This result is not intuitive and requires further explanation:

The experiment design assumes that the effort the user must put into the configuration process determines the complexity. Correspondingly, the low- and high-complexity versions of the prototype differ regarding their number of input fields. Low and high complexity is defined by relative means, i.e., by comparing the two versions against each other. No objective measure of complexity is applied.

Now, what the data shows, is that this simplified assumption is inadmissible: from a user’s perspective complexity is not (only) determined by the number of questions but rather by the type of the questions. The quality of the questions may be more important than the quantity. This is an interesting finding since it shows that in the given setting asking questions about the consumer should be preferred over asking questions about the product.

The association between complexity and solution utility is not significant too. Asking more questions does not necessarily produce better results. In conjunction with the finding above, this shows that asking the right question is more important than asking many questions.

Lastly, there is no significant relationship between complexity and MC utility. Making a configuration process simpler, does not result in higher acceptance or vice versa. Complexity is an essential part of the configuration process that gives consumers the feeling of receiving more individual and more accurate results. The statistical data can be interpreted
in a way, that there is a “sweet-spot” of complexity for specific use cases. Higher or lower complexity from that (yet undefined) reference point will reduce the perceived quality of the generated solution.

**Limitations/Biases**

Most systemic limitations of this experiment and sources of bias have been revealed and discussed during its conceptualization in Section 4.2, Section 4.3, and Section 4.4. The probably most important factors that influence the generalizability of the findings are the specific setting and domain of the experiment and the regional and temporal scope. The evaluation of CSM based on a single use case within a single industry is a current deficit that should be overcome by other researchers in future.
5 Results, Evaluation and Outlook

5.1 Summary and Results

Content of this Work
This work is motivated by current technological, economic and social trends. Especially the empowerment of the consumer and the digitalization of the service economy are believed to lead to a fundamental paradigm-shift towards customer-centric economies. However, putting the customer in the “driving seat”, causes new challenges, such as the need to support inexperienced service users in composing service network on their own.

The various facets of customer-centricity in the service domain have been elaborated in this work and the term Customer-centric Service Management (CSM), as a means of self-directed service composition by less-expertized customers, has been introduced. CSM touches many fields of research (interdisciplinary service science research) and requires a multi-perspectival view (customer perspective, business perspective, IT perspective).

The main hypothesis of CSM states, that customer-centric service individualization can be improved (respectively enabled in complex-service domains) by shifting the configuration perspective from product-centricity to customer-centricity: by letting the customer describe “himself” (i.e., his intentions and his needs), instead of specifying product properties, the existing problems of consumer-driven service composition can be solved. These problems regard insufficient solution utility, poor user experience, and overwhelming complexity. At the same time, these factors represent the main obstacles that prevent any mass-customization technology from market adoption and in return define the perceived customer value of any mass customization approach. These are the main challenges of CSM to be solved.

To achieve this goal, models and methods in three areas have been elaborated: first, the relevant dimensions that consumers use to describe their needs and intentions in a service domain are determined and structured (customer model). Second, the solution space is structured in a way that meets the requirements of consumers and business alike (service model). Additionally, the description and quantification of services from a customer perspective is provided as a method to instantiate the service model. Third, a matchmaking process between the demand- and supply-side is formalized that creates a service solution, maximizes customer value and meets the requirements of the service provider. All this takes place based on the knowledge about customer’s information processing and decision-making strategies. Business requirements and constraints must be considered at any time too. Finally, the findings are translated into technical specifications that describe the implementation of CSM in a configuration toolkit. Taking these aspects into account, this work delivers a contribution by integrating formerly distinct fields of research to solve current practical challenges.

Based upon established theories, the integrated concept of CSM is derived. An essential contribution of this work is the empirical validation of CSM by testing its anticipated benefits in user experiments. This is done by a qualitative and quantitative validation based on a direct comparison between product-centric composition and customer-centric
composition. For this purpose, a prototype within the domain of financial services is implemented that was conceptualized using the developed methods and models.

**Key Findings**

The work is structured according to four research questions (see Section 1.2.3). These research questions cover each stage of Design Science research (see Section 1.3.1) and refer to the main chapters of this work. To summarize this work, a conclusive answer to each research question is given:

**RQ 1 (Analysis): Which deficits do existing self-service individualization approaches have?**

Individualization of services differs significantly from the individualization of physical goods. Goods are personalized via the variation of product parameters – services via composition of distinct elements into integrated bundles. Goods can be objectively described, whereas services are subjectively perceived during the value creation process. Current configuration toolkits do not take these specifics into account or require highly skilled users. In a consumer scenario, there is usually no such expertise. This makes existing SM-concepts and toolkits unfeasible in such a setting.

In the context of mass customization for services, literature identifies three deficits, which refer to SSTs, respectively configuration toolkits. They justify this work:

- **User Experience**: The acceptance and understanding of the configuration toolkit is more important for consumers than it is for professional users. The configurator is often the initial touchpoint for (potential) customers and essential for many business models. If the process does not meet current standards, customers probably will not use it all. Existing toolkits do not meet the expectation of consumers regarding simplicity and convenience yet.

- **Solution Utility**: The outcome of the configuration tool must provide value to the customer, concerning correctness and usefulness. Even for less expertized users, the result must deliver a level of quality that meets the quality of other forms of intermediation (e.g., personal advisers).

- **Perceived Complexity**: All of the named deficits above, can be attributed to the overwhelming complexity that faces the user while individualizing services in a domain, that consists of a large number and high diversity of services. Finally, the transformation of complexity is a key function that a service individualization technology for consumers must provide.

**RQ 2 (Design): How can customer-centric individualization of complex services be enabled?**

The naive idea, that one could simply transfer existing approaches of user profiling and elicitation, such as forms, that are used by personal intermediaries, into an online setting, is about to fail. An empirical evaluation based on consultation minutes from the financial services industry showed, that customers are not able to answer these questions on their own correctly and reliably.

The whole individualization process needs a paradigm change. Current configuration approaches in self-service settings typically specify the product. A better approach would be to let the customer specify himself (i.e., his intentions and needs) in his own language
instead. This is what intermediaries and advisors have done in personal consultation sessions for a long time. They translate the needs of the customer into product specification and match it against the available offering on the market. This customer-centric approach has not been done in SSTs so far. Since this process relates to the service lifecycle, it is based on a service management process that is referred to as Customer-centric Service Management. It consists of three key elements: the customer model (Section 3.2), the service model (Section 3.3) and the service composition logic (Section 3.4). These artifacts are deducted in an approach that integrates the current body of knowledge from various academic fields.

RQ 3 (Evaluation): Does customer-centric service composition provide a significant value to the customer?

The value of CSM is evaluated in a prototype-based experiment that consists of qualitative focus-group interviews in conjunction with a quantitative field experiment. Besides being a proof of concept, the experiment delivers data that validates the following hypotheses, which refer to the main challenges of customer-induced service individualization. Hereby, the customer-centric configuration is compared to its product-centric counterpart and the perceived value is measured by the user. Regarding the hypotheses, the findings are:

- Customer-centric service composition provides a significantly better customer experience.
- Customer-centric service composition lowers the perceived complexity by the customer significantly.
- Customer-centric service composition provides equal or better results than product-centric composition does.

Based on these results, the overall hypothesis can be confirmed: customer-centric service composition provides higher customer value than product-centric composition does.

RQ 4 (Diffusion): Which practical and theoretical implications do occur from customer-centric composition?

It turns out that the expected benefits of CSM are proven empirically. In most aspects, there is a (statistically) significant improvement: service composition based on customer’s self-description provides a better user experience, lowers perceived complexity and delivers equal or better results. Thus, CSM is a superior approach to traditional product-centric configuration within the domain of complex services in regards of customer value. This not only proves the benefits of CSM but also verifies the correctness of the underlying methods so that that practice can adopt them.

This leads to the final question, which influence does this concept have on practice? The remaining part of this work points out potential implications of CSM and takes first-hand startup experiences into account.
5.2 Customer-centric Service Management as a Business-Model – Practical Startup Experiences

After finalizing research activities on CSM within the CC Sourcing in Q1/2014, the process of writing this thesis was suspended for the exceptional opportunity to found a startup based on the findings of this work. Encouraged by the empiric results from the validation phase, the idea of a neutral and scientific-based platform for recommending financial services to “average” customers was born. In a project named “Finanzomat”\textsuperscript{63}, public-seed funding has been acquired and subsequent activities have been supported by a university-based founders’ network. During a phase of 18 months, a team of up to seven people at peak worked on this project. A six-digit sum (EUR) was invested during that time. During this period, considerable practical knowledge has been accumulated by deploying CSM “in the field”. This led to valuable insights which are beyond the scope of purely academic research and contribute to this topic from a business model perspective.

The shared insights are from a business founder’s perspective. The founding project is further on consistently referred to as the “startup”. This section serves the purpose to reflect the potentials of CSM-based business models with a focus on possible revenue streams. All the shared insights fulfill the criteria to be of general interest. However, generalizability might be limited since the findings were not elaborated based on scientific standards.

Business Plan and Revenue Models

Founding a startup is basically the process of developing and deploying a sustainable business model. Every activity contributes directly or indirectly to this main goal. As it turned out, the fundamental task of developing a business model proved to be the biggest challenge of funding a CSM-based company.

The idea of the startup is originated in the research presented above and on the insights gained during the prototype-based validation. To persuade investors and other stakeholders to support the idea of a matching platform for financial services, this technology was translated into a captivating use case. For this purpose, the founders relied on a persona-based description (Figure 5-1). It is highly comprehensible since it describes a situation from a consumer’s perspective. Thus, regardless of the personal background, any stakeholder understands the problem and the proposed solution. However, the translation of that use case into a business model requires many aspects that must be taken into consideration (cf. Osterwalder & Pigneur, 2010). A subsequent evaluation by the founder’s team identified three major types of business models that could be applied to the startup:\textsuperscript{64}

Business-to-customer (B2C) Business Models

B2C business models in the context of CSM are based on the idea that the user causes and pays the revenues. This inevitably requires the startup to become a platform provider. Platforms strive to scale their business via the size of their user base. This makes it an attractive model for growth-oriented investors such as venture capitalists (VCs). On the other hand, it requires significant investments up front to reach a critical mass of users.

\textsuperscript{63} Finanzomat is a pun on the well-established German recommendation-platform “Wahl-o-mat”, that gives voting advices on political elections.

\textsuperscript{64} The evaluation is based on the St. Gallen Business Model Navigator, which comprises fifty generic business models (Gassmann & Frankenberger, 2013).
A B2C model allows an uncompromised approach that puts the customer benefits at the center. However, the readiness of users to pay for such an intermediating service is highly questionable. There are three possible revenue streams to apply a B2C business model:

**Usage fees:** Revenues for the platform are generated through usage fees, e.g., the user pays for each generated solution concept. During the startup-stage, also non-monetary compensation is a viable option to leverage growth (e.g., pay with a tweet).

**Freemium model:** The core service is free, but additional features must be paid for by the user. This works especially for downstream features, such as the task of selecting a particular service provider. The most likely source of income hereby would be paid content, e.g., provider rankings or product reviews.

**Advertisements:** Ad-based revenues often finance consumer-platforms that seek for reach and traffic. This source of income scales exceptionally well and needs little resources up-front. On the other hand, returns per customer are subtle, so a relatively high quantity of traffic must be reached.

**Platform-based (B2B2C) Business Models**

Closely related to advertisement-based revenue models is affiliate marketing. Instead of showing generic banners for a promoted product or company, sales that directly result from the platforms pre-purchase information will be compensated by partner companies (leads). This allows higher returns per user, in comparison to banner advertisement, but requires the set-up and management of a partner network. In this case, the startup operates a mult-sided marketplace. This means, there are two types of customers - users and providers. Reaching a critical mass of users is crucial in this case to attract providers. There is also the inherent risk that matching results will be questioned by users regarding the objectivity and neutrality since the platform provider has a conflict of interest (lead maximization).

Another revenue model that requires both stakeholders, users and companies, is that of a **data broker**. Users state their intentions and preferences in an unbiased way during the elicitation process on the platform. This generates a high volume of up-to-date, unbiased and comprehensive data that could be sold as a periodic report and could be used by companies for purposes such as product development, marketing optimization, or VC-investment decisions.

**Business-to-business (B2B) Business Models**

Instead of hosting and operating the CSM toolkit itself and being an intermediary/platform provider, the toolkit could also be licensed to third-parties. In this case, the startup would be a software provider that has two potential sources of revenue:

**White-labeling:** Instead of monetarizing the CSM–services itself, the income stream originates from third parties that license the technology. The startup must deal with only a small number of clients. The danger of imitating the software and the underlying knowledge is inherent to this business model. Also, the licensee must offer a product portfolio (=solution space) that is large and diverse enough to take advantage of pre-purchase advise. This narrows down the market of potential applicants.
EXEMPLARY USE CASE

Persona:
Nina Müller
Age: 25
Job: Development-assistant
Hobbies: Friends, Geocaching, Traveling

Nina Müller has completed her engineering studies and has been working for an international industrial company for one year. With the expiration of her employment contract and the first salary increase, she has now a fixed amount per month left over. She would like to save that up “for the future.”

She avoided financial topics so far. Her knowledge is therefore limited to her bank account (e-banking) and her payment card. Therefore, she does not even know how to find the appropriate savings investment. She mistrusts bank advisers because they want “only her best.” Financial transactions on the Internet are interesting, but she feels not familiar enough with the products at all.

After an initial Google search, she ends up on an online service called “Finanzomat,” which is offered by a well-known bank. Contrary to the previous pages she has seen, she is not confronted with a long list of widely incomprehensible financial products. Instead, the Finanzomat shows only a single text input field entitled “What do you want?”. This arouses her interest, and she tries it out. Nina enters “save money” and hits Enter. Next, she is asked a few questions on a page labeled: “What is important to you?”

The slider between personal interaction and electronic interaction she immediately pushes to the right.

Aspects such as comprehensiveness, transparency, and simplicity are also very important to her, and they get high scores. In contrast, she describes her expectations towards cost and risk relatively low.

Intuitively, she understands the questions. She is also positively surprised that she is not asked about her assets or her investment horizon. Because at the moment she cannot estimate this at all and does not want to give that sensitive information away online.

Once again, Nina presses “Enter” and immediately receives a solution which is not just a single bank product, but a solution package. An “online financial planner” is proposed to her as a core product with a matching score of 83.3%. When she clicks the matching score, she receives detailed information about why she was recommended. At a glance, Nina recognizes the benefits and disadvantages of this service and feels well informed without the need for technical jargon. “Cool that there is such a thing, I would never have stumbled upon that anywhere else,” she thinks. Alternatively, a service called “Mobile Personal Finance Management” is recommended to her. For comparison, Nina also checks that matching score but then trusts the system’s recommendation. However, she is very enthusiastic about the supplementary products. She has never heard of an impulse savings app, but the idea of simply saving money on the mobile phone for the holidays she would otherwise probably have spent on cigarettes convinces her. She already has heard of the second supplementary product “savings account.” However, encouraged by the feeling that it fits her will, she will surely open one from the cooperative bank, which provided her the Finanzomat. A click on the deposited provider link and immediately it is on the corresponding page in the e-banking of the bank. She’d never have found there in other ways.

“That was easy,” Nina thought, leaning back satisfied. Another problem comes to her mind: Now, when she moves to the outskirts of the city, she needs a solution to stay mobile. “Why is there no such solution to that problem such as the Finanzomat” she wonders.

Figure 5-1: Exemplary use case for “Finanzomat”

Consulting: Consulting contains a variety of concepts that are not primarily based on the provision of the CSM toolkit, but on providing methodological and domain knowledge that helps business to take advantage of this concept. E.g., to capture the consumer perspective via VOC-OE. However, this business model is hardly scalable and might work out as a standalone business model.

Evaluation of the Business Model

The overview above objectively lists alternative business models.65 It does not favor any of the presented models. Each one is a viable option if the environment and the objectives...

65 Other revenue sources from the St. Gallen Business Model Navigator (Gassmann & Frankenberger, 2013) have evaluated too, e.g., crowdfunding, and public-funding (non-profit).
of the company are suitable. Some particular aspects of CSM must be considered to find the right business model:

- **Heterogeneity**: Service matching on the level of service-classes suits only companies that offer a diverse product portfolio. This usually refers to highly integrated service providers like banks, intermediaries, such as service brokers, or customer-facing companies that offer third party services, e.g., through collaboration. If the setting for CSM is placed within a solution space that consists of only a few services, there is no matching necessary and other decision support approaches might be more suitable.

- **Monetarization vs. trust**: The CSM concept is primarily designed for consumers in their pre-purchase decision-making phase. At this stage, businesses or sources with otherwise conflicting interests are usually avoided. If a biased company now offers support during that stage, this should be done very cautiously. Running CSM-based business models always causes a dilemma: on the one hand, users are probably not willing to pay money for using this service. On the other hand, indirect revenues from service providers will erode trust in this platform and thus will prevent its use. There still is an unresolved contradiction between monetarization (what the business wants) and trust (what the customer wants).

- **Process design**: Related to the monetarization issue is the issue of the process design. CSM covers only a section of the customer process. The cut between pre-purchase and purchase phase results in process breaks which usually cause the user to change their touchpoints. So, from a CSM-providers perspective, the user is handed over to another service provider. This causes challenges in establishing a profitable and lasting customer relationship. A possible solution is to integrate downstream features, such as the constant administration and management of the service network for the customer.

- **Frequency of use**: Consumers usually avoid dealing with complex service domains and its representatives. For example, banking and insurance services are widely considered as boring – thus consumers rarely proactively start purchase processes in this field. If a business model now is settled in this domain, there is the risk that relevant trigger moments rarely occur for the customer. There is an imminent danger to never reach the necessary interaction frequency or critical mass for some of the business models above.
5.3 Outlook and Impact of CSM

The proven value of CSM gives relevance to it in future application scenarios. This section analyzes the impact of the concept in the context of recent trends. The potentials are examined from a technological, business and social perspective.

5.3.1 Technological Impact of CSM

CSM as an Element of Future Customer Interaction and -Interfaces

From a technical perspective, CSM enables a new form of service configuration that significantly lowers customer-facing complexity. Thus, it becomes a viable option for innovative forms of human-computer-interaction and natural interfaces:

Smartphones, touch screens and mobile devices, in general, have led to a more omnipresent use of software applications. Interaction became more casual and the complexity of representable information input and output was limited. The fast and intuitive user experience that can be offered by CSM has great potential in this application area. Especially, graphical user interfaces, such as the slider elements in the introduced Full-profiling scenario (see Section 4.3.3), are well-suited for today’s mobile interaction scenarios.

However, more innovative developments lie ahead. The advent of voice interfaces reduces the relevance of touch-interaction and screen interfaces further. Interaction increasingly takes place via the most intuitive form of human expression – natural language. The demonstrated low-complexity-scenario of CSM takes an obvious reference to verbal input. It shows certain parallels between linguistics and IS, as the coalescence between adjectives and non-functional parameters becomes evident. This process is still unidirectional, as it relies on command-like user input. The inevitable next steps will be conversational interfaces, such as chat bots, that enable dialogues between men and machine.

Consequently, recommending services (or features) to the user, based on preference profiles and contextual information becomes more important, as human-computer interaction evolves. The previous technologies in conjunction with contextual information, such as historical user profiles and third-party data, will lead to software-based personal assistants. At this point, large parts of consumer’s life will be supplemented, or supplanted, by technology. This changes the relationship with technology profoundly (Michelman, 2017). CSM helps to understand the language of the customer and is a tool to augment his decision processes. In this journey towards future customer interaction, CSM is one piece that backs this evolution.

From Search Engines to Solution Engines

The rising expectations of customers towards online interaction are insufficiently met by many service providers today. Particularly in complex service domains, the customer often does not have an adequate equivalent to the personal adviser in electronic channels. As a result, many processes cannot be performed online and entire customer segments remain unsatisfied. Significant progress has already been made in the field of standardized processes, such as transactions. However, complex interactions, such as decision-making or information processes, are still far from the quality and simplicity of personal advice. During the online interaction, the customer is left on his own during the vital phase of pre-
purchase information and decision making. Previous approaches either require manual interaction, e.g., using chat or hotlines, or demand a high level of user expertise.

Due to their specific characteristics, intangible services cannot be presented like classic goods and offered in the form of product catalogs via web shops or portals. To make consultancy-intensive services accessible to the customer, alternatives to the existing product-centric tools are required. Via CSM, the user no longer specifies the product. Instead, a solution is offered to him. Through this paradigm shift, various advantages arise over existing approaches such as search engines or product configurators. No longer the configuration- or search process is the focus of the application system, but the solution is instead. Search engines are strictly focused on the filtering of information and cannot be applied for service composition. Consequently, a new category of application systems named solution engines, that is based on the concept of CSM, is proposed (see Table 5-1).

<table>
<thead>
<tr>
<th>Technical aspects:</th>
<th>Configuration tool</th>
<th>Search engine</th>
<th>Solution engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>Product parameter</td>
<td>Search query</td>
<td>(User) Profile via Elicitation</td>
</tr>
<tr>
<td>Result</td>
<td>Individualized product</td>
<td>Individualized information</td>
<td>Individualized Solution (service bundle)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Functional aspects:</th>
<th>Configuration tool</th>
<th>Search engine</th>
<th>Solution engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paradigm</td>
<td>Product-centric</td>
<td>Information-centric</td>
<td>Customer-centric</td>
</tr>
<tr>
<td>User value</td>
<td>Individualized product at little extra cost. Mass production</td>
<td>Easy and fast access to information</td>
<td>Transparent, simple and neutral way to individualized solutions</td>
</tr>
<tr>
<td>Provider value</td>
<td>Cost reduction and quality improvement, by independently specifying and commissioning production</td>
<td>Comprehensive knowledge about customers and influence in the market through direct customer access</td>
<td>Influence as a gatekeeper and comprehensive knowledge about customers and markets</td>
</tr>
</tbody>
</table>

Table 5-1: Characteristics of a solution engine

Solution engines may be a new class of individualization software. They address the issues named above in the context of service individualization. Solution engines emphasize the customer experience instead of the product parameterization. They focus on service composition instead of information filtering. Thus, it is a tool for superior user experience in its given application area. From a business perspective, the focus on user experience allows companies to differentiate themselves on the market. They must no longer rely on price or product as their key differentiation factor and can, instead, evolve to a holistic marketing concept (Kotler & Keller, 2011, p. 816). For instance, 70 percent of purchases are based on how the customer feels and not on rationales (Gudrus, 2015). Application areas for this type of software exist in many sectors, such as healthcare, education, mobility or finance (A. Winter et al., 2012).

5.3.2 Business Impact of CSM

(Re-)Intermediation

The concept of customer-centricity fosters empowerment of the consumer. He takes over control and is in charge of every business transaction in his regard. Also, new services increasingly offer additional self-service alternatives to businesses that require (personal) intermediaries, such as salespeople. This shift affects the whole market structure: from a
business perspective, the act of being replaced or becoming obsolete is referred to as disruption. If new technology causes the act of replacement, this effect is called digital disruption (Vermeulen, 2017). The consequence of both trends, disruption, and customer-centricity, is disintermediation – the effect that middlemen are cut out from the value creation process. For example, customers become self-reliant and do not need intermediaries, such as advisors or salespersons. CSM plays a major role in this context since it proposes alternative services and self-services to the customer. Since domain knowledge and expertise becomes less necessary, the adoption of new services by the consumer may be accelerated.

Interestingly, exactly the opposite could happen too. The findings from the startup-phase indicate that services, such as the “Finanzomat”, may become necessary in future markets. Instead of bringing the consumer closer to the business via self-services, new intermediating services emerge that help the user to navigate in this environment. Additionally, new services will offer complements instead of substitutes. Therefore, the consumer uses additional services that supplement the actual self-service (i.e., services for review or cross-provider integration) (Vermeulen, 2017). Consequently, CSM-based implementations may drive reintermediation.

Figure 5-2: Scenarios for disintermediation and reintermediation caused by CSM

From a business perspective, it is of great importance where the company is placed within this chain of services during the customer process. According to Krulak’s law, the closer you get to the front, the more power you have (Godin, 2010, p. 61). Services that represent initial customer-touchpoints are the most important ones in the whole process, since the company has direct access to the customer and has control over all subsequent services (and providers).

Platforms and Ecosystems

The concept of CSM is the result of a changing market structure and altering business environments. The future economy might no longer be described solely based on the two entities of customers and providers. Instead, the notion of ecosystems and platforms might become more relevant:

Ecosystems: CSM describes “the world” through the eyes of the customer. Not only service attributes are defined from a client perspective, but also the solution space, i.e., the market, is defined by the client perception. Thus, the market is no longer defined by traditional criteria such as industry classifications. For instance, the Standard Industry Classification (SIC) codes were introduced in the year 1937. Although successively updated,
this standard has become increasingly insufficient in the current era of digital business. For example, the industry of “information technology” was classified in the 1970s at a time when the Silicon Valley was actually the home of mostly hardware companies. However, today, this category subsumes companies like Microsoft and Facebook which earn their money in totally different fields (software and advertising). In contrast, Amazon is classified by SIC as a consumer discretionary firm. Although it shares many bits of its DNA with the former both, it is categorized in a different industry. This example shows, that focusing on vertical industries no longer seems to work. This calls for new approaches on how to define the “ecosystem” in which companies (and consumers) operate in (Wind et al., 2016). Shared characteristics of the business model may be appropriate measures. For example, companies that target similar customers or have a similar value proposition may be within the same ecosystem (either as competitors, or cooperators). What they all have in common, are shared common functionalities for the customer. Also, they fulfill similar needs. In this regard, CSM helps to identify future ecosystems by defining the market from shared customer needs and value propositions.

Platforms: An essential element of ecosystems are platforms that foster multilateral interaction among the entities. Platforms play a crucial role in any network: they connect (formerly separate) entities in a viable and meaningful way. A core function of service platforms is matchmaking – the process of bringing two or more groups together and do business. Different to traditional businesses, platforms do not buy resources, create an outcome and sell it. Instead, they attract participants and sell each group contact to the other group. Apple, Google, and Microsoft - three of the five most highly valued companies in the world – generate a significant amount of their turnover from connecting different entities, like users and developers (Evans & Schmalensee, 2016b). The underlying process of matchmaking is a fundamental aspect of CSM. Thus, CSM has great potential for building and establishing consumer-oriented service platforms. These platforms in return may become the central hubs in future service ecosystems.

5.3.3 Social Impact of CSM

The trends named above have a very broad impact on social areas too. On the one hand, the new abilities of the customer will put him in a new role. On the contrary, the digital substitution of formerly manual knowledge may lead to social distortions and upheavals.

Empowerment (and Incapacitation) of the Customer

At the background of the previously mentioned technological and business trends, three effects of CSM on the consumer behavior can be expected:

First, CSM causes relief. By lowering complexity in the increasingly relevant field of services, the life of the consumer is significantly simplified. In return, this creates the opportunity to spend more time on “valuable” services and more free time for consuming additional services is created. Administrative tasks of service management are delegated to a machine (an instance of CSM) by the customer so that he can spend his time more meaningful.

Second, CSM leads to greater empowerment of the customer. Customer-centric service composition enables the customer to be more self-reliant: the required knowledge for decision making is lowered. Information asymmetries are reduced. The interaction between
the customer and the provider takes place through the system-assisted implementation via defined processes and rules. This leads to a higher equality between all participants. Neither party will be left behind due to information or knowledge deficits, and usually, negotiation is left to the machines.

Third, consumers will be decoupled from their decision making to a higher degree. There is a paradox expected to occur regarding the adoption of CSM (and other decision support technologies): enabling the customer to make decisions in the field of complex services on his own via technology, eventually leads to consumers being incapable of decision making without any tool support at all. It may lower the general ability of the customer to question or reflect their choices and their consequences. Behind it lies a deeper question that affects the whole society: are computers used to complement human intelligence or will they displace it? Researchers think that a combination of both will outperform every variant for itself. Human judgment, which is unaided by algorithms (such as CSM), will decline in societies reliance (Frick, 2013).

**Automatization of Knowledge Work**

Brynjolfsson and McAfee (2012) have traced the evolution of IT under the aspect of skills and abilities that define humans and machines: once, there was a clear distinction between the preferred application areas for humans and machines. Machines had their strength in the application of existing rules, like algebraic calculations and reoccurring tasks. In contrast, humans were good in tasks from the other end of the complexity spectrum, like pattern recognition and unstructured conversation (see Figure 5-3). This clear separation is gradually becoming obsolete, due to recent advances in IT.

<table>
<thead>
<tr>
<th>Application of rules</th>
<th>Pattern recognition</th>
<th>Complex interaction</th>
<th>Intuition &amp; creativity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Machine</td>
<td>✗</td>
<td>✗</td>
<td>✗ (→ ✓)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>✗ (→ ✓)</td>
</tr>
</tbody>
</table>

✓ - Strength  ✗ - Weakness

Figure 5-3: Strengths of machines vs. strengths of humans (based on Brynjolfsson & McAfee, 2012)

An example is IBM Watson. Watson combines advanced computer-hardware with cognitive technology that enables it to process information more like a human than a computer does. Watson gained popularity in 2011 when it won the quiz show Jeopardy against former record holder. Despite IBM’s marketing claims, this was not a proof of artificial intelligence (yet), but it has proofed that machines can handle complex communications. Only a few years ago, many of today’s examples for cognitive technologies (like autonomous cars or personal assistant) would have been considered as science fiction.

Brynjolfsson and McAfee (2012) name two drivers for this progress: first, Moore’s Law that claims processing power and computer performance is doubling every 18 months. However, exponential advances do not only apply to hardware. Similar effects have been described for software performance too. A linear optimization problem that took 82 years to solve in 1988 could have been solved in one minute in 2003. That is an increase in computing power by a factor of 43 million. Surprisingly, the advances in hardware do

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66 https://www.ibm.com/watson/
only result in a factor of roughly 1,000, while improvements in algorithms were responsible for a rise of a factor of roughly 43,000 (Holdren, Lander, & Varmus, 2010, p. 71). Capable new algorithms (such as CSM) are a major driver of the trends towards smarter machines.

The second concept, which drives this progress, is closely related to Moore’s Law but is focused on the impact of advances in non-technical fields. Ray Kurzweil (2000) states that all advances based on exponential growth are deceptive because they are initially unremarkable. At a certain point, these advances suddenly become apparent, and their impact will be greater than everything that was known before. After that point, exponential growth confounds intuition and expectations. Suddenly, one can do things that had just seemed impossible before.

The increasing capacity of IT enables its use in fields that previously were considered too complex. The boundary between areas of application of human labor and algorithms is becoming increasingly blurred. It is constantly kept questioning what tasks machines can provide in future and whether they are doing them better than people. CSM meets the characteristics of this development. First, there is a need (or want) to replace humans by algorithms in some cases, such as for service composition. Second, technology has advanced to a state, that it can handle higher complexity than most customers can. Third, machines prove to perform better than humans and make the traditional approach to the given problem setting obsolete. This work has contributed to this development - both in its potentially good and in its potentially bad implications.

5.4 Limitations and Need for Future Research

The author conducted the presented research with utmost care. Nevertheless, it cannot be ruled out that systematic and unsystematic errors occur and distort the results or restrict the transferability to other fields of application. The aspects that are considered as the most relevant ones regarding the limitations of this work and that need for further development are:

**Optimization:** The CSM model names all required elements that are necessary to implement it. It pursues a pragmatic approach: it should work reasonably well to proof its work. However, every element of CSM can be further optimized. So, refinements of the customer model, the service model, and the composition logic is a rich field for future research.

**Economical application:** In its current state, CSM is a toolset that shows what can be done with configuration toolkits that follow the paradigm change towards customer-centricity. Building products and businesses on this concept is a challenging task, as the experiences from the startup-phase indicate. Explorations about use cases and business models must be carried out to foster the diffusion of this concept.

**Generalization:** In addition to the previous key point, it should be noted, that the work is biased towards the domain of financial service. The chosen examples and even the prototype are settled in this field. Although the notion of "complex service ecosystems" is highly generalized, specific characteristics of other industries might influence the adaptability of CSM to it.
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mass-customization-from-frank-piller


- 225 -


# Curriculum Vitae

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## Education

<table>
<thead>
<tr>
<th>Institution</th>
<th>Details</th>
</tr>
</thead>
</table>
| University of Leipzig and University of St. Gallen (HSG) | (2011 – 2017) Ph.D. at the Institute of Information Management (IWI-AS) 
Topic: Customer-centric Service Management 
First thesis adviser: Prof. Dr. Rainer Alt, University of Leipzig |

## Experience

<table>
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<tr>
<th>Role</th>
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<tr>
<td>mell-on UG</td>
<td>(since 2016)</td>
<td>Founder &amp; CEO</td>
</tr>
<tr>
<td>VNG AG</td>
<td>(since 2018)</td>
<td>Manager Digital Transformation</td>
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<td>Finanzomat</td>
<td>(2015 – 2016)</td>
<td>Co-Founder &amp; CEO</td>
</tr>
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<td>Hannover Reinsurance</td>
<td>(2008 - 2009)</td>
<td>Student trainee</td>
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<tr>
<td>Versicherungsfen Torgau</td>
<td>(2006 - 2010)</td>
<td>Student trainee and project consultant</td>
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## Projects

<table>
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<td>BIAN Banking Model Working Group</td>
<td>(since 2016) Contributor</td>
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<tr>
<td>Banking IT-Innovation Award</td>
<td>(since 2011) Director and jury-member</td>
</tr>
<tr>
<td>Banking Innovation Database</td>
<td>(since 2011) Director</td>
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</table>
Abstract: This work proposes the concept of Customer-centric Service Management (CSM). It is an interdisciplinary approach to adopt the service composition process from the field of business and IT to the particularities of consumers. Combining modular services to individualized and valuable service bundles is its objective. Making this type of interaction accessible for consumers requires a substantial reduction of complexity in the front end. The key to achieving this is by taking an outside-in perspective. This means understanding the decision process of the customer and speaking his language in a field that has been dominated by formal description standards and product parameters for a long time.

This work hypothesizes that a paradigm-shift enables consumer-driven service composition. Thus, the concept of customer-centricity is applied to service management. By letting the consumer describe himself, respectively his distinct needs and requirements, a better customer value is achieved than by traditional product-centric approaches. Unlike existing product-centric configuration tools, customer-centric configurators do not elicit product parameters. Instead, they rely on a structured description of customers’ intentions and values captured in a domain specific customer model. Consequently, the concept applies to a more abstract level of service categories instead of specific product instances. This refers to the pre-purchase phase of the consumer journey – a phase that is widely neglected by academia and practice yet.

This work analyzes the concept of CSM on a technical, process-related, and strategic level. Three elements are identified as the core of CSM: the customer model, the service model, and the composition logic. Each item is elaborated in detail at the example of financial services.

The concept of CSM facilitates current knowledge from different fields of research and finally implements them into a prototype. This demonstrator is the basis for a large field experiment to answer two questions: in the first place, does customer-centric service composition provide higher customer value regarding perceived complexity, solution utility and process utility? Moreover, secondly, does a reduced complexity, in respect of the amount of information that needs to be handled, without changing the configuration paradigm, have a greater impact on customer value?

Empirical validation shows that the customer-centric approach has significant advantages over the product-centric one. It offers higher customer value with respect to perceived complexity, perceived solution utility and perceived user experience. This proves the high...
potential of this concept. The findings of this thesis form the basis of a new form of customer interaction and enable new business models.
## Appendix 1 Design-Science Research Guidelines

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guideline 1: Design as an Artifact</td>
<td>Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.</td>
</tr>
<tr>
<td>Guideline 2: Problem Relevance</td>
<td>The objective of design-science research is to develop technology-based solutions to important and relevant business problems.</td>
</tr>
<tr>
<td>Guideline 3: Design Evaluation Description</td>
<td>The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.</td>
</tr>
<tr>
<td>Guideline 4: Research Contributions</td>
<td>Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations and/or design methodologies.</td>
</tr>
<tr>
<td>Guideline 5: Research Rigor</td>
<td>Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.</td>
</tr>
<tr>
<td>Guideline 6: Design as a Search Process</td>
<td>The search for a useful artifact requires utilizing available means to reach desired ends while satisfying laws in the environment.</td>
</tr>
<tr>
<td>Guideline 7: Communication of Research</td>
<td>Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.</td>
</tr>
</tbody>
</table>

*Table 0-1: Design-science research guidelines (Hevner et al., 2004)*
Appendix 2  Banking IT-Innovation Framework

Figure 0-1: Banking IT-Innovation Framework
### Appendix 3  Structure and Content of the Consultation Templates of Selected Banks

<table>
<thead>
<tr>
<th>Section</th>
<th>Question title</th>
<th>Input type of the question</th>
<th>Purpose of the question</th>
<th>Relevance regarding SM</th>
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<td>Income - expenditure = savings ratio</td>
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<td>Bound investments</td>
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<td>Free investments</td>
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<td></td>
</tr>
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</tr>
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<td>Liabilities/plans</td>
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<td>Net assets</td>
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<td>Retirement provision</td>
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<td></td>
<td>Ratio of free investments</td>
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<td>Compensation of losses</td>
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<td>Duration of asset consumption</td>
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<td>Underfunding of liabilities</td>
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<td>Table 0-2: Structure and content of the consultation template of Bank 1 (anonymized)</td>
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<td>-----------------------------------</td>
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<td>Dealing with losses</td>
<td>X</td>
<td>Willingness to take risks</td>
<td>Restriction (risk)</td>
<td></td>
</tr>
<tr>
<td>Knowledge/Experiences</td>
<td></td>
<td>Justification of the recommendation</td>
<td>Explanation</td>
<td></td>
</tr>
<tr>
<td>Risk-classification of the customer</td>
<td>X</td>
<td>Justification of the recommendation</td>
<td>Explanation</td>
<td></td>
</tr>
<tr>
<td>Strategy investing/provision</td>
<td>Investment objectives</td>
<td>X</td>
<td>Investment objectives</td>
<td>Intention (functional req.)</td>
</tr>
<tr>
<td></td>
<td>Risk budget</td>
<td>X</td>
<td>Justification of the recommendation</td>
<td>Explanation</td>
</tr>
<tr>
<td></td>
<td>Investment-/provision strategy</td>
<td>X</td>
<td>Justification of the recommendation</td>
<td>Explanation</td>
</tr>
<tr>
<td>Investor profile and consultation form</td>
<td>Interest in capital markets</td>
<td>X</td>
<td>Knowledge and experience</td>
<td>Requirements for execution (non-functional req.)</td>
</tr>
<tr>
<td></td>
<td>Investment interests</td>
<td>X</td>
<td>Knowledge and experience</td>
<td>Requirements for execution (non-functional req.)</td>
</tr>
<tr>
<td></td>
<td>Selection of assets</td>
<td>X</td>
<td>-</td>
<td>Requirements for execution (non-functional req.)</td>
</tr>
<tr>
<td></td>
<td>Monitoring/customization</td>
<td>X</td>
<td>-</td>
<td>Requirements for execution (non-functional req.)</td>
</tr>
</tbody>
</table>

X – mandatory field  (X) – optional field
<table>
<thead>
<tr>
<th>Section</th>
<th>Question title</th>
<th>Input type of the question</th>
<th>Purpose of the question</th>
<th>Relevance regarding SM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Free text</td>
<td>Multiple-Choice</td>
<td>Number</td>
</tr>
<tr>
<td>Needs assessment</td>
<td>Family / partnership (“Your plans…”)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Career / education (“Your plans…”)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leisure (“Your plans…”)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Investing</td>
<td>Assets, annual savings ratio, investment goals</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Investment knowledge</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Customer education</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Investment strategy</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sustainability</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Portfolio management</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial situation</td>
<td>Free assets</td>
<td></td>
<td>X</td>
<td>Assets and liabilities</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>-------------</td>
<td>---</td>
<td>---</td>
<td>------------------------</td>
</tr>
<tr>
<td>Illiquid assets</td>
<td>X</td>
<td></td>
<td></td>
<td>Restriction (current situation)</td>
</tr>
<tr>
<td>Liabilities</td>
<td>X</td>
<td></td>
<td></td>
<td>Restriction (current situation)</td>
</tr>
<tr>
<td>Entitlements</td>
<td>X</td>
<td></td>
<td></td>
<td>Restriction (current situation)</td>
</tr>
<tr>
<td>Income</td>
<td>X</td>
<td></td>
<td></td>
<td>Restriction (current situation)</td>
</tr>
<tr>
<td>Future commitments / investments</td>
<td>X</td>
<td></td>
<td></td>
<td>Restriction (risk)</td>
</tr>
<tr>
<td>Expenditure</td>
<td>X</td>
<td></td>
<td></td>
<td>Restriction (current situation)</td>
</tr>
<tr>
<td>Savings rate</td>
<td>X</td>
<td></td>
<td></td>
<td>Restriction (current situation)</td>
</tr>
</tbody>
</table>

*X – mandatory field  *(X) – optional field

Table 0-3: Structure and content of the consultation template of Bank 2 (anonymized)
<table>
<thead>
<tr>
<th>Section</th>
<th>Question title</th>
<th>Input type of the question</th>
<th>Purpose of the question</th>
<th>Relevance regarding SM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal details of the customer</td>
<td>Account owner</td>
<td>X</td>
<td>Personal data</td>
<td>Identification</td>
</tr>
<tr>
<td></td>
<td>Authorized representative</td>
<td>X</td>
<td>Personal data</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Legal representative</td>
<td>X</td>
<td>Personal data</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Advisory on the initiative of</td>
<td>X</td>
<td>Reason for the consultation</td>
<td>Restriction (current situation)</td>
</tr>
<tr>
<td></td>
<td>Reason for investment advice</td>
<td>X</td>
<td>Reason for the consultation</td>
<td></td>
</tr>
<tr>
<td>General customer information</td>
<td>Investment objectives</td>
<td>X</td>
<td>Investment objectives</td>
<td>Restriction (current situation)</td>
</tr>
<tr>
<td></td>
<td>Financial situation (monthly income, assets)</td>
<td>X</td>
<td>Assets and liabilities</td>
<td>Restriction (risk)</td>
</tr>
<tr>
<td></td>
<td>Willingness to take risks</td>
<td>X</td>
<td>Willingness to take risks</td>
<td>Requirements for execution</td>
</tr>
<tr>
<td>Knowledge / experience regarding investment business</td>
<td>Type, scope, frequency and period of the traded transactions</td>
<td>X</td>
<td>Knowledge and experience</td>
<td>Restriction (temporal)</td>
</tr>
<tr>
<td></td>
<td>Education, professional activity</td>
<td>X</td>
<td>Knowledge and experience</td>
<td>Restriction (current situation)</td>
</tr>
<tr>
<td>Intentions of the customer</td>
<td>Issue</td>
<td>X</td>
<td>Investment objectives</td>
<td>Intention (functional req.)</td>
</tr>
<tr>
<td></td>
<td>More information by the customer</td>
<td>X</td>
<td>Other objectives</td>
<td>Intention (functional req.)</td>
</tr>
<tr>
<td>Recommendations / Information on financial instruments and investment services / Reasons for recommendation</td>
<td>Recommendation</td>
<td>X</td>
<td>Recommendation</td>
<td>Explanation</td>
</tr>
<tr>
<td></td>
<td>Information about the product</td>
<td>X</td>
<td>Recommendation</td>
<td>Explanation</td>
</tr>
<tr>
<td>Information on fees / kickbacks</td>
<td>X</td>
<td>X</td>
<td>Recommendation</td>
<td>Explanation</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>---</td>
<td>---</td>
<td>----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Essential reasons for the recommendation</td>
<td>X</td>
<td>X</td>
<td>Reasons for the recommendation</td>
<td>Explanation</td>
</tr>
<tr>
<td>Remarks</td>
<td>X</td>
<td></td>
<td></td>
<td>Explanation</td>
</tr>
</tbody>
</table>

*X – mandatory field   (X) – optional field*

*Table 0-4: Structure and content of the consultation template of Bank 3 (anonymized)*
<table>
<thead>
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<th>Section</th>
<th>Question title</th>
<th>Input type of the question</th>
<th>Purpose of the question</th>
<th>Relevance regarding SM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment objectives</td>
<td>Investment horizon</td>
<td>X</td>
<td>Investment horizon</td>
<td>Restriction (temporal)</td>
</tr>
<tr>
<td></td>
<td>Age group</td>
<td>X</td>
<td>Personal data</td>
<td>Restriction (temporal)</td>
</tr>
<tr>
<td></td>
<td>Living</td>
<td>X</td>
<td>Income and expenditure</td>
<td>Restriction (current situation)</td>
</tr>
<tr>
<td></td>
<td>Household</td>
<td>X</td>
<td>Income and expenditure</td>
<td>Restriction (current situation)</td>
</tr>
<tr>
<td></td>
<td>Reserves</td>
<td>X</td>
<td>Risk-bearing capacity</td>
<td>Restriction (current situation)</td>
</tr>
<tr>
<td></td>
<td>Investment objective</td>
<td>X</td>
<td>Investment objectives</td>
<td>Intention (functional req.)</td>
</tr>
<tr>
<td></td>
<td>Fixed assets</td>
<td>X</td>
<td>Assets and liabilities</td>
<td>Restriction (current situation)</td>
</tr>
<tr>
<td></td>
<td>Allocation</td>
<td>X</td>
<td>Assets and liabilities</td>
<td>Restriction (current situation)</td>
</tr>
<tr>
<td>Willingness to take risks</td>
<td>Expected return</td>
<td>X</td>
<td>Investment objectives</td>
<td>Restriction (risk)</td>
</tr>
<tr>
<td></td>
<td>Rising markets</td>
<td>X</td>
<td>Assets and liabilities</td>
<td>Restriction (risk)</td>
</tr>
<tr>
<td></td>
<td>Personal assessment</td>
<td>X</td>
<td>Risk-bearing capacity</td>
<td>Requirements for execution (non-functional req.)</td>
</tr>
<tr>
<td></td>
<td>Investment strategy</td>
<td>X</td>
<td>Risk-bearing capacity</td>
<td>Restriction (risk)</td>
</tr>
<tr>
<td></td>
<td>Declining markets</td>
<td>X</td>
<td>Risk-bearing capacity</td>
<td>Restriction (risk)</td>
</tr>
<tr>
<td>Evaluation / investment profile</td>
<td>Recommended investment profile</td>
<td>X</td>
<td>Recommendation</td>
<td>Explanation</td>
</tr>
<tr>
<td></td>
<td>Chosen investment profile</td>
<td>X</td>
<td>Recommendation</td>
<td>Explanation</td>
</tr>
</tbody>
</table>

X – mandatory field  (X) – optional field

Table 0-5: Structure and content of the consultation template of Bank 4 (anonymized)
Appendix 4

Examples for Service Domain Representation Concepts

Figure 0-2: Service repository (Fischbach, 2014)

Figure 0-3: Service map (Glöckner, Augenstein, & Ludwig, 2014)
Figure 0-4: Ontology

Figure 0-5: Taxonomy
Building a system model, thus, involves choosing an arbitrary boundary for the system. 

There are two main categories of DSMs: static and time-based. Static DSMs represent system elements existing in the present. They can be advantageous for modeling information flow and organization DSMs, useful for modeling service architecture. Time-based DSMs are typically used to determine the order of system components, allowing for the determination of system components that are completed before others. Time-based DSMs represent processes as well as the interactions among processes; thus, they are useful for designing integrated organization structures that account for team interactions. Static DSMs represent structural relationships; thus, they are useful for modeling architectural decomposition strategies; and 4) a discussion of the advantages of DSMs in practice and barriers to their use. The paper also discusses research directions and new DSM applications, both of which may be approached with a perspective on the four types of DSMs and their relationships.

Figure 0-6: Service architecture (Voss & Hsuan, 2009)

Figure 0-7: Design Structure Matrix (DSM) (Browning, 2001)

Figure 0-8: Domain Mapping Matrix (DMM) (Lindemann, 2009)
Appendix 5  Consumer Decision Heuristics and Decision Biases

Abstractions and simplifications characterize consumer’s decision making. These mental shortcuts aim at minimizing complexity, reducing mental effort, avoiding negative emotions, justifying decisions, and coping with limited information (Al-Qaed & Sutcliffe, 2006). Although consumers strive for “optimal” choices, their judgment is based on heuristics that inevitably cause decision biases. To better understand the particularities of consumers’ decision making in the field of services, relevant concepts are enumerated below:

**Decision fatigue**: Making choices is exhausting. Studies have shown that after an extended period of decision making, consumers become mentally tired and depleted. A declining quality of decisions made is the result. In light of decision making, taking a product into closer consideration or not already is a choice. Being confronted with a vast range of alternatives causes decision fatigue inevitable. Important decisions intensify this effect.

**Consideration theory**: To reduce complexity, consumers form a subset of alternatives they apply their decision strategy too. Consideration is a multi-stage decision-making strategy. The first step, the forming of the subset, hereby is highly arbitrary. (Richarme, 2005)

**Involvement theory**: Involvement describes the effect, that consumers put more effort into decision-making the more important the decision is to them. For example, buying groceries gets not the same attention like choosing a new car (Richarme, 2005). Involvement theory caters to the widely recognized fact, that human decision making is an adaptive behavior. Payne et al. (1993) call it the Adaptive Decision Making (ADM) theory.

**Ambiguity effect**: Consumers tend to favor choices, that have the least uncertainty. In that case of ambiguity, consumers tend to choose options for which the probability of the outcome is known, even if it objectively is the least favorable one (Ellsberg, 1961).

**Confirmation bias**: People tend to find evidence to confirm things they already know. Information search and filtering are conducted under the unconscious goal to validate or existing beliefs (Wason, 1968).

**Not invented here syndrome**: This phenomenon describes the tendency of humans to evaluate ideas of others more critically than their own. Higher standards are adopted and likeliness to reject others ideas is greater (Grosse Kathoefer & Leker, 2012).

**Visual overflow**: Visual representation of products improves the consumer experience, especially in electronic commerce. However, faced with a high number of alternatives, it becomes confusing and likeliness to give up choosing an option rises. In that case, textual representation has advantages. It triggers mental processing that is more systematic and thus delivers better decision quality (Townsend & Kahn, 2014).

**Anchoring bias**: People are overconfident in the first information they hear. Particularly in negotiation settings, the first offer defines the range (Strack et al., 1997).

**Conservatism bias**: New evidence tends to be rejected more easily than older ones, even if it meets all standards (Patatoukas & Thomas, 2011).
**Ostrich effect:** Negative or dangerous information is far less recognized or even avoided by people. If there is a high probability to find uncomfortable information, people tend to avoid consulting these sources (Karlsson, Loewenstein, & Seppi, 2009).

**Overconfidence:** People tend to be too optimistic about their abilities and causes them to take greater risks.

**Salience:** People focus on the most easily recognizable feature to describe people or things.

**Narrative information:** US economist Tyler Cowen (2009) found out, that an important factor that causes decision biases is, that consumers rely too much on stories. Information that is packed in easy to digest narratives easily seduces them. If embedded in a story, even single factoids convince people to form conclusions and to make confident decisions.
Appendix 6        Interview Script for Focus Group Interviews/Post-study Questionnaire for Field Experiment

The following interview script is translated from German. The meaning of some terms might slightly differ from the original interview script.

Introduction and Target Setting

Currently, changing requests on the customer’s side as well as technological progress lead to profound social and economic changes. This trend also affects the banking industry. On the one hand, self-service-solutions, such as ATMs or E-Banking, gained in importance massively, whereas on the other hand, the significance of bank consultancy and branch offices continues to diminish. Especially, current developments, like Mobile Banking and Social Finance, will reinforce and accelerate the process.

The classical bank consultancy remains mostly unaffected. It has almost no significance in self-services hitherto. This may be due to the fact that technological support is lacking. This interview and the underlying research, contributes to this subject. The concept of “Customer-centric Service Management” is introduced and evaluated based on a prototype.

Up to now, approaches for customers to create individual finance solutions were product-centric, hence, the customer states the products he wants to buy, finds a supplier and eventually buys the product. This is, for instance, how comparison portals or bank websites work.

The customer-centric approach does not require any specific knowledge about possible products from the customer. Instead, the customer describes himself and his needs. Afterwards, an individual series of solutions will be constructed. This approach is unparalleled in the field as yet.

In the following, alternative approaches for service management will be carried out. Goal is to acquire qualitative insights, such as opinions, critics and constructive suggestions for improvement, within the scope of an interview.

This survey is conducted within the Competence Center “Sourcing in the Financial Industry”, which belongs to the University of Leipzig, the University of St. Gallen, and the “Swiss Design Institutes for Finance and Banking” of the University of Arts in Zürich.

Personal information

To guarantee a proper use of the prototype, a specific problem situation has to be simulated. It is preferable to use a problem that personally interests the participant. Only in this way, it is possible to simulate a concrete advisory issue and its following context of use. While preparing for the interview, the participant is encouraged to think of two miscellaneous problems that appear interesting for him and give a short, personal overview.

In the following, please describe two personally relevant problems or advisory issues in the field of personal finance.
Example: “I have a problem with retaining an overview of my expenses. I would like to know where my money goes and to have some money to spare at the end of the month. This should happen as easy as possible, causing as few effort as possible.”

Advisory issues 1:

Advisory issues 2:

Demographical details
Name: __________________________
Age: __________________________
Profession/Education: ________________

Affinity:

1. How do you assess your knowledge in terms of financial issues?

<table>
<thead>
<tr>
<th>1 (very low)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7 (very high)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: _________________________________________________________________

2. How do you assess your technological affinity?

<table>
<thead>
<tr>
<th>1 (very low)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7 (very high)</th>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: _________________________________________________________________

3. How relevant is the problem you chose in reality?

<table>
<thead>
<tr>
<th>1 (very low)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7 (very high)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Scenario questionnaire (for each scenario)

**Complexity:**
Questions 4-6 refer to the configuration process (not to the suggested solution).

| 4. Understanding: The questions (or the options) were not understandable and complicated. |
|---|---|---|---|---|---|---|
| 1 (I do not agree) | 2 | 3 | 4 | 5 | 6 | 7 (I agree) |

Notes: ________________________________________________________________

| 5. Ease of answering: The questions (or the options) were hard to answer. |
|---|---|---|---|---|---|---|
| 1 (I do not agree) | 2 | 3 | 4 | 5 | 6 | 7 (I agree) |

Notes: ________________________________________________________________

| 6. Effort: The configuration was too long and took a lot of effort. |
|---|---|---|---|---|---|---|
| 1 (I do not agree) | 2 | 3 | 4 | 5 | 6 | 7 (I agree) |

Notes: ________________________________________________________________

*Value of the suggested solution:*
Questions 7-11 refer only to the suggested solutions (not to the previous configuration process).
7. **Adequacy**: The suggested solution does not solve my problem and is not appropriate to my requests.

<table>
<thead>
<tr>
<th></th>
<th>1 (I do not agree)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7 (I agree)</th>
<th>I cannot tell</th>
</tr>
</thead>
</table>

Notes: __________________________________________

8. **Information**: The presentation of the solution and the provided information are useful.

<table>
<thead>
<tr>
<th></th>
<th>1 (I do not agree)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7 (I agree)</th>
<th>I cannot tell</th>
</tr>
</thead>
</table>

Notes: __________________________________________

9. **Function**: The suggested solution seems technically correct and functional.

<table>
<thead>
<tr>
<th></th>
<th>1 (I do not agree)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7 (I agree)</th>
<th>I cannot tell</th>
</tr>
</thead>
</table>

Notes: __________________________________________

10. **Benefit**: All in all, I think, the suggested solutions are useful.

<table>
<thead>
<tr>
<th></th>
<th>1 (I do not agree)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7 (I agree)</th>
<th>I cannot tell</th>
</tr>
</thead>
</table>

Notes: __________________________________________
11. How likely is it (probability in percent) for you to put the suggested solutions - when available- in practice?

<table>
<thead>
<tr>
<th>%</th>
</tr>
</thead>
</table>

Notes: _________________________________________________________________

**Value of the configurator:**

Questions 12-17 only refer to the configuration process (not to the suggested solution).

12. **Function:** The configuration approach does not seem to have any functional mistakes or defects.

<table>
<thead>
<tr>
<th>1 (I do not agree)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7 (I agree)</th>
<th>I cannot tell.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: _________________________________________________________________

13. **Interaction:** The configuration approach gives me the possibility to deal independently (without any help from an advisor) with tasks like that.

<table>
<thead>
<tr>
<th>1 (I do not agree)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7 (I agree)</th>
<th>I cannot tell.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: _________________________________________________________________

14. **Experience:** The configuration process was a pleasant experience.

<table>
<thead>
<tr>
<th>1 (I do not agree)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7 (I agree)</th>
<th>I cannot tell.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: _________________________________________________________________
15. **Understanding**: The configuration process was understandable and considered all the necessary information.

<table>
<thead>
<tr>
<th></th>
<th>1 (I do not agree)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7 (I agree)</th>
<th>I cannot tell</th>
</tr>
</thead>
</table>

Notes: _________________________________________________________________

16. **Everyday Usefulness**: The configuration approach suits my personal preferences to interact in my daily life.

<table>
<thead>
<tr>
<th></th>
<th>1 (I do not agree)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7 (I agree)</th>
<th>I cannot tell</th>
</tr>
</thead>
</table>

Notes: _________________________________________________________________

17. How likely is it *(probability in percent)* for you to use the configurator you just used - when available - in practice?

<table>
<thead>
<tr>
<th></th>
<th>1 (I do not agree)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7 (I agree)</th>
<th>I cannot tell</th>
</tr>
</thead>
</table>

Notes: _________________________________________________________________

**Overall assessment**

Please order the previous configuration scenarios in accordance with your personal preferences.
Appendix 7  

Sample Size Estimation for the Field Experiment

An estimation of the sample size provides an ex-ante indicator for the needed number of participants to support statistical significance in quantitative research. For this experiment the paired means method has to be applied, because the sufficient conditions are met (cf. Sauro & Lewis, 2012, p. 4):

- A comparison of groups takes place
- Groups do not contain distinct individuals
- No binary data is analyzed
- Equal group size for all groups

The paired means method is applied on the prior measured data from the focus group interviews and iteratively executed as described by (Sauro & Lewis, 2012, p. 110f.).

Paired means is calculated using the formula:

\[ n = \frac{2(t_\alpha + t_\beta)^2 \times s^2}{d^2} \]

The sample size (n) for a comparison between two groups (product-centric configuration vs. customer-centric configuration) is the factor searched for.

The first criterion of the formula is the desired level of confidence (t_α). The confidence level describes the probability that a parameter falls within a certain range (confidence interval) if an experiment is indefinitely repeated. An ex-ante estimation of the t-value is problematic, because it depends on the sample size, which is the one to be defined. That is why for initial estimation the z-value is used for once. It is comparable to the t-value under the assumption of normal distribution and a large sample size. In the first iteration, the z-value is replaced by the t-value for the previously computed n. The assumption of the confidence level affects the Type I error. This statistical error occurs when the null hypothesis is true but is rejected. Something is asserted, that is absent in reality (false hit).

As an accepted convention, an α of 0,95 is an established confidence level in scientific publishing (Cowles, 2001). This convention is applied in this calculation.

Desired power is the second criteria (t_β). It caters to the Type II error. This error occurs when the null hypothesis is false, but is erroneously not rejected. This means something that is actually present, is not recognized by statistics (false negative). The value for power (β) describes the probability to support the alternative hypothesis and to reject the null hypothesis. Unlike α, there are hardly common practices to estimate β. Some suggest a value equal to α (Kirakowski, 2005), others suggest, setting it to 0,2 (means power = 80%) (Diamond, 2001). Since the second assumption is also supported by other references, this β-value will be used.

The variance (s^2) is an important factor that hardly can be assumed by general conventions or rules of thumb. Because of the focus group experiment that relied on the same questionnaire, sufficient data is available to calculate a reliable variance estimation. Variance is evaluated for the factor “likeliness to use” of the structural equation model. It is the most

67 This calculation is also implemented and available on http://www.gpower.hhu.de/
A comprehensive single factor to represent mass customization utility as perceived by the participant. So, it is best suited to compare the configuration scenarios among each other and avoids biases in building composite scores.

Critical difference (d) describes the smallest difference between the true and obtained value that needs to be detected. As for variance, there is no general guidance how to determine an appropriate value. For this experiment, a difference as small as one point on a seven-point Likert-scale is assumed to be the critical difference. This corresponds to a difference of 15% (rounded up) converted to a percent scale (in which the factor “likeliness to use” is measured).

The iterative calculation of the sample size as described by Sauro & Lewis (2012, p. 110f.) is shown in Table 0-6.

<table>
<thead>
<tr>
<th></th>
<th>Initial</th>
<th>1st Iteration</th>
<th>2nd Iteration</th>
</tr>
</thead>
<tbody>
<tr>
<td>tα</td>
<td>1,96 (z-value)</td>
<td>1,99962359</td>
<td>1,99834055</td>
</tr>
<tr>
<td>tβ</td>
<td>0,842</td>
<td>0,842</td>
<td>0,842</td>
</tr>
<tr>
<td>tα + tβ</td>
<td>2,802</td>
<td>2,84162359</td>
<td>2,84034055</td>
</tr>
<tr>
<td>t²α+β</td>
<td>7,851204</td>
<td>8,07482462724</td>
<td>8,06753443997</td>
</tr>
<tr>
<td>Variance (s²)</td>
<td>0,088198718</td>
<td>0,088198718</td>
<td>0,088198718</td>
</tr>
<tr>
<td>Critical difference (d)</td>
<td>0,15</td>
<td>0,15</td>
<td>0,15</td>
</tr>
<tr>
<td>d²</td>
<td>0,0225</td>
<td>0,0225</td>
<td>0,0225</td>
</tr>
<tr>
<td>Degree of freedom (df)</td>
<td>61</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>Unrounded</td>
<td>61,5525446717</td>
<td>63,3057049064</td>
<td>63,248550669</td>
</tr>
<tr>
<td>Rounded up (n)</td>
<td><strong>62</strong></td>
<td><strong>64</strong></td>
<td><strong>64</strong></td>
</tr>
</tbody>
</table>

Table 0-6: Sample size iteration procedure for ANOVA

The interpretation of the results states that with a confidence level of 95% a difference as small as one point on the rating scale might be detected by a sample size of 64 participants. This is the minimum sample size to show significant differences between customer-centric and product-centric approaches (respectively between low-complexity and high-complexity approaches).
Appendix 8  Statistical Analysis of Learning Effect for Second Scenario Evaluation

## Does evaluation differ between a given scenario due to being the first pass respectively the second pass?

## Determine similarity with ANOVA for example scenario "CC-LC"

```r
responses.learning_effect <- manova( cbind( ovrl_complexity, usol5, umc6) ~ as.factor(pass), data=data1, subset = as.factor(scenario) %in% c("cc-lc"))
```

```r
summary(responses.learning_effect)
```

```
   Df Pillai approx F num Df den Df Pr(>F)
as.factor(pass) 1 0.009173 0.16664      3     54 0.9184
Residuals       56
```

Source 5: ANOVA between first-pass and second-pass evaluation
Appendix 9  MANOVA Calculation for the Factor “Configuration Paradigm”

## Read in data from CSV (via OS dialogue window)
data1 <- read.csv( file.choose(), header=TRUE )

## Optional: Show the column names in the dataset to check correct import
names(data1)
[1] "affin1"          "affin2"          "affin3"        "intention"
[5] "pref"            "user_id"         "pass"          "scenario"
[9] "paradigm"        "complexity"      "clicks"        "usol1"
[13] "usol2"           "usol3"          "usol4"         "usol5"
[17] "compl1"         "compl2"         "compl3"        "ovrl_complexity"
[21] "umc1"            "umc2"            "umc3"          "umc6"
[25] "umc4"            "umc5"            "umc6"

## MANOVA for factor "paradigm": Does the configuration-paradigm interaction (customer-centric vs. product-centric) influence perceived complexity (ovrl_complexity), perceived solution utility (usol5) and perceived MC-utility (umc6)?
responses.manova_paradigm <- manova( cbind( ovrl_complexity, usol5, usol5, umc6) ~ as.factor(paradigm), data=data1)

summary(responses.manova_paradigm)
Df Pillai approx F num Df den Df  Pr(>F)
as.factor(paradigm)   1 0.054692   3.7414      3    194 0.01206 *
Residuals           196
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ’.’ 0.1 ‘ ’ 1

## As a check: Different tests for MANOVA (should provide similar results)
summary(responses.manova_paradigm, test = "Hotelling-Lawley")
Df Hotelling-Lawley approx F num Df den Df  Pr(>F)
as.factor(paradigm)   1         0.057856   3.7414      3    194 0.01206 *
Residuals           196
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ’.’ 0.1 ‘ ’ 1
summary(responses.manova_paradigm, test = "Roy")
Df Roy approx F num Df den Df  Pr(>F)
as.factor(paradigm)   1 0.057856   3.7414      3    194 0.01206 *
Residuals           196
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ’.’ 0.1 ‘ ’ 1
summary(responses.manova_paradigm, test = "Pillai")
Df Pillai approx F num Df den Df  Pr(>F)
as.factor(paradigm)   1 0.054692   3.7414      3    194 0.01206 *
Residuals           196
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ’.’ 0.1 ‘ ’ 1
summary(responses.manova_paradigm, test = "Hotelling-Lawley")
Df Hotelling-Lawley approx F num Df den Df  Pr(>F)
as.factor(paradigm)   1 0.057856   3.7414      3    194 0.01206 *
Residuals           196
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ’.’ 0.1 ‘ ’ 1
summary(responses.manova_paradigm, test = "Roy")
Df Roy approx F num Df den Df  Pr(>F)
as.factor(paradigm)   1 0.057856   3.7414      3    194 0.01206 *
Residuals           196
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ’.’ 0.1 ‘ ’ 1
summary(responses.manova_paradigm, test = "Pillai")
Df Pillai approx F num Df den Df  Pr(>F)
as.factor(paradigm)   1 0.054692   3.7414      3    194 0.01206 *
Residuals           196
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ’.’ 0.1 ‘ ’ 1

Doing additional ANOVA: Which dimensions do differ?

```r
summary.aov(responses.manova_paradigm)
```

<table>
<thead>
<tr>
<th></th>
<th>as.factor(paradigm)</th>
<th>Residuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Df</td>
<td>1</td>
<td>196</td>
</tr>
<tr>
<td>Sum Sq</td>
<td>163.1</td>
<td>3886.4</td>
</tr>
<tr>
<td>Mean Sq</td>
<td>163.135</td>
<td>19.828</td>
</tr>
<tr>
<td>F value</td>
<td>8.2274</td>
<td></td>
</tr>
<tr>
<td>Pr(&gt;F)</td>
<td>0.004578 **</td>
<td></td>
</tr>
</tbody>
</table>

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Response usol5:

```r
as.factor(paradigm) 1 2727 2727.5 2.3905 0.1237
```

Residuals: 196 223630 1141.0

Response umc6:

```r
as.factor(paradigm) 1 5496 5495.8 4.8805 0.02832 *
```

Residuals: 196 220708 1126.1

58 observations deleted due to missingness

Source 6: MANOVA and additional ANOVA for factor "Configuration Paradigm"
Appendix 10  MANOVA Calculation for the Factor “Complexity”

```r
## Read in data from CSV (via OS dialogue window)
data1 <- read.csv( file.choose(), header=TRUE )
## Optional: Show the column names in the dataset to check correct import
names(data1)
[1] "affin1"          "affin2"          "affin3"          "intention"
[5] "pref"            "user_id"          "pass"            "scenario"
[9] "paradigm"        "complexity"       "clicks"          "usol1"
[13] "usol2"           "usol3"           "usol4"           "usol5"
[17] "compl1"          "compl2"          "compl3"          "ovrl_complexity"
[21] "umc1"            "umc2"            "umc3"            "umc4"
[25] "umc5"            "umc6"

## MANOVA for factor "complexity": Does the complexity of the configuration process influence perceived complexity (ovrl_complexity), perceived solution utility (usol5) and perceived MC-utility (umc6)?
responses.manova_complexity <- manova( cbind( ovrl_complexity, usol5, umc6 ) ~ as.factor(complexity), data=data1)
summary(responses.manova_complexity)
Df   Pillai approx F num Df den Df  Pr(>F)
as.factor(complexity)   1 0.011689  0.76483      3    194  0.515
Residuals             196

## As a check: Different tests for MANOVA (should provide similar results)
summary(responses.manova_complexity, test = "Hotelling-Lawley")
Df Hotelling-Lawley approx F num Df den Df  Pr(>F)
as.factor(complexity)   1         0.011827  0.76483      3    194  0.515
Residuals             196

## Doing additional ANOVA: Which dimensions do differ?
Response ovrl_complexity :
Df Sum Sq Mean Sq F value  Pr(>F)
as.factor(complexity)   1 40.4  40.387 1.9744 0.1616
Residuals             196 4009.1  20.455

Response usol5 :
Df Sum Sq Mean Sq F value  Pr(>F)
```
Source 7: MANOVA and additional ANOVA for factor "Complexity"
Appendix 11  List of Additional Content on the Storage Medium

Finance Ontology: Need Dimensions, Service List, Service Model (en/de)
Path: ../Ontology/customer_finance.owl

Protegé (Ontology Viewer)
Path: ../Ontology/Viewer/protege-4.3.0-304.zip

Prototype Customer-centric/High complexity (de)
Path: ../Prototype/needs-full.html

Prototype Customer-centric/Low complexity (de)
Path: ../Prototype/needs-fast.html

Prototype Product-centric/High complexity (de)
Path: ../Prototype/products-full.html

Prototype Product-centric/Low-complexity (de)
Path: ../Prototype/products-fast.html

List of double-blind service evaluation (de)
Path: ../Service Evaluation/service_evaluation.xlsx

Raw data of the online experiment (en/de)
Path: ../Results/result_19_08_21014_valid_results_for_r_analysis.csv

VOC-analysis (de)
Path: ../VOC-Analysis/Quantification Bottom-Up Analysis.xlsx