

A Review of Product-service System Design Methodologies

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Abstract: In a fast-changing and increasingly digitalized world, companies face numerous challenges today. One of these challenges is the customer's demand for an integrated offer instead of the purchase of a single product. By offering product-service systems (PSS), companies are able to fulfil this need with an integrated and desirably unique value proposition. For the development of those PSS there are numerous process models in the literature, which present a procedure for systematic PSS development. This paper systematically identifies and examines available existing process models and compares them with the challenges that PSS are facing within their development as well as implementation and use-phases. This research aims to support the integrated and innovative development of future digital product-service systems.

1 INTRODUCTION

The business world today is changing due to numerous influences and ever-shorter innovation cycles. This also applies to traditionally oriented, mostly manufacturing companies, which have to date often focused on the development, production and sale of physical products. However, even these traditional business models, which have been successful for a long time, are coming under increasing pressure, as customers no longer demand just a product, but their focus is increasingly turning towards the utility of the offering. As a result, former pure product-oriented companies increasingly discover new business models that extend the value proposition through services. In this way, product-service combinations can offer customers a unique utility and value. They can also lead to increased customer loyalty. However, these product-service combinations must be modularly developed and individually customizable to the customer in order to deliver this new value proposition. This shift in offerings towards servitization can be achieved with the help of Product-Service Systems (PSS). While the advantages of these product-service combinations are obvious, their systematic development is a significant challenge. For this purpose, the literature offers some approaches in the form of PSS process models.

This paper aims to identify PSS process models by means of a systematic literature search and to compare them with a series of challenges for PSS,

which were identified in a previous analysis (Richter et al., 2018). On the basis of these criteria, it is analysed to what extent current PSS process models are designed in relation to current and future challenges for PSS. This is particularly relevant in the context of the increasing digitization of business processes, business models and entire companies. Therefore, the development of digital PSS (dPSS) is becoming increasingly relevant which also might require novel approaches (Lerch and Gotsch, 2015).

2 METHODOLOGY

The following subsections present the methodology of the paper. First, the research goal and research questions are discussed, then the process of literature research and analysis is described in detail.

2.1 Research Objectives

The aim of this literature analysis is to identify the current process models for PSS development available in the literature and to review their applicability based on challenges that were identified for this field.

- RQ1: Which approaches for PSS development are available in the literature?
- RQ2: Which of the identified approaches are process models for PSS development?

- RQ3: Which of the identified process models address commonly discussed PSS challenges?

2.2 Research Process

The literature search was conducted in five consecutive steps. These consist of (1) the determination of the basic research parameters through the application of the Cooper (1988) taxonomy, (2) the definition of the search terms and search term combinations for the search of the databases, (3) the selection of the databases to be used, (4) the methodological analysis method for the analysis of the search results as well as (5) a backward search for further sources of information.

2.2.1 Definition of Research Scope

Harris M. Cooper (1988) analysed a number of literature reviews and derived a taxonomy for literature reviews from this research. The taxonomy consists of six characteristics, which contain several categories. Table 1 below shows Cooper's characteristics (left column) and their configuration for the presented research (right column).

Table 1: Definition of the research.

Focus	The focus of the research is the identification of process models available in the accessible literature for the development of PSS. The identified process models must have a description.
Goal	The aim of the research is to identify and analyse described process models for PSS development. In addition, the models are reviewed for the fulfilment of certain criteria.
Perspective	The perspective of the analysis should be neutral.
Coverage	The coverage of the review is intended to be exhaustive with selective citation on the focused field of investigation.
Organization	The organization of the analysis is methodologically for the purpose of analysing different methodological approaches for PSS development.
Audience	The audience of the review are general scholars as well as practitioners and service scientists.

2.2.2 Definition of Search Terms

Since the goal of the research was to identify process models for the development of PSS, which can be

seen as a part of the research field of servitization, the following search string was chosen to identify relevant literature on the searched data bases and search engines:

“PSS” OR “Product-Service System” OR “Servitization” AND “Development” OR “Design” OR “Framework” OR “Model”.

The reasons for defining the named search terms are that servitization can be seen as a superordinate term for PSS (Lightfoot et al., 2013) and the terms framework, model, development, and design are often used synonymously in the academic literature. Therefore, those four last terms are most likely to bring the best search results for PSS process models.

2.2.3 Database Search

The targeted publications were journals and conference papers from the following databases/search engines: Science Direct, Springer Link and Google Scholar. In addition, the scope of the analyses was limited to the first hundred results from each source. The last criteria were that the publication had to be accessible with a regular license for the database. The search included findings, which were published until the end of 2017. A further investigation for new relevant search results was carried out in April 2018. This search did not lead to any additional relevant findings. Based on 300 search results, seven duplicates were removed. After the relevance check, 87 sources were left. Including further literature, the total mass was increased to 94 results. The subsequent check for the occurrence of "model", "framework", "method" and "methodology" revealed 42 sources. These were then examined for Kleuker's (2018) process model criteria, which led to a remaining total of 13 described procedural models.

2.2.4 Analysis of Search Results

The analysis of search results was conducted through application of the concept matrix method of Webster and Watson (2002). All search results were transferred to an Excel file and the concept matrix method was applied to them. The concept matrix provides a framework, for the concept-centric analysis of literature. Hereby, all relevant findings can be analysed by pre-defined concepts as well as by sub-concepts.

2.2.5 Further Search based on First Analysis

If authors of the identified articles cited other sources that were not identified in the initial database search, then these sources were also considered for the

analysis. This was done in order to gain further insights on the subject of the research.

3 PRODUCT-SERVICE SYSTEMS

The PSS research community originally emerged from the Scandinavian region. Basic work on this topic was carried out by Goedkoop et al. (1999) and Mont (2000), among others. Further contributions to the classification of PSS were made by Tukker (2004) with his description of various PSS types.

In general, according to Baines et al. (2007), the PSS research field can be seen as a part of servitization. In this context, the discipline places a higher focus on the use and benefits of products and places these factors above their ownership. Furthermore, it is expected that the integrated development and offering of the service packages will generate a higher customer benefit (Baines et al., 2007).

The field of servitization described by Vandermerwe and Rada (1988) is divided into five research fields by Lightfoot et al. (2013). These include Services Marketing, Service Management, Operations Management, PSS and Service Science (Lightfoot et al., 2013). As an addition to PSS, there is a developing field of industrial PSS that attaches great importance to the industrial business to business character (Lightfoot et al., 2013; Meier et al., 2010).

In this article, this research area is assigned to the overall field of PSS.

The term PSS is also defined differently by various authors. The following table 2 shows some common PSS definitions.

For the analysis of PSS process models, an understanding for the definition on the field and PSS capabilities is quite relevant. Table 2 lists numerous definitions, which have all different foci. Those definitions give the reader room for interpretation of the PSS field.

4 RESULTS

During the analysis of the literature, the terms framework, methodology, method, model and approach were frequently used. Some of them were used synonymously. The table below presents the identified process models and allocates them to one of the five categories. Additionally, the title of the model is also mentioned. In the course of the analysis it became apparent that, despite the promoted

contents (e.g. in title or abstract), the literature does not always address the exact process model of such a PSS development model or does not describe it in detail.

Table 2: PSS Definitions.

Source	Definition
Goedkoop et al. (1999)	“A Product Service system (PS system) is a marketable set of products and services capable of jointly fulfilling a user’s need. The PS system is provided by either a single company or by an alliance of companies. It can enclose products (or just one) plus additional services. It can enclose a service plus an additional product. And product and service can be equally important for the function fulfilment.”
Mont (2002b)	“A system of products, services, supporting networks and infrastructure that is designed to be: competitive, satisfy customer needs and have a lower environmental impact than traditional business models.”
Manzini and Vezzoli (2002)	“A Product-Service System can be defined as the result of an innovation strategy, shifting the business focus from designing and selling physical products only, to selling a system of products and services which are jointly capable of fulfilling specific client demands.”
Brandstotter et al. (2003)	“A PSS consists of tangible products and intangible services, designed and combined so that they are jointly capable of fulfilling specific customer needs. Additionally PSS tries to reach the goals of sustainable development.”
Wong (2004)	“Product Service-Systems (PSS) may be defined as a solution offered for sale that involves both a product and a service element, to deliver the required functionality.”
Tukker and Tischner (2006)	Product-service systems (PSS) are a specific type of value proposition that a business (network) offers to (or co-produces with) its clients. PSS consists of a mix of tangible products and intangible services designed and combined so that they jointly are capable of fulfilling final customer needs.
Baines et al. (2007)	“The concept of a Product-Service System (PSS) is a special case of servitization. A PSS can be thought of as a market proposition that extends the traditional functionality of a product by incorporating additional services. Here the emphasis is on the ‘sale of use’ rather than the ‘sale of product’.”

The lack of details results in the reader not being able to transfer the presented theoretical model into the practical application. Furthermore, an analysis of models that are described in a superficial way is not feasible.

In order to be able to analyse the presented models more precisely, the identified 42 models were examined based on the predefined criteria of a procedure model according to Kleuker (2018) in the subsequent step. In a second step (Table 2), the models that meet these criteria are analysed and described in more detail.

Finally, the remaining 13 models are confronted with the challenges for the development of PSS, which were identified in a previous analysis (Richter et al., 2018).

4.1 Process Model Definition

According to Kleuker (2018) a process model generally describes the entire process from initiation through execution to completion of a project (defined in this paper as selection of the right PSS). Like all other models, a process model represents a simplified representation of reality and is based on an idealized project. The goal of all process models is the specification of a methodical procedure. As a rule, a standardized structuring of projects into clearly defined project phases is carried out using a process model (Kleuker, 2018).

4.2 Identified Models

As described above, the following table displays the identified 42 models.

Table 3: Identified PSS Development Models.

Source	Type					Meets criteria according to Kleuker (2018)
	Framework	Methodology	Method	Model	Approach	
Geum and Park (2011)					X	
Aurich et al. (2010)					X	X
Rondini et al. (2016)			X			X
Marilungo et al. (2016)		X				
Maussang et al. (2009)		X				

Bakås et al. (2013)		X				X
Marques et al. (2013)		X				X
Yang et al. (2009)		X				
Medini et al. (2014)		X				X
Chen and Li (2010)			X			
Tan et al. (2007)	X					
Pigosso and McAlloone (2016)				X	X	
Pieroni et al. (2016)	X					X
Nguyen et al. (2013)	X	X				
Helo et al. (2017)	X					
Song and Sakao (2017)	X					X
Maleki et al. (2017)	X					
Mourtzis et al. (2017)	X					
Adrodegari et al. (2016)	X					
Tran and Park (2016)	X					X
Bertoni et al. (2016)				X		
Scherer et al. (2016)		X		X		X
Medini et al. (2015)	X					
Pezzotta et al. (2015)	X					X
Weeks and Benade (2015)	X					
Schmidt et al. (2015)	X			X		X
Joore and Brezet (2015)				X		
Kim et al. (2015)	X			X		X
Pigosso and McAlloone (2015)	X			X		
Vezzoli et al. (2014)				X		
Schenkl et al. (2014)	X			X		

Table 3: Identified PSS Development Models (cont.).

Source	Type					Meets criteria according to Kleuker (2018)
	Framework	Methodology	Method	Model	Approach	
Stacey and Tether (2014)				X		
Pezzotta et al. (2013)	X					X
Gokula Vijaykumar et al. (2013)	X					X
Pezzotta et al. (2012)		X		X		
Isaksson et al. (2011)	X					
Yang et al. (2010)				X		X
Shih et al. (2009)				X		
Aurich et al. (2009)	X			X		
Maussang et al. (2007)				X		
Weber et al. (2004)		X		X		
Manzini and Vezzoli (2003)	X			X		
Mont (2001)	X	X				

Table 4: Selection of identified PSS Process Models that meet the criteria for the definition to Process Models.

Source	Kind of PSS	Number of Phases
Yang et al. (2010)	Result-oriented	4
Bakås et al. (2013)	General	9
Gokula Vijaykumar et al. (2013)	General	10
Marques et al. (2013)	General	4
Pezzotta et al. (2013)	General	5
Medini et al. (2014)	General	3
Kim et al. (2015)	Service-oriented	4
Schmidt et al. (2015)	General	3
Pieroni et al. (2016)	General	6
Rondini et al. (2016)	General	3
Scherer et al. (2016)	General	5
Tran and Park (2016)	General	3
Song and Sakao (2017)	General	4

4.3 Challenges for PSS and Model Analysis

This section describes the analysis of the identified process models. Here, the models are confronted with the challenges described for PSS development (Richter et al., 2018). The aim of this approach is to assess existing models in relation to current and future challenges of PSS design. The majority of the presented challenges relate to the organizational level or to the design of the services.

4.3.1 Pricing Policies

The costs and pricing policy of the PSS pose a problem, as on the one hand, customers are not familiar with buying PSS concepts and on the other hand, companies have difficulty in offering them. In the analysed process models this challenge is only considered to a limited extent. While Schmidt et al. (2015) considers costs at the level of the "cost/price customer barrier" with its sub-categories of acquisition costs and total operating costs as well as transaction costs, Marques et al. (2013) states the importance of a cost-benefit analysis, which is intended to evaluate the feasibility and benefits of PSS solutions in the planning phase. In their "Service Engineering Framework", Pezzotta et al. (2013) describe costs only in the context of cost savings during the service development phase. This is emphasized as an advantage of the presented model. Compared to this, Tran and Park (2016) acknowledge the challenge of pricing, but do not describe how this difficulty can be overcome. All other models do not contain statements on this topic.

4.3.2 Contracts and Cooperation

Since the offer of a PSS often requires a consortium of companies to provide the offer jointly, the cooperation agreements and the associated regulations on the distribution of sales are an important aspect, which can have a negative impact on the success of the PSS (Richter et al., 2018). None of the models analysed deals with this difficulty.

4.3.3 Uncertainty and Risk

This challenge describes the emergence of uncertainties and risks due to the transfer of product-related risk to the provider. While this risk is transferred to the customer when selling products, it remains on the seller's side when selling PSS due to the lack of transfer of risk. Bakås et al. (2013) model is based on the principle of portfolio management, the

objectives of which include balancing risks and payment. For example, based on Hanski et al. (2012), a product service portfolio is to be managed like a financial portfolio. As a result, solutions with a high risk factor are balanced by solutions with a low or medium risk factor. Tran and Park (2016) mention risks and uncertainties in a different context. They state that the evaluation of the PSS during the development phase can reduce the risk associated with the launch. Pezzotta et al. (2013) also describe a way of reducing risks. They are convinced that the introduction of a tool for assessing profitability and risks can reduce the associated costs. The other models do not explicitly address the challenges of uncertainty or risk.

4.3.4 Communication Strategy

A lack of market acceptance can be overcome by convincing the customer of the value of the PSS, its potential and the benefits of ownership-free consumption through a strong communication strategy. The focus of the communication strategies must therefore be well aligned with the needs of the customers. None of the models analysed allows more detailed insights into this topic.

4.3.5 Current Business Model

In order to design future business models as successfully as possible, a detailed understanding of the current business model, the company's mindset and tools is important. This creates a good basis for future developments. Bakås et al. (2013) begin their model by examining existing internal offerings. Gokula Vijaykumar et al. (2013) also describe how essential it is to identify the current business models.

However, the focus here is not only on offers already launched on the market which could help to meet customer needs, but also on those which are currently being planned. Similarly, Rondini et al. (2016) argue that it is important to evaluate how current business models can be changed to meet customers' needs. Marques et al. (2013) also deal with the analysis of existing business models in their framework. In contrast to the other models, the review of existing design processes is seen as one of the organizational prerequisites for developing a PSS. However, Pieroni et al. (2016) describe the handling of the topic of current business models in the most detailed way. The aim of the first phase of the model presented by them is to understand the current business models and further information about the business context. This is done, among other things, by evaluating the current business model using specific

questionnaires containing internal and external aspects. The models of the authors who are not mentioned do not cover this challenge.

4.3.6 Organizational Transformation

The shift from a product or service provider to a PSS provider requires organisational adjustments. These include the alignment and development of processes and the framework conditions for the effective development and provision of PSS. This change represents a major challenge, especially for manufacturing companies (Baines et al., 2009; Gebauer and Fleisch, 2007; Gebauer and Friedli, 2005; Mathieu, 2001; Oliva and Kallenberg, 2003).

Both Marques et al. (2013) and Medini et al. (2014) recognize this challenge and deal with it in their models in different ways. While Medini et al. (2014) focus on supporting organizational restructuring, Marques et al. (2013) focus on a more detailed description of organizational transformation and its importance. Organizational transformation is not explicitly described in the other models.

4.3.7 Customer Mindset

A change in the mindset of the customer is a challenge that can negatively influence the market launch of a PSS and its associated benefits. Only the model of Yang et al. (2010) deals with this challenge. Among other things, the model contains a quotation phase. This phase contains an element that deals with the training of PSS users. It is intended to prepare customers to understand the features of the PSS offering and their responsibilities.

4.3.8 Ability to Deliver Services

Another challenge is to build the skills needed for service provision and delivery (Richter et al., 2018). The only process model that considers the capabilities of the company is the model of Gokula Vijaykumar et al. (2013). It starts with the analysis of customer skills, through which the offers can be tailored to potential customers. This analysis also helps to develop the company's capabilities together with those of its stakeholders. In addition, changes in capabilities between different stakeholders may require additional resources and should therefore be coordinated. The model does not specifically address the skills needed to deliver services.

4.3.9 Service Design

Service design is one of the biggest obstacles when it

comes to offering PSS solutions. Services tend to be less well developed, due to the lack of expertise of companies in this field (Cavalieri and Pezzotta, 2012). Service design is described by Rondini et al. (2016) as a very difficult task that has to work seamlessly with traditional product design. Due to their intangibility, vagueness and parallelism of services, they are difficult to reconcile with a traditional product design method. All other models do not deal more closely with the design of the service.

4.3.10 Right People and Qualifications

Based on the differences in the required skills (PSS development compared to product development), it is necessary to train or hire the right people (Brehm and Klein; Tukker, 2004). The challenge of strategically building human resources management is also related to this (Matsumoto and Kamigaki, 2013). None of the process models presented is specifically dealing with the selection, hiring or training of the right people in the design team. Kim et al. (2015) only identify the two different actors, service providers and product partners, who are responsible for different phases of the model.

4.3.11 Customer Needs and Value Understanding

For traditionally oriented companies, another challenge is to understand customer needs and to create a value understanding for PSS on the customer side. Martinez et al. (2010) describe this process as "reading between the lines" and to empathize the customer. Yang et al. (2010) dedicate a separate phase to this challenge, in which customer requirements are identified and classified through discussions with the customer or through the analysis of marketing data. Yang et al. (2010) refer to the derivation of customer needs in the first step of their model. Pezzotta et al. (2013) deal with this challenge in their first phase (Idea phase), in which an analysis of the different customer segments is carried out in order to develop an understanding of the core needs of the customers. Marques et al. (2013) believe that customer needs can be identified through market studies or direct contact with customers. In addition, the operator of the model should focus on the needs related to PSS solutions. In contrast, Kim et al. (2015) argue that for service-oriented PSS, a requirements analysis should be conducted based on services. With product-oriented PSS, on the other hand, an analysis of requirements should be carried out which relate specifically to product characteristics. In their second

phase, they focus on looking at the needs of customers who have led to the development of existing services and derive product functions from them. Rondini et al. (2016) go one step further. They present the three different options (1) analysis of social networks and moods, (2) the persona model and (3) brainstorming, through which customer needs can be assessed in the first phase of the PSCT model. Scherer et al. (2016) add another aspect, which is not described by the other models. This process model analyses not only the articulated, but also the non-articulated customer needs in order to develop innovative and thus profitable PSS concepts. Tran and Park (2016) show a different approach in their framework to determine what customers are searching for in their offerings. They suggest obtaining customer opinions on already developed PSS concepts and implementing them in a new PSS. In Medini et al.'s (2014) model, customer interviews are conducted in order to find out their requirements as precisely as possible. The models of Medini et al. (2014) and Pieroni et al. (2016) are very similar in the idea of identifying customer needs in order to develop value creation potentials with respect to services and products. In contrast to the models mentioned above, the process model of Schmidt et al. (2015) does not deal with the analysis of customer needs. Instead, on the second level of their model, they focus exclusively on the barriers that prevent the selected target customers from taking advantage of the PSS offering.

4.3.12 Traditional Methods for New Challenges

The literature argues that companies often fail in their PSS projects due to the use of traditional frameworks and the new challenges they face (Baines et al., 2007; Beuren et al., 2013; Cavalieri and Pezzotta, 2012; Exner and Stark, 2015; Lerch and Gotsch, 2015; Sassanelli et al., 2015). The model of Yang et al. (2010) was developed from a combination of the product lifecycle perspective and the customer service lifecycle perspective, and extended by adjustments of some phases. Bakås et al. (2013) developed their process model on the basis of portfolio management, but it consists of four reassembled phases. The model by Schmidt et al. (2015) is based on the layer model by Schenkl et al. (2014). The individual levels were adapted to the goal of creating a customer-oriented model. Furthermore, they add a strategy environment to their model. Kim et al. (2015) also derive their framework from an existing one. The product development model of

Table 4: Confrontation of PSS Process Models and Challenges for the Application of PSS.

X: Challenge is taken up by the model and is taken up in parts of the model during execution. The challenge is eliminated, or its impact reduced.

[X]: Challenge is recognized by the author, but the problem is not solved by the process model.

Challenge - Sources	Yang et al. (2010)	Bakås et al. (2013)	Gokula Vijaykumar et al. (2013)	Marques et al. (2013)	Pezzotta et al. (2013)	Medini et al. (2014)	Kim et al. (2015)	Schmidt et al. (2015)	Pieroni et al. (2016)	Rondini et al. (2016)	Scherer et al. (2016)	Tran and Park (2016)	Song and Sakao (2017)
Contracts and profit distribution													
Price policy and costs				x	[x]			x				[x]	
Uncertainty and risk		x			x							x	
Communication strategy													
Current business model		x	x	x					x	x			
Organizational transformation				x		x							
Changes in customer mindset	x												
Capabilities for service delivery			[x]										
Service Design										[x]			
The right people with the right capabilities							[x]						
Customer requirements and value creation potential	x		x	x	x	x	x			x		x	
New frameworks		[x]	x	x	x	x		[x]	x	x		x	x
Support from top management													
Excited group of people													
Strategic planning and an ideal management information system							x	x					
New tools and methods													

Cooper et al. (2002a, 2002b) was taken as a model and combined with the service development process of Brügemann (2000) as well as the approaches of various PSS development projects described by Tukker and Tischner (2006). Another model based on existing approaches is the framework of Scherer et al. (2016). Their design is based on the SEEM (Service Engineering Methodology) by Pezzotta et al. (2014).

4.3.13 Top Management Support

Another aspect that can determine the success of the PSS, but is difficult to achieve, is the support of the top management (Kuo et al., 2010; Mont, 2002a; Richter et al., 2018). None of the models presented describes this problem explicitly or offers a solution.

4.3.14 Passionate PSS Supporter

A previous analysis (Richter et al., 2018) highlights a challenge presented by Mont (2002a) to find a person

or group who are interested in the topic of PSS and can actively promote it. This topic is not explicitly dealt with in any of the process models analysed.

4.3.15 Strategic Planning and Management Information System

Further obstacles are the lack of strategic planning and management information systems (Kuo et al., 2010). These challenges are considered in two of the thirteen process models. The first stage of the PSS development project by Kim et al. (2015) is initiated by the service provider and begins with the strategic planning phase. This includes activities ranging from the choice of product strategy to the development of a PSS development concept that combines existing services with products to increase competitiveness. The second approach to this issue is the model of Schmidt et al. (2015), which incorporates strategic planning activities within its strategy environment.

4.3.16 Traditional Tools and Methods

This challenge is described by Cavalieri and Pezzotta (2012) and Baines et al. (2007) in the context of traditional approaches for new challenges. They argue that the traditional methods and tools that are often used are no longer suitable for the new circumstances in the context of PSS, and therefore rarely lead to new results. All models analysed use tools and methods that were originally developed for traditional product or service development. Table 5 confronts the selected PSS process models with the previously (Richter et al., 2018) identified challenges for PSS development. In conclusion, based on the analysis carried out on the basis of the predefined criteria (Richter et al., 2018), it can be stated that none of the analysed models considers all challenges. While the issues of contracts and cooperations, communication strategy, top management support, passionate PSS supporter and traditional tools and methods are not addressed by any of the models, almost all of the models presented an analysis of customer needs. The model of Marques et al. (2013) is the one that tries to overcome the most challenges.

5 CONCLUSION AND OUTLOOK

With regard to the research questions of this contribution, it can be summarized that PSS development approaches were systematically identified and analysed. From those identified models, process models were extracted and analysed in detail. These identified process models were examined to determine whether they address commonly discussed challenges for PSS development and implementation, which were identified in an earlier research. Therefore, all research questions were answered and new insights for PSS research were generated.

Within the analysis of PSS process models, no model has been identified that represents a holistic solution among all predefined challenges. The analysed models are very different, but similar in the aspect that they often use traditional tools. Important topics, such as the choice of the right actors and partners, as well as their training on PSS, are not discussed in detail by the models presented.

Concerning future process models for the development of PSS, this analysis deduces that the methodology and design of the models must be more adapted to current requirements. This also applies to the increasing number of domains and business models that are influenced by digitization and that

entail an adaptation of PSS development. This also applies to the use of methods that incorporate the opportunities that digital advances have opened up.

To develop PSS business models successfully and thus ensure a higher benefit for the customer side as well as for the company side and to reduce the uncertainty on both sides, a stronger involvement of top management can also be useful. In addition, the sensitization of the actors involved in the development of PSS, such as employees or customers, can have a positive effect on the resulting uncertainties and reservations of the involved parties.

Further research should therefore focus on developing a process model that can be used universally for the development of all PSS types. It should address the presented challenges as well as topics such as the uncertainty of the actors and the increase of their knowledge in the area of PSS. In addition, this model should also focus on digitalisation issues and contribute to the development of innovative digital PSS (dPSS).

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