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SCHOOLS OF THOUGHT IN SERVICE MODULARITY

Florian Müller
University of Bremen, mueller@is.uni.bremen.de

Aleksander Lubarski
lubarski@is.uni.bremen.de

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SCHOOLS OF THOUGHT IN SERVICE MODULARITY

Research

Müller, Florian, University of Bremen, Bremen, Germany, mueller@is.uni.bremen.de
Lubarski, Aleksander, University of Bremen, Bremen, Germany, lubarski@is.uni.bremen.de

Abstract

Modularity in services has emerged as a promising design principle to achieve a sound balance between cost-effective standardization and individualization at the same time. However, the multiple perspectives from which scholars have addressed service modularity reflect the high degree of complexity of the concept. We denoted numerous research streams within the service modularity domain that use different terminology and draw on their distinctive understanding about the modular service design. The implications that arise from these research streams are manifold and have not yet been covered from a holistic perspective. The purpose of this paper is therefore to provide an overview of the commonalities and differences between existing research pathways and thereby guide both future research as well as service providers. We approach this goal by the use of an innovative methodology that combines both systematic literature review and hermeneutic approach, which enabled us to develop fresh research perspectives while avoiding certain pitfalls of traditional methodologies. Our findings show the emerging of four schools of thought in service modularity research. Each school draws on a distinctive understanding about the interrelation between modularity in service, product and business model.

Keywords: Service Modularity, Business Model, Service Logic, Schools of Thought, Hermeneutics
1 Introduction

Our modern economy is shaped by an increasing importance of the service sector (Bask et al. 2011). Not only service firms, whose core competency is the provision of services, generate a high portion of the economic output, but also manufacturers recognize the importance of services for the business success (Vargo and Lusch, 2004). However, service providers are increasingly challenged by growing competition and cost pressure, so that they face a higher need for standardization and efficiency gains (Böttcher and Klingner, 2011). Simultaneously, ambitions to standardize services are contradicted by growing heterogeneity and complexity among customer demands (Bask et al., 2011, p. 306). With this background, the standardization of services is only possible as long as the flexibility to meet individual customer demands is not diminished (Pekkarinen and Ulkuniemi 2008).

From this challenge, the concept of modularity has emerged as a promising approach to achieve a sound balance between standardization and individualization at the same time. In general terms, modularity can be defined as a process of building a complex system from smaller parts (modules) that can be designed, improved and substituted independently, yet function together as a whole (Baldwin and Clark, 1997). Consequently, this idea of loosely coupled modules results in interchangeability and flexibility in the value creation process, as long as the interfaces between separate modules are well-defined and standardized and a clear one-to-one matching of modules and functions exists (Arnheiter and Harren, 2005). Scholars have so far discussed a large number of positive effects that derive from the use of a modular service architecture, including decreased time-to-market by reusing components for different service products (Böttcher and Klingner, 2011), increased variety and flexibility (Yang and Shan, 2009), as well as economies of scale and scope (Tuunanen et al., 2012), which all lead to an overall cost-efficiency and stronger competitiveness (Bask et al., 2011). A good overview over existing work on service modularity, regarding its relevant definitions as well as discussion of positive and negative effects, can be found in the literature review of Dörbecker and Böhmann (2013).

Even though the concept of modularity has been so far adopted predominantly to products, especially in manufacturing and automotive industry (Geum et al., 2012), service providers already offer customizable services, where the customer (both private and industrial) can “build” his own individual service (e.g., customized parcel in terms of size, speed and insurance, as offered by the German logistics company DHL) out of a limited number of possible alternative modules, thus having more transparency over what is possible and how the final price is calculated. However, despite its roots in manufacturing and software engineering, service modularity has more similarities to process modularity than to product modularity (Bask et al., 2010a) and is thus regarded as a highly complex issue. Similarly, Pekkarinen and Ulkuniemi (2008) point out that due to the intangibility of services, their process character and ongoing close interaction between service provider and customers, the modularization of services may not be that intuitive and result in implementation problems.

The high degree of complexity in service modularity discloses a particularly large interpretation space for service scholars. Over time, several distinctive pathways have emerged from different understandings on fundamental concepts of the terms “service” and “modularity”. As a result, understanding and usage of terminology among scholars in the field of service modularity is diverging. There exist numerous controversial perspectives in the service modularity literature that either oppose each other in a way that they cannot be applied simultaneously or that they again by themselves define distinctive research segments within the service modularity domain e.g. modularity in service organization and in service network production (Bask et al., 2010a). Although scholars reviewed certain research aspects such as the typology of modular service design (Tuunanen et al., 2012) or effects of service modularity (Dörbecker and Böhmann, 2013), we denoted a lack of comprehensiveness in the discussion about the implications of these perspectives.

The multiple perspectives from which scholars have addressed service modularity reflect the complexity of the concept. Considering the large number of theoretical contributions that often use heterogeneous terminology, one may even speak of a certain degree of confusion in the research domain. Similarly, there have been calls for the development of a more comprehensive understanding.
of service modularity that covers the issue from multiple perspectives (Bask et al., 2011; Campagnolo and Camuffo, 2010). The purpose of this paper is therefore to provide scholars with an overview of the commonalities and differences between existing research pathways and thereby clarify future research direction on service modularity. Such research contribution will increase the academic awareness of the implications of certain premises such as the fundamental understanding of “service” and “modularity” in which they ground their research approaches.

The remainder of this paper is structured as following. After giving a quick overview of the overall applied research methodology in chapter 2, we start our research by reviewing existing literature on service modularity and later develop a classification framework consisting of 7 research dimensions in chapter 3, which can be used to structure academic papers based on their fundamental understanding of service modularity. Subsequently, based on the similar patterns in these dimensions, we introduce four schools of thoughts of service modularity in chapter 4. In chapter 5, the implications of each school both for the academic community, as well as for the practitioners in form of advice on what to keep in mind when implementing a modular architecture, will be explained. Scholars from the field of service modularity will also find useful guidelines in these schools when planning their research endeavour. Finally, in our last chapter 6 we conclude our paper with research limitations as well as possible future pathways.

2 Methodology

In order to familiarize ourselves with the current state of research on service modularity as well as to identify current academic void, we conducted an extensive literature review. Due to the overall aim of our research endeavor to cover differences and commonalities in research perspectives, we had to deal with a high degree of uncertainty at the beginning of the research process. When choosing the methodology for our research endeavor, we decided not to use a strictly systematic literature review as suggested by e.g. Cooper (1988) or Webster and Watson (2002), since these are often criticized for being solely formalistic literature searches, lacking a certain level of creativity and academic curiosity (MacLure 2005). Instead, our research process combines a systematic research framework with the hermeneutic approach proposed by Boell and Cecez-Kecmanovic (2014). The idea of the hermeneutic approach is that the “search and acquisition” of relevant articles and the “analysis and interpretation” of the considered literature should be carried out as two major hermeneutic circles (Boell and Cecez-Kecmanovic, 2014, p. 264). The researcher’s initial understanding of the research issue is thereby refined in the course of multiple iterations, so that he does not get lost in the variety of articles and succeeds in developing a distinct and unique contribution. In this way, we provide an innovative approach for analyzing the literature on service modularity. Figure 1 presents the overall methodology of our research and illustrates the two hermeneutic circles.

In our first step (Step 1, Figure 1) we screened the main academic search engines (Web of Knowledge, Google Scholar, EBSCO, Science direct, Elsevier and Jstor) for relevant journal and conference articles. While searching these databases, we used the search term “service” in combination with one of the following additional terms “modularity”, “modularization OR modularisation” and “modular”. We identified 16 relevant articles that deal with modularity in services as a key issue. Six further articles were located and added to our list of relevant articles using forward and backward search. The search for relevant articles was followed by an analysis of the literature (Step 2, Figure 1) and insights from the analysis gradually altered the research aim and the scope of the search (Step 3, Figure 1).

In the course of this hermeneutic circle (search and acquisition), we extended our search with new search terms (combination of previous search terms with dimension descriptions, e.g. strategic modularity, customer perspective in modularity), which enriched our results by five additional papers. On the other hand, five papers were excluded due to a lack of focus on modularity in services. In this way, the body of considered literature (A, Figure 1) constantly evolved during the research process. At the end of the review process, the considered literature comprised 22 relevant articles that we believe cover the status quo in research on service modularity. Most of these articles either deal with the general understanding of service modularity, assessing and analyzing modular service architectures or...
service modularization methods. Articles that themselves were solely literature reviews were not considered unless they demonstrated an additional conceptional contribution. A majority of the identified articles were younger than 2010 with several publication stemming from 2015. This underlines the growing attention that scholars devote to service modularity as a relatively new field of study.

In the course of the research process, not only the scope of the search was refined but also the applied review criteria to analyse the data. To deal with the high uncertainty that most review processes are subject to (Boell and Cecez-Kecmanovic, 2014), at the beginning of the review process, a tentative research framework, i.e. coding scheme (Y, Figure 1) was derived from our overall research aim to capture the heterogeneity in understanding of service modularity among the literature. The tentative research framework consisted of six general search fields: terminology, premises, references, research context, research problems and motivation. Based on these general search fields we analyzed differences and commonalities among the service modularity literature (Step 1, Figure 1). The coding scheme then evolved in the course of the second hermeneutic circle (analysis and interpretation) in which we iteratively analyzed the data, searched for patterns in our findings to classify articles with a similar understanding about service modularity (Step 4, Figure 1) and critically assessed the applied coding scheme (Step 5, Figure 1). As suggested by the hermeneutic review circle, we thereby moved back forth between the understanding of a larger whole and the understanding of parts in the literature.

In the second hermeneutic circle (analysis and interpretation), we introduced a certain degree of systematics (Keele, 2007, pp. 7–8) by employing MaxQDA - a software for qualitative data analysis that helped us to organize and manage the data, i.e. to code relevant passages in the literature. MaxQDA was further applied to identify reoccurring patterns in the coded data and to develop larger categories to capture these patterns (Saillard, 2011). In response to our growing understanding of the research issue, the coding scheme was gradually transformed into research dimensions and corresponding characteristics. Clustering of articles based on their commonalities was an iterative step, since articles could not always be intuitively assigned to a certain school of thought due to their heterogeneity and sometimes-blurred definitions and research direction.

In the last iteration, we elaborated seven dimensions (B, Figure 1) for service modularity, which, in our opinion, deliver a good overview over current research directions and are able to capture much of the heterogeneity in understanding of service modularity in the literature. Using these dimensions we tested whether all the identified papers can be categorized appropriately and for the purpose of the validation of findings (Green et al., 2001), these iterations were carried out by two different researchers. This resulted in an inter-coder reliability (Kurasaki, 2000) of 82%, pointing out that the developed raster along with the dimensions seems to be plausible. Based on these dimensions the literature on service modularity reflected certain patterns, which were subsequently aggregated to four schools of thought in service modularity (C, Figure 1).

Figure 1. Research Methodology
3 Dimensions in Service Modularity Research: Status Quo

Service modularity is a highly complex research discipline (Bask et al., 2010a; Dörbecker and Böhm-mann, 2013) and discloses a particularly large interpretation space for service scholars. Over time, several distinctive pathways have emerged from different understandings on fundamental concepts behind service modularity. Due to this complexity scholars call for research that covers service modularity from multiple perspectives (Campagnolo and Camuffo, 2010).

In the course of our research process, we denoted numerous controversial perspectives in the service modularity literature, that either oppose each other in a way that they cannot be applied simultaneously or that they again by itself define distinctive research segments within the service modularity research domain. We identified and examined these essential differences in service modularity literature to elaborate sets of interconnected research dimensions. Within these dimensions, we searched for related research characteristics. For example, we distinguished between different understandings (characteristics) about service in the dimension Service Paradigm (see below). Similarly, further characteristics were identified and categorized into dimensions. To ensure consistency, those characteristics that were modified or newly introduced during the analysis were rigorously applied again to the entire list of relevant literature (Burnes, 2005). This was done in multiple iterations (Step 2, Figure 1) until the arrangement of dimensions and characteristics gave both a sound impression to cover the diversity in service modularity research from a holistic perspective, and no further characteristics in our dimensions could be identified. In total, the final research framework that was systematically applied to the relevant literature consisted of seven dimensions including 15 characteristics. These dimensions are outlined below in detail (characteristics marked cursive).

- **Roots:** Service modularity has been established in a wide range of scientific disciplines, long before becoming a popular research topic in the service domain. Many scholars have transferred insights from these established fields to services and thereby in many cases inherited a particular understanding of modularity and distinctive terminology. Besides, in a business and technological context, modularity has also been discussed in a wide range of other fields including biology (Schlosser and Wagner, 2004), psychology (Fodor, 1983) and American studies (Blair, 1988). However, we could not find evidence that insights from these fields have found application in service modularity research. Instead, the roots of service modularity stem from Manufacturing and Information Systems (including software engineering), which by far rank among the most often cited research disciplines in service modularity literature (cf. Böhmann and Krcaur, 2003; Tuunanen et al., 2012). Although a few articles mention modularity in organizational and management contexts (Cabigiosu et al., 2015; Campagnolo and Camuffo, 2009), these domains seem to play a negligible role in comparison. Most outlets, in which articles about service modularity have been published, stem from the manufacturing (7 articles) and information systems domain (9 articles).

- Only six articles were published in traditional service and marketing journals (e.g., Lin et al., 2010; Tuunanen et al., 2012; Tuunanen and Cassab, 2011) but these publications also explicitly draw on insights and terminology from modularity in a manufacturing and information systems context. Overall, we identified many further interrelations to other dimensions, which we believe makes it worth paying closer attention to the roots of service modularity during our literature review.

- **Service paradigm:** Service science is regarded as a comparably young research discipline (Ostrom et al., 2010). According to Voss and Hsuan (2009), “Services can feature high or low human involvement and high or low experiential outcomes; they are IS or physically based, they may be B2B or B2C, and so on” (Voss and Hsuan, 2009, p. 560). In this heterogenic service environment, scholars have developed different understandings about the interrelation between service modularity and modularity in product. This is reflected by a large number of sub areas that scholars address from the viewpoint of modularity in a service setting, including modularity in service production, service product, service process, service organization, service offering and service production network (Bask et al., 2010a; Pekkarinen and Ulkuniemi, 2008; Tuunanen et al., 2012). Modularity is discussed in a similar fashion in a manufacturing context (e.g., modularity in pro-
duction, product, production process, organization and supply chain). Thus, we denote a low degree of consensus among scholars in the field of service modularity about service in general and in particulars about the delimitation and interplay between service and product. With a unified definition for service and modularity still being absent (Bask et al., 2010a; Carlborg and Kindström, 2014), this raises the question: where does service modularity end and where does modularity in product begin? We searched for commonalities between the service understandings and identified two research streams that can be distinguished by the role of product modularity in a service context. The first research stream is close to the traditional good-dominant logic (GD-logic) and clearly distinguishes between modularity in service and modularity in product. From this perspective, services are regarded as an add-on to products (Vargo and Lusch, 2004) and modularity in service and modularity in product are two research disciplines of equal importance. Interrelations between these disciplines have to be taken into account in a distinct and synchronized fashion. In contrast, in the second research stream, service modularity plays a dominant role and is regarded as encompassing modularity in product. Product requirements in terms of modularity are derived from the modular service. Scholars that adhere to this perspective often pay little attention to interference between service and product modularity. For instance, numerous scholars that study service modularity in an IS context do not even mention product modularity (e.g., Ho et al., 2009; Kazemi et al., 2011). This perspective is closer to a service-dominant logic (SD-logic) that regards service as an all-encompassing logic in which services are rendered by products (Vargo and Lusch, 2004, 2008; Smyth, 2014). Although most of the reviewed articles do not clearly state whether their service understanding draws on established service paradigms (exceptions: Tuunanen and Cassab (2011); Tuunanen et al. (2012), who explicitly ground their research in the SD-logic), we were able to recognize tendencies by using characteristics from the established literature (Vargo and Lusch, 2004, 2008).

- **Operating level:** The ambivalence of service modularity is also reflected on the operating level: Modularity may be understood as either a strategic or an operational concept (Bohmann et al., 2003; Geum et al., 2012). Scholars point out that depending on the role of service modularity, the concept is subject to various limitations (Bohmann et al., 2003). This raises the question: Does service modularity act in the boundaries of the business logic or may it be used to transform the business logic? Other scholars indicate that service itself may be understood as a business logic (Grönroos and Ravald, 2011). Generally, the operating level seems to be closely interrelated to other important questions in service modularity research. While scholars, who emphasize the operational role of service modularity often highlight positive effects such as efficiency gains and cost reductions that may be achievable by using a modular architecture, articles that highlight the strategic nature of the concept generally pay more attention to an optimal trade-off between positive and negative effects (Bask et al., 2010b; Carlborg and Kindström, 2014). However, the path to finding an optimal balance is closely intertwined to the operational level to which service modularity is applied. According to Bask et al. (2010), service modularity has not been recognized as a particular method for the strategic repositioning of services. We found that the potential of service modularity in a strategic role and its usability in the field of business model transformation remains widely undiscovered. Therefore, we consider the operational level of service modularity as another dimension in our review as many implications (e.g., benefits, costs, limitations and methods) arise from the understanding of service modularity as either operational or strategic.

- **Actor spheres:** Service provision always takes place between service provider and customer (Vargo and Lusch, 2004; Grönroos, 2011). During service provision, service is individually experienced by the customer and in dependency of the service design (Zehrer, 2009; Lin et al., 2010). Tuunanen et al. (2012, p. 102) define service experience “as the outcome of the firm meeting the users’ needs through modularity-enabled customization, personalization and value creation of the service”. Thus, changing the degree of customization and standardization of a service may likely influence the customer’s service experience. For this reason, service modularity literature may be segmented depending on the degree of attention that scholars devote to the provider role and customer role in the service process and, more specifically, to the service experience of the customer.
Many of the reviewed articles emphasize the provider role and highlight certain positive effects that may be achieved by the use of a modular architecture. The discussion on service modularity must also deal with the question how modularity in service affects the customers’ service experience and under which circumstances these changes are desired. However, to which degree the customer role is taken into account in the discussion about service modularity is mainly a question of the motivation behind its use and the operational level on which the concept is applied. Operational benefits such as cost reductions or a shorter time-to-market may be achieved using a modular architecture while maintaining a present customer experience (e.g., Hsuan, 1999; Rahikka et al., 2011). In contrast, other scholars recognize the service experience as an important variable in the service modularity discussion that may intentionally be altered to improve service value and even achieve a reposition of a service in the marketplace (Bask et al., 2010b).

- **Module orientation**: Baldwin and Clark’s (1997, p. 84) original definition of modularity distinguishes between modularity in product and processes: “Building a complex product or process from smaller subsystems that can be designed independently yet function together as a whole” (Baldwin and Clark, 1997). However, the nature of services allows viewing them from both a product and process perspective at the same time (Bask et al., 2010a). While the process perspective provides insights on activities during service production, the product perspective is more static as it mainly highlights customer perception of the service offering and resources that are applied during service provision (Bask et al., 2010a). As none of these perspective seems to be sufficient to cover full service complexity on its own, scholars elaborate service architectures based on combinations of multiple description layers for service modules (Bohmann et al., 2003; de Blok et al., 2010). Owing to the product and process character of services, each module in such a service architecture includes product specific information (e.g., about performance, price, costs and related resources) that plays a vital role during module production or in the service offering. While this information reflects the product perspective and is merely static (de Blok et al., 2010), an explanation of the functionality of the module in the service architecture demands for a more dynamic perspective, which is often introduced through a process or functional layer. While most of the reviewed articles suggest the use of multiple layer covering both dynamic and static elements, most service architectures emphasize either a static or a dynamic perspective by using it on a first level of the architectural hierarchy. For instance, Bohmann et al. (2003) uses a first-level layer of single functional modules that are derived from the workflow of the service and Voss and Hsuan (2009) use a static layer on the first level of the hierarchy that is based on tangible resources.

- **Contribution**: Literature on service modularity may be segmented based on their academic contribution, namely – **Definition, Assessment and Modularization Methods**. Due to the large heterogeneity among service scholars about modular services, the development of a clear definition of service modularity is still in its infancy. Scholars that aim at the definition of service modularity often additionally deal with the applicability in different areas of application (e.g., Bask et al., 2010a) and investigate interdependencies between principles and effects of the concept on a conceptual level. In contrast, another group of articles aims at the assessment to which a given service architecture reflects principles of service modularity such as decoupling, standardization and commonality. In addition, different application fields and service perspectives are addressed. For example, Bohmann & Loser (2005) describe a method that allows the assessment of a firms agility based on principles of service modularity. Similarly, Kazemi et al. (2011) provide a metric suite for measuring service modularity. Finally, Liu et al. (2010) present a framework for analyzing modularity in product family design. Assessment methods may also be used to evaluate the qualification of an existing service for further modularization as indicated by Carlborg & Kindström (2014). A third group, **Modularization Methods**, of articles aims at providing guidelines and methods on how to accomplish a modular service architecture either during the new services development (NSD) or by altering the degree of modularity in existing services. Articles from this category outline pathways for the decomposition of a service into components and the reconstruction of these components into service modules. Therefore, we found it important to consider the overall purpose of service modularity literature.
Motivation: In general, the motivation behind service modularity may be differentiated between positive effects and trade-off/balance. Positive effects that may potentially emerge due to the use of a modular architecture have been already extensively discussed (Bask et al., 2010a; Bohmann et al., 2003). A detailed literature review on positive effects associated to service modularity can be found in Dörbecker and Böhmann (2013). However, service modularity has also been recognized as an approach to achieve a certain balance between different effects. For example, the often cited trade-off between meeting customer requirements while maintaining cost efficiency is often discussed with respect to mass customization (Brusoni et al., 2007; Tuunanen et al., 2012). Although the costs of modularity and further negative effects (e.g., the so-called modularity trap (Ernst, 2005)) that may arise due to an inappropriate use of modularity or emerge through the development and maintenance of a modular architecture (Brusoni et al., 2007) were partially mentioned, we could not find articles that deal with this issue in the service domain. If scholars highlight possible negative effects, then this is mostly done as part of the discussion on an optimal trade-off or balance between positive and negative effects.

In the last iteration of our methodology, the outlined seven research dimensions were rigorously applied to our final list of relevant articles (B, Figure 1). These dimensions provide the foundation for the successive synthesis of the schools of thought in the field of service modularity and the discussion of implications for theory and practice (Figure 1, Step 3). A summary of our review is provided in Table 1.

We demonstrate the systematic application of our research framework at the example of the journal article “Service Architecture and Modularity”, in which Voss and Hsuan (2009) present a service modularity function, which allows mathematical assessment of the degree of modularity derived from unique services (Contribution: Modularity assessment). The authors adopt their assessment approach from the manufacturing context, more precisely draw from insights of Tu et al. (2004) (Roots: manufacturing). They outline the motivation behind service modularity in the facilitation of outsourcing, agility and the achievement of economies of scope and scale. Although negative effects are not explicitly discussed, the article outlines the role of modularity in service for achieving a trade-off between customization and standardization (Motivation: Positive Effects and Trade-Off). Voss and Hsuan (2009) draw on a understanding of service which is close to the SD-logic which mirrors in their discussion on one-to-one mapping of service functions to physical products (Service understanding: Service-dominant). At the same time, they discuss the strategical implications of the use of a modular architecture at the example of modular platform strategies (Operational level: Strategical). The customer’s service experience is taken into account in the assessment method (Actor spheres: Provider + Customer). The assessment method is oriented at the product perspective of service and on a first level of the hierarchy measures the degree of modularity based on tangible resources (Module orientation: Static).
| Dimensions                      | Characteristics                      | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|--------------------------------|--------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Roots of Modularity           | Manufacturing                        | X  | X  | X  | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|                               | Information Systems                  |    | X  | X  | X  | X  | X  | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Service Understanding         | Service-dominant                     | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |    |    |    |    |    |    |    |
|                               | Distinctive                          |    | X  | X  | X  | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Operational Level             | Strategic role                       | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|                               | Operational role                     | X  | X  | X  | X  | X  |    |    | X  | X  | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Actor spheres                 | Provider role                        | X  | X  | X  | X  | X  |    | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
|                               | Customer role                        |    | X  | X  | X  | X  |    | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
| Module Orientation            | Static                               | X  | X  | X  | X  | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|                               | Dynamic                              | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Scientific Contribution       | Modularity Assessment                | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|                               | Modularization Methods               | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|                               | Definition                            | X  | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Motivation                    | Positive Effects                     | X  | X  | X  | X  | X  |    | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
|                               | Trade-Off/Balance                    |    | X  | X  | X  | X  |    | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |

*Table 1. Literature review based on dimensions of service modularity*
4 Schools of thought in service modularity

Table 1 alone merely gives a summary of the existing work, structured with the newly developed criteria. However, in order to identify the major research streams in service modularity, additional analysis of this seven-dimensional space is necessary (Step 3, Figure 1). Here it is important to not only measure the correlation between the characteristics mathematically by counting the crosses (e.g., Customer Perspective has a high correlation with Operational Level of service modularity), but also trace back what dimensions are the actual causality and what are their implications. Therefore, an additional review of the identified literature had to be performed, paying particular attention to explanations and linkages between dimensions (Step 2, Figure 1). As a result, we denoted that Operational Level and Service Understanding are in fact dominant dimensions, whereas other dimensions can be interpreted as their implications. Therefore, the findings of our literature research can be simplified and summarized in a 2x2-matrix (Figure 2).

In this 2x2 matrix, the interrelation between business model, service and product lays the foundation for four schools of thoughts (research streams) of service modularity, which bundle the remaining dimensions (Motivation, Scientific Contribution, Actor spheres and Module Orientation) in form of implications. An exception constitutes the dimension Roots, which we identified as a major driver of these four schools of thought. In most of the papers representing GD-logic, we found a strong background in manufacturing, which explains their intention of transferring the ideas of product modularity into service modularity. The other service paradigm, SD-logic, has its roots in Information Systems (including software engineering) and therefore sees a physical product merely as a tool of delivering a certain service, meaning that modularity in product is solely interpreted as a mechanism to fulfill service modularity requirements. This linkage between Roots and Service Paradigm is confirmed when looking at the research outlets in which articles were published.

![Figure 2. Schools of service modularity](image)

In Figure 2 there are three key elements: Business Model, Service and Product. Each of the four schools provides a distinctive understanding about the fashion in which modularity is applied to these elements (indicated by straight arrows). Either modularity is applied solely to product and/or service (Schools 1 and 2) or it is used to transform the business model of the service provider (Schools 3 and 4). Elements that can be altered by modularity are indicated by dashed frames. Additionally, the interdependence between Service and Product is illustrated: they can be seen either as compliments (two identical dashed bars in Schools 1 and 2) or Service is regarded as an all-encompassing logic (dashed...
bar for products inside a service bar in Schools 3 and 4) in which products merely render services (Vargo and Lusch, 2004). The developed schools along with their corresponding characteristics (representing all seven dimensions) are summarized in Table 2. The numbers in the brackets indicate the occurrence of certain characteristics within the relevant literature in the considered school. For example, in the Traditional school, 4 out of 5 identified papers have their roots in manufacturing, all 5 separate between services and products and concentrate on the provider perspective, and so on.

<table>
<thead>
<tr>
<th>Category</th>
<th>Dimension</th>
<th>Traditional</th>
<th>Versatile</th>
<th>Service excellence</th>
<th>Visionary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cause</td>
<td>Service Understanding</td>
<td>Distinctive (5/5)</td>
<td>Distinctive (3/3)</td>
<td>Service-dominant (7/7)</td>
<td>Service-dominant (7/7)</td>
</tr>
<tr>
<td>Cause</td>
<td>Operational Level</td>
<td>Operational role (5/5)</td>
<td>Strategic role (3/3)</td>
<td>Operational role (7/7)</td>
<td>Strategic role (7/7)</td>
</tr>
<tr>
<td>Implication</td>
<td>Actor spheres:</td>
<td>Provider (5/5)</td>
<td>Customer (3/3)</td>
<td>Provider (6/7)</td>
<td>Customer (7/7)</td>
</tr>
<tr>
<td>Implication</td>
<td>Module Orientation:</td>
<td>Static (4/5)</td>
<td>Dynamic (2/3)</td>
<td>Static (5/7)</td>
<td>Dynamic (5/7)</td>
</tr>
<tr>
<td>Implication</td>
<td>Motivation:</td>
<td>Benefits (4/5)</td>
<td>Trade-off (2/3)</td>
<td>Benefits (5/7)</td>
<td>Trade-off (5/7)</td>
</tr>
</tbody>
</table>

Table 2. Schools of thought in service modularity and their characteristics

The purpose of these schools of thoughts is therefore not only the simplification and summary of our literature review, but also the identification of distinct research streams for service modularity researchers. As for the practical use, the developed framework shall help service providers to decide about the scope of their modularization initiative, based on their service understanding and what part of their company they plan to modularize (i.e. single services or complete business model). The following chapter outlines the four schools of thought in detail.

5 Discussion of schools and their implications

In the Traditional school the business model does not play an active role in the discussion about service modularity, instead it frames the application area in which modularity is applied to service and product in a potentially synchronized but separate fashion. When applied in this manner, service modularity can be understood as an operational instrument to achieve cost reductions and internal efficiency gains, which often may be yielded without altering the present customer experience. Hence, scholars that follow this school generally do not aim at changing the customer experience, or the business model. Articles that we categorized in this school include Bask et al. (2010), de Blok et al. (2010) and Böttcher and Klinger (2011). These articles mainly discuss positive effects of using a modular architecture in general and regard service modularity as closely intertwined with modularity in products. Future researches in this school should pay special attention towards how service modularity is reflected on the (modular) products. As for the practical implications, in the first place, companies have to define for themselves strictly, what operational means for their business. This includes predefinition of boundaries of the business logic that frame the application space of service modularity and thus constitute premises in the course of the modularization process. On the other hand, those elements that may be subject to revision must be identified. However, additional coordination and transaction costs may arise from the necessary synchronization between modularity in products and services.

Since the elements in School 2 may be altered through the modularization process independently of each other (as this leads to the highest possible methodical flexibility) we call this school Versatile. In the Versatile school service modularity is regarded as a strategic concept and thus aims at altering the business logic to deliver services to customer segments that have not been addressed in the past. This
strategic repositioning of a firm opens up a wider application space in which modularity is applied to services and products in similar fashion as in the Traditional school. Scholars that follow the Versatile school interpret modularity in services as a mechanism that supports strategic repositioning of a firm. However, we could identify only few articles that combine a distinctive perspective on products and services while applying modularity on a strategic operational level (e.g., Pekkarinen and Ulkuniemi (2008) and Cabigiosu et al. (2015)). This may be due to extended need for synchronization between modularity in the business model, modularity in service and modularity in product. Another pattern that can be observed in the Versatile school, is that most articles not only deal with possible benefits of service modularity, but also analyze the trade-off between these benefits and resulting costs. For this reason, there is a need for the development of a framework that provides guidelines on how to analyze whether and in what scope a company could benefit from modularity in general and from a strategic perspective in particular. Similarly, before altering the degree of modularity in the business logic, service providers must develop an understanding about whether customers will perceive the planned changes in a positive or negative way in order to improve their competitiveness on the market.

Similar to the Traditional school, the Service Excellence school sees the business model as a boundary to the application of modularity in services. However, service and product are no longer equally understood and the need for synchronization is replaced by a dominant role of the service from which requirements of product modularity are derived (Geum et al., 2012). Scholars from this school focus on modularity in services with the overall aim to achieve operational agility, while maintaining the present service experience of the customer (Ho et al., 2009). Instead, the focus lies on the role of the supplier as well as on the operational service improvements through introducing configuration options and implementation standards. Due to the operational boundaries of service modularity, this school mostly pays more attention to certain positive effects instead of trying to achieve a balance or trade-off. For this reason, scholars need to develop frameworks that enable measurement of both positive effects resulting from service modularity and the costs of developing and maintaining a modular service architecture. Another pattern that could be observed in the Service Excellence school is that most papers decompose services into modules based on a merely dynamic process perspective (e.g., Li et al., 2012) on the first level of the architectural hierarchy (cf. Chapter 3). The implication for the practitioners is therefore to develop a clear differentiation between parts of the service process that are visible to the customer and those process steps that are mainly carried out in the back office and hence may be altered without changing the customer experience.

In the Visionary school, service modularity is seen as a strategic element that challenges both service and business model, which are strongly interconnected. Some scholars have also proposed that service itself may represent a certain form of the business logic (Grönroos and Ravald, 2011). Similarly, to the Versatile school, modularity can alter not only the service and the product, but also transform the business model. However, the Visionary school draws on an understanding of service that is close to the SD-logic and thus sees service in a dominant role. Hence, more attention is devoted to the customer service experience, which may be intentionally altered in order to achieve a strategic repositioning of the firm (e.g., targeting a new customer segment). As for the motivation for modularity, more attention is devoted to a sound balance between benefits (both operational and strategic) and resulting costs of modularity. However, this trade-off becomes more complex, since the business model is no longer regarded as a constraint and instead is an elastic element and subject to possible modification. Given this higher degree of complexity, further research is required that investigates how service modularity can be integrated into strategic decision making on a managerial level. At the same time, due to the higher complexity resulting from the elastic nature of the business model, assessing the degree of modularity of existing services is comparably more difficult than in other schools. Practitioners, on the other hand, need to determine what advantages can be achieved on both operational and strategic level and prioritize these, while paying special attention to their corresponding costs. Here, the typology of service process types by Carlborg and Kindström (2014) offers a promising starting point, although the modular strategies they describe might still be too vague to guide measures for implementing the modularity concept in organizations.
6 Conclusion and future pathways

As displayed by the results of our literature review, service modularity has attracted a lot of attention in the academic society in recent years. Contributions from scholars stemming from various research domains have enriched the discussion on the definition, assessment and application of modularity in services, but also lead to a certain degree of confusion. Our research shows that different research streams have emerged that draw on their own unique understandings and terminology. Judging from the publications of previous years, it seems that the academic world has identified and exploited certain research streams, which can be observed in both a small number of publications as well as in a comparably low number of industries in which service modularity has found broader adoption. In accordance with other scholars (Bask et al., 2010a; Campagnolo and Camuffo, 2010) we identified the need to provide a holistic framework, which captures service modularity research from multiple perspectives at the same time. For this reason we used an iterative literature analysis based on a hermeneutic approach of Boell and Cecez-Kecmanovic (2014) to first develop seven dimensions of service modularity and then structure the existing literature according to these dimensions.

Our research indicates that two of these dimensions (Operational Level and Service Understanding) can be perceived as dominant, whereas other dimensions can be seen as their implications. Drawing on these results, we identified similar patterns in the research articles and subsequently synthesized these patterns into four schools of thought (Traditional, Versatile, Service Excellence and Visionary) in service modularity research. Finally, each of the modularity schools contained not only the detailed description and current research status, but also implications for both academic society and practitioners. The relations between dimensions show that scholars who study service modularity need to clearer demarcate their interpretation of service modularity with respect to the different dimensions. For example, scholars who seek to develop service modularization methods need to determine the motivation behind their research. For this purpose, future service design researchers should classify their research endeavour into one of the schools of thought, keeping the corresponding dimensions and their characteristics in mind.

However, so far the concept of modularity has remained rather theoretical than a practical approach. One of the possible reason for that is the fact that service providers do not see the practical potential of modularity and what benefits it can bring along, since academic papers usually speak of it in general terms. Hence, further research similar to the typology of the service process types by Carlborg and Kindström (2014), should concentrate on defining a set of evaluation criteria that can serve as a guidance for service providers to determine whether and in what scope they could benefit from the concept of service modularity. Another obstacle in applying the concept of modularity in practice lies in the specifics of services compared to tangible products, in particular intangibility of services and a close interaction between the provider and customer through the whole value-creating process. Therefore, new modularization methods, specially designed for services have to be developed, which is of particular interest for the Versatile and Visionary schools, where business model is no longer a constraint, but can be influenced by the modularization process as well. Finally, additional research on the trade-offs between possible benefits and modularization cost is needed. In this context it is also of importance to test whether a systematically established modular system is stimulating, or, on the contrary, limits radical service innovations by falling in the so-called modularity trap (Ernst, 2005).

Limitations of our paper arise from the hermeneutic approach, which cannot ensure that all relevant perspectives of service modularity were covered. Similarly the derivation of the schools of modularity from the dimension table was not conducted mathematically and was subject to the interpretation of the authors and might still be improved or enriched by other service modularity researchers in the future, for instance in terms of additional dimensions and related characteristics. To validate our findings empirically, we call for additional research to investigate the highlighted relations between dimensions of service modularity by means of case studies at service providers.
References


