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RICHTER (Alexander), SCHOBLIK (Johanna), KÖLMEL (Bernhard), BULANDER (Rebecca), « Un bilan des facteurs déterminants de la mise en œuvre de systèmes produits-services »

RÉSUMÉ – La tendance à la servitisation des entreprises gagne en importance. Mais la plupart des entreprises traditionnelles ont du mal à adopter ce nouveau paradigme de la valeur des services et de l'offre de produits-services. L'objet de cet article est d'identifier les facteurs qui déterminent la mise en œuvre de systèmes produits-services. Les résultats de la recherche peuvent servir de base aux stratégies de mise en œuvre de SPS dans les entreprises et à l'identification de pistes de recherche.

MOTS-CLÉS – Systèmes Produits Services, SPS, bilan, avantages, barrières, défis, déterminants, tendances

RICHTER (Alexander), SCHOBLIK (Johanna), KÖLMEL (Bernhard), BULANDER (Rebecca), « A review of influential factors for Product Service System application »

ABSTRACT – The trend towards servitization of businesses is growing in importance. But most traditional businesses have difficulties to adopt this new paradigm of the value of services and the importance of a product service offering. Therefore, the aim of this paper is to identify influential factors of product service system application. The research findings can be a basis for the development of a PSS implementation strategy for companies and for the identification of future research need in this field.

KEYWORDS – Product Service Systems, PSS, review, benefits, barriers, challenges, drivers, trends

A REVIEW OF INFLUENTIAL FACTORS FOR PRODUCT SERVICE SYSTEM APPLICATION

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INTRODUCTION

Today's economy and new business models focus more and more on services as a value proposition. The customers increasingly value the utility of a good. Also, well-designed product service offerings have a high market potential since they are able to provide a unique utility for the customer and increase market entry barriers for competitors at the same time.

While in the past, especially manufacturing companies concentrated their resources on the development, manufacturing and sales of physical products, nowadays they see a need for change and a need for differentiation from domestic as well as global competitors. However, most traditional businesses and especially SMEs have difficulties to adopt this new paradigm of the value of services and the importance of a product service offering (Hsin and Ching-Fang, 2005). The concept

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of product service systems (PSS) provides an adequate theoretical background for the described trend towards a servitization of the economy (Vandermerwe and Rada, 1988). While different research communities observed and analysed the transition from products to services by using different terms, such as servitization (Vandermerwe and Rada, 1988), service-dominant logic (Vargo and Lusch, 2004), the characteristics-based approach (Gallouj and Weinstein, 1997) or product service system (Mont, 2002b; Goedkoop *et al.*, 1999), the key message is the shift to a servitized economy. The term product service system is not new and has several precursors (Levitt, 1972; Grönroos, 1996; Bryson, 2010). The term is mainly used in the European research community (Mont, 2002b; Tukker, 2004; Goedkoop *et al.*, 1999; Manzini and Vezzoli, 2003; Baines *et al.*, 2009).

Within the PSS community, this term was defined in different ways with varying emphases in certain topics. For this paper the definition of Baines *et al.* (2007) is applied, which states that “A PSS is an integrated product and service offering that delivers value in use. A PSS offers the opportunity to decouple economic success from material consumption and hence reduce the environmental impact of economic activity. The PSS logic is premised on utilizing the knowledge of the designer-manufacturer to both increase value as an output and decrease material and other costs as an input to a system” (Baines *et al.*, 2007, p. 3). This definition is a result of the analysis of most common PSS definitions. Other popular definitions (Goedkoop *et al.*, 1999; Manzini and Vezzoli, 2003; Mont, 2002b; Tukker, 2004; Morelli, 2006) show that definition focuses are mainly put on the market proposition and customer needs as well as on the concept of system. By looking at other publications in the PSS field, the foci are many put on subjects, such as strategy, design, sustainability, production, logistic/networks or ICT (information and communication technologies) (Annarelli *et al.*, 2016).

Porter and Heppelmann (2014) forecasted, that companies need to develop innovative services around their products in order to be able to offer and deliver a higher customer value. Furthermore firms should focus on solving their customers’ problems and overcome several obstacles by adopting PSS business models. Therefore, the aim of this paper is to identify benefits, barriers and challenges in PSS application and

analyse them as a basis for the development of a PSS implementation strategy for companies and for the identification of future research need in this field.

I. RESEARCH METHODOLOGY

In the following sub-chapters, the methodology is presented. First, the research aim and the research questions are described. Afterwards the literature review process is presented in detail.

I.1. RESEARCH OBJECTIVES

The aim of the presented research is to identify currently discussed benefits, barriers and challenges as well as drivers and trends in product service system application and use. The results were gathered by conducting a literature review on several databases and search engines. The main focus of the paper is to answer the following research questions (RQ):

- RQ1: What are benefits, barriers and challenges for PSS?
- RQ2: Did benefits, barriers or challenges change over time?

I.2. RESEARCH PROCESS

The literature review was carried out in five steps, which included (1) the definition of the basic research parameters by applying the taxonomy by Cooper (1988), (2) the definition of the search terms and search term combinations for the database search, (3) the selection of the searched data bases, (4) the methodological application for findings analysis and (5) backward search for further information sources.

I.2.1. Definition of the research by applying the taxonomy of Cooper (1988)

Harris M. Cooper (1988) analysed literature reviews themselves and defined a taxonomy of literature reviews. This taxonomy consists of six characteristics which contain several categories. Table 1 shows Coopers

characteristics (left column) which were applied for the definition of the presented research. The definition of each characteristic for this paper is then described in the right column of table 1.

Focus	The foci of the research are on research outcomes presented by scientists as well as on use-cases where practices, applications and lessons learned from PSS applications are described.
Goal	The goal of the research is the identification of benefits, barriers and challenges for companies in the field of product service systems as well as the identification of drivers and further research needs.
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 conceptually for the purpose of identifying same patterns in PSS benefits, barriers and challenges as well as selected unique approaches.
Audience	The audience of the review are general scholars as well as practitioners and service scientists.

TAB. 1 – Definition of the research.

1.2.2. Definition of search terms

Since the goal of the research was to identify benefits, application and adoption barriers and challenges of product service systems and 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 “Benefits” OR “Barriers” OR “Challenges” OR “Trends”.

The reasons for the definition of the named search terms are, that benefits are factors, which favour and promote the adoption and application of product service systems. They encourage economic actors to offer, accept or support PSS value propositions. Barriers are issues that may occur before or during PSS application and which hinder a

successful implementation or usage of the PSS. Challenges are factors, which are not as discouraging as barriers but still make a successful PSS application difficult and therefore must be mastered. Drivers are influential factors which can also relate to benefits or barriers and have therefore influence on PSS. Trends focus research directions and address further research needs.

1.2.3. Search for publications on the following search engine/database

The targeted publications were journal and conference papers from the following databases/search engines: Science Direct, Springer Link and Google Scholar. Furthermore, the scope of analyses was limited to the first one hundred findings from each source. The last criterion was that the publication had to be accessible with a regular license for the database (which is mostly relevant for the Springer Link database). All 243 (Science Direct: 43 findings; Springer Link: 100 findings; Google Scholar: 100 findings; searched in May and June 2017) search results were analysed by title and abstract. Due to a limited scope of the review, books were not included into the analysis. Also doublets and non-relevant findings were excluded from the analysis.

1.2.4. Analysis of the search outcomes by using the concept matrix of Webster and Watson (2002)

All findings were implemented in an Excel file and the concept matrix methodology (Webster and Watson, 2002) 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 (units of analysis). Within the presented research the main concepts were “Benefits of PSS”, “Barriers of PSS”, “Challenges for PSS application”, “Drivers of PSS” and “Trends in PSS”. By following these categories, the intention was to identify the future research challenges and to extract subjects for future research from the identified benefits and barriers.

1.2.5. Further search based on of the first analysis

If authors of the found articles cited other sources, which were not found by the initial database search, then those sources were also considered by the analysis. This was done in order to provide the original source of important statements.

II. BENEFITS OF PRODUCT SERVICE SYSTEMS

Benefits are factors, which favour and promote the adoption and application of product service systems. They encourage actors and stakeholders to offer, accept or support PSS offerings. The literature review identified seven summarized benefits of PSS. Even though all benefits are mentioned separately, it is important to note, that the benefits can have a strong interconnection and be able to influence each other. A good example for the effect of findings on each other are “financial benefits” which are linked to almost all the other benefits.

The table below gives an overview over the identified main benefits of product service systems. The found benefits of PSS are described and explained afterwards.

Sustainability
Increase of market barriers to competition and product differentiation
Intensified customer relationship and loyalty
Financial benefits
Innovation through attachment of additional value to traditional products
Growth strategy in mature industry
Better monitoring of products and customer data use

TAB. 2 – Benefits of product service systems.

SUSTAINABILITY

Sustainability is one of the most often occurring benefit and for the authors of basic PSS literature one of the most important benefit of PSS as well as an essential target for the whole PSS application (Wise and Baumgartner, 1999; Goedkoop *et al.*, 1999; Mont, 2002b; Morelli, 2002; Manzini and Vezzoli, 2003; Tukker, 2004). Since the term PSS has its origins also in the Nordic school (Grönroos, 1996), those authors are the ones, who see it deeply connected with sustainability.

“Producers become more responsible for their product-services in case material cycles are closed. Producers are encouraged to take back their products, upgrade and refurbish them and use them again. In the end, less waste is incinerated or landfilled” (Mont, 2002b, p. 240). Other authors (Beuren *et al.*, 2013; Baines *et al.*, 2007; Krucken and Meroni, 2006; Stahel, 1997) also mention those benefits. Additionally Baines *et al.* (2007) argue that the services can be planned in unison with the product life cycle and those named factors all together can help to minimize the usage of scarce resources and help saving the environment. Those positive aspects can also increase the lifetime of a PSS (Pessoa and Becker, 2017). Another benefit is that PSS driven sustainability automatically tends to decrease the total amount of products by offering alternative ownership and use scenarios like product leasing, renting or sharing (Mont, 2002b; Tukker, 2004). Therefore, PSS may have a positive effect on the total number of goods. As well environmental improvement as societal benefit is mentioned by several authors (Cook *et al.*, 2006; Goedkoop *et al.*, 1999; Manzini and Vezzoli, 2002; Mont and Plepys, 2003; Morelli, 2002; Neely, 2008; Brehm and Klein, 2017). Environmental improvement in general is also a particularly named benefit by companies (Mont, 2002a). Furthermore, by applying PSS strategies and payment schemes, companies like Atlas Copco AB, Electrolux, and Gambro were able to “[...]develop more expensive, higher quality and more environmentally benign technology, which customers can afford as they are paying per unit of function not for the product [...]” (Mont, 2002a, p. 97). They also have the tendency to develop a more sustainable approach to business in general (Cavaliere and Pezzotta, 2012). Additionally, though the shift of focus from product ownership to product usage, PSS tend to have the potential to uncouple

environmental burden from economic growth (Tukker, 2004; Lightfoot *et al.*, 2013). Furthermore alternative product use leads to reduction in consumption (Beuren *et al.*, 2013; Li *et al.*, 2010).

INCREASE OF MARKET BARRIERS TO COMPETITION AND PRODUCT DIFFERENTIATION

Some authors state that PSS may have a positive impact on a company's competitive situation and can even contribute to establish market entrance barriers. In 1988, Vandermerwe and Rada argued that a product-service-based build-up of barriers to third parties is advantageous. This is especially relevant, if third parties are mushrooming in between the firms and their existing customers. According to Vandermerwe and Rada (1988) this is especially true for markets that are complex, highly specialized and customized. It is also mentioned that PSS help to set up “[...] barriers to competitors by creating a customer-supplier intimacy and mutual dependence [...]” (Cavalieri and Pezzotta, 2012, p. 279). They also “[...] safeguard market share by bringing the service component into the offer that is not so easy to copy [and they also] safeguard a certain level of quality that is difficult to change (product quality)” (Mont, 2002b, p. 240). The argument, that services are difficult to imitate and therefore lock-out competitors as well as strengthen the firm's competitive situation is also mentioned by several other authors (Oliva and Kallenberg, 2003; Matsumoto *et al.*, 2016; Baines *et al.*, 2007; Brehm and Klein, 2017). Moreover, PSS offerings “[...] can be a means of differentiation and provide a robust market defence to competition from lower cost economies, particularly in the manufacturing sectors where there is a high installed product base” (Lightfoot *et al.*, 2013, p. 1409). This argument was also mentioned by Wise and Baumgartner (1999). By competing in mass-markets, where technologies and products are commoditised, Cavalieri and Pezzotta (2012) see PSS as a tool for differentiation. Vandermerwe and Rada (1988) name the possibility to increase the level of differentiation as one of three reasons why manufacturing companies should move towards servitization (Neely, 2008). But also general differentiation from regular competitors in other markets is a common argument (Beuren *et al.*, 2013; Pessoa and Becker, 2017; Meier *et al.*, 2010; Schenkl *et al.*, 2014).

INTENSIFIED CUSTOMER RELATIONSHIP AND LOYALTY

Intensified customer relationship is one of the key benefits of product service systems. Services are good for relationship building with customers (Brax, 2005). Because of more intense relationships which include a greater insight into the customer's needs, customer processes and an information flow about the customer's specific preferences, a more tailored offering can be developed (Mont, 2002b; Mont, 2002a). These close customer relations finally lead to problem specific and customized solutions. The growth of customer-company relationships increases customer engagement and intimacy in the long run (Vandermerwe *et al.*, 1989; Galbraith, 2002). This new relationship also stimulates higher trust and customer loyalty towards the offering company (Aurich *et al.*, 2010; Baines *et al.*, 2009; Beuren *et al.*, 2013; Pessoa and Becker, 2017; Schenkl *et al.*, 2014; Schultz and Tietze, 2014; Matsumoto *et al.*, 2016). A successful PSS can be identified by a lifecycle long customer-provider relationship. The longer the relationship lasts, the higher the generated profit from the cost intensive build-up of the PSS structures is (Meier *et al.*, 2010; Pessoa and Becker, 2017). Finally, a good customer relationship can lead to the build-up of barriers and provide a competitive advantage for the offering firm.

FINANCIAL BENEFITS

According to Baines *et al.* (2009) servitization in companies frequently occurs due to financial benefits, such as a constant revenue stream or a higher profit margin. The decrease of variability and volatility of cash flows throughout the product life can also increase shareholder value (Cavalieri and Pezzotta, 2012). Furthermore, services tend to encourage recurring sales and intensified customer contact, which then leads to opportunities for the offering of other products or services (Mathieu, 2001b; Malleret, 2006). Further advantages named in the literature are financial savings through closed loops in service oriented solutions (Mont, 2002a) or re-usage of formerly leased products (Mittermeyer *et al.*, 2011).

Schultz and Tietze (2014) argue that services increase the value of a product because they are knowledge and technology intensive. By increasing the value for customers, they generate additional revenues

(Brehm and Klein, 2017; Neely, 2008; Barquet *et al.*, 2013) and are often mentioned to generate a higher profit margin (Lockett *et al.*, 2011). Additionally, the created knowledge through service provision and customer interaction can be offered, in turn, as consulting or training services (Mittermeyer *et al.*, 2011; Beuren *et al.*, 2013).

INNOVATION THROUGH ATTACHMENT OF ADDITIONAL VALUE TO TRADITIONAL PRODUCTS

PSS enable innovation through the attachment of additional value to traditional products. This can be realized by adding customer value like financial services, upgrading or refurbishing services, or through the transformation to a truly integrated offering. By adding services, a company can extend the existing functionalities and thereby redefine its market proposition and gain new competitive advantages (Baines *et al.*, 2007; Porter and Heppelmann, 2014; Sassanelli *et al.*, 2015). Moreover, additional value can be added throughout the lifecycle and can also contribute to a higher and more constant profit (Lockett *et al.*, 2011; Laurischkat, 2013; Brehm and Klein, 2017). While most literature focuses on the innovation from the manufacturing perspective, the innovation from a service perspective also needs to be mentioned.

GROWTH STRATEGY IN MATURE INDUSTRY

Another important benefit for the adoption of a product service strategy is the opportunity for company growth through services even by competing in mature, stagnating markets. Furthermore, companies are able to find new business opportunities outside of their known market boundaries (Mont, 2002b; Mont, 2002a; Vandermerwe and Rada, 1988; Schenkl *et al.*, 2014).

BETTER MONITORING OF PRODUCTS AND CUSTOMER DATA USE

The monitoring of products during usage phase can be an advantage for both, the PSS provider and the user. The product performance monitoring during the product use (Barquet *et al.*, 2013) is a good way to ensure product availability or a certain service level (which can also be defined by a service contract). By the generation of product data, intelligent predictive maintenance concepts can be offered to the customer.

Through the trend of digitalization, “Smart Connected Products” (Brehm and Klein, 2017) or also “intelligent, smart and connected” (Porter and Heppelmann, 2014) solutions are more and more available and offer a wide range digitally enabled services which can be based on the possibilities of digitalization. For example, additional services which are enabled through interconnected and embedded systems allow to “[...] trace, track, monitor and control remotely the physical artefact creating [value for the customer or the provider] [...]” (Sassanelli *et al.*, 2015, p. 191). Here again, the provision of services generates direct or indirect customer interactions which support the customer-provider relationship through the PSS-lifecycle (Vasantha *et al.*, 2012). The usage of information exchange with customers, users and other stakeholders during the PSS-lifecycle has also the benefit of being able to prolong the PSS lifespan (Pessoa and Becker, 2017). Furthermore, today's and also future products tend to have more and more embedded ICT components and therefore allow a variety of new services to be integrated into a PSS and enable even more servitization (Neely, 2008). Those new and innovative PSS have the ability to generate a multitude of new datasets about the customer, the product and its use. By appropriate usage of the data, companies can develop new offerings which may be more beneficial for the customer, foster further innovation and improve the firm's position in the value chain and in the market (Tukker and Tischner, 2006; Beuren *et al.*, 2013; Sundin *et al.*, 2009). If the producer retains the owner of the product during the product life cycle, a constant data flow is more likely (Matsumoto *et al.*, 2016). In sum the technological benefits of data use can enable higher productivity, foster innovation, provide a source of additional revenues, reduce costs and financial risks and enable stronger customer relationships (Brehm and Klein, 2017; Meier *et al.*, 2010).

III. BARRIERS OF PRODUCT SERVICE SYSTEMS

Barriers are issues that may occur before or during PSS application and which hinder a successful implementation or usage of the PSS. They discourage actors and stakeholders to offer, accept or support PSS

offerings. The literature review identified 13 barriers of PSS. Even though all barriers are mentioned separately, it is again important to note, that the barriers as well as benefits can have a strong interconnection and be able to influence each other.

The table below gives an overview over the identified main barriers of product service systems. The found barriers of PSS are described and explained afterwards.

No existing market yet
Close cooperation required
Sustainability trade-offs
Sustainability seen as slowing down time to market
Change from short-term to long-term profit
Extended involvement with a product beyond point-of-sale
Shift in corporate culture and market engagement required
Ownerless consumption
Lack of knowledge about life cycle costs of product ownership
High labour costs
Integration problems
Lack of care (customer side)
Opposition of the personnel (provider/customer)

TAB. 3 – Barriers of product service systems.

NO EXISTING MARKET YET

In some cases, a social system or infrastructure, which would accept a PSS scenario, must be found or, if not existing, created by the offering company. Further complexity is given, if stakeholders are involved (Mont, 2002b). A lack of market demand for PSS is a barrier identified by Mont (2002a) during interview studies with Swedish companies. She reports that customers have problems accepting the producers new role as service provider and knowledge source (Mont, 2002a).

CLOSE COOPERATION REQUIRED

For the provision of a PSS, a close cooperation with stakeholders and customers is often required. Therefore, trustful relationships or strong regulatory tools for this cooperation are essential. Further factors are the involved individuals, who must be equipped with a reasonable amount of power to make the relationships work. The final barrier for close cooperation can be information sharing and transparency between partners (Mont, 2002b; Martinez *et al.*, 2010; Lightfoot *et al.*, 2013).

SUSTAINABILITY TRADE-OFFS

Since the PSS community has a strong focus on sustainability, trade-offs in this area seem to be crucial. As a study discovered, multiple use of a product does not automatically lead to less impact on the environment (Krutwagen and van Kampen, 1999; Tukker, 2004). As Mont (2002b) argues, the environmental impact of product service offerings depends to a significant degree on the overall circumstances, the contract arrangements and conditions of use. For example, leasing can foster the consumption of goods, which – under regular circumstances – the customer would not be able to afford and therefore would not have purchased in the first place or would have had postponed to a later date (Mont, 2002b). As leasing comes with a lack of ownership for the customer, it can lead to a non-responsible usage of the product and a subsequent higher environmental impact. Another argument for sustainability trade-offs are the total product using hours which may remain the same, no matter if purchased as a PSS or not. Hence, PSS do not have per se the ability to reduce material consumption by less produced units or a more constantly usage (Tukker, 2004).

SUSTAINABILITY SEEN AS SLOWING
DOWN TIME TO MARKET

While the previous section focused on sustainability barriers in terms of a negative environmental impact, this section focuses on sustainability as a decelerator for new product releases. Because, making a product market ready is one thing, making it market ready and sustainable is something quite different. Therefore, some authors state, that companies

often see the addition of environmental considerations to the product development cycle as lengthening time to market. And even though partnerships with other firms that help to provide a PSS solution may reduce the needed time, the effort, developing a product and services which are explicitly environmentally friendly is considered to take longer (Mont, 2002b; Mont, 2002a; Stoughton *et al.*, 1998).

CHANGE FROM SHORT-TERM TO LONG-TERM PROFIT

Traditional firms are used to sell a product and get a one-time payment. They sometimes offer a service option for maintenance or consulting services. Changing from a short-term profit to a long-term profit by offering an integrated solution is a new concept to them and therefore has some acceptance barriers. Furthermore, the point-of-sale becomes the point-of-service. And still, success is not guaranteed since also the traditional incentives and control levers do not work the same in service business (Mont, 2002b; Martinez *et al.*, 2010). Manufacturing companies traditionally have little experience in the development and provision of services. Hence they have no experience with the setting of service-related goals and tend to set overambitious objectives and expect high returns too fast (Gebauer and Fleisch, 2007). Since service orientation often occurs as a response to financial difficulties, changed customer demands or strategic product differentiation needs (Gebauer *et al.*, 2006), servitization brings new challenges for the companies. For example management of multi-year partnerships, management and controlling of long-term risk and exposure as well as the modelling and understanding of costs and profitability implications associated with (high) investment expenses of PSS (Neely, 2008; Pessoa and Becker, 2017).

EXTENDED INVOLVEMENT WITH A PRODUCT BEYOND POINT-OF-SALE

The extended involvement with a product is also seen as a barrier for PSS adoption and has a strong relation to the challenge of long-term profits. Since companies are historically used to end their involvement at the point-of-sale, the increased responsibility for the product is seen as a major barrier (Stoughton *et al.*, 1998). Therefore many providers rather prefer to keep the status quo than to extend their involvement

by introducing a PSS (Aurich *et al.*, 2009). Extended involvement leads to intra-organizational and inter-organizational changes (Mont, 2002b). Here all the involved partners have to adopt to each other (Pessoa and Becker, 2017). Ideally, producers offer an additional set of services, which delivers great value to the customer. Customers in contrast, have to adapt to the providers new services and its frame conditions (Tuli *et al.*, 2007; Rese *et al.*, 2013).

SHIFT IN CORPORATE CULTURE AND MARKET ENGAGEMENT REQUIRED

The shift in corporate culture is an essential factor for a successful transformation towards becoming a PSS provider (Mont, 2002b; Mont, 2002a; Cavalieri and Pezzotta, 2012; Martinez *et al.*, 2010; Beuren *et al.*, 2013; Lightfoot *et al.*, 2013; Hou and Neely, 2013). For being able to deliver PSS, companies have to transform their corporate culture to a service-oriented culture (Brax, 2005). Here the company needs to create a shift in employees mindsets towards service-orientation (Neely, 2008). The target should be a 24-7 mindset instead of a 9-to-5 one (Brax, 2005; Gebauer, 2009). Hence, the sale of PSS requires a different skillset than selling just products (Tukker, 2004). For being able to tackle the employee and culture related shifting issues, the right human resource management is a further challenge (Matsumoto and Kamigaki, 2013; Matsumoto *et al.*, 2016).

OWNERLESS CONSUMPTION

In the late 1990s research showed, that customers did not seem to be as enthusiastic about ownerless consumption as it was expected (Stahel, 1997; Mont, 2002b). Success stories were limited to small market niches (Mont, 2002b). The task of private customer engagement was described as challenging (Mont, 2002a), because “the producer usually has five seconds or one line written on a paper to get the customers’ attention to a particular product service characteristic, otherwise the purchasing will be made according to their traditional criteria and preferences, in which price is most important” (Pettersson, 2000 in Mont, 2002a, p. 97).

In later publications, the author’s opinions on this subject didn’t change much. A need for change in customer’s mindsets was detected,

because still, many customers are emotionally attached to the products. Which – for the private sector – can be observed in automotive industry (Neely, 2008). Since customers are used to pay for the purchase of a product instead of paying for its use, the expected behavioural and cultural change may make customers uncomfortable adopting PSS offerings (Rexfelt and Ornäs, 2009). Also in the B2B market difficulties were detected because only few customers tend to outsource their processes to the provider and therefore the investment for the implementation of the needed infrastructure does not pay off without a certain degree of demand (Meier *et al.*, 2010; Pessoa and Becker, 2017). Another problem for customer acceptance is the missing awareness of possibilities, which a PSS is able to offer to them (Baines *et al.*, 2007). For overcoming this barrier, Brehm and Klein (2017) suggest companies to change their strategy from product-centric to a customer-centric perspective (Baines *et al.*, 2009) and especially to invest in durable customer relationships for the duration of the whole product life cycle (Laurischkat, 2013). To overcome this barrier is seen as challenging, because for some products, customers value owning things and having full control over them (Tukker, 2015; Cavalieri and Pezzotta, 2012).

LACK OF KNOWLEDGE ABOUT LIFE CYCLE COSTS OF PRODUCT OWNERSHIP

PSS offerings can be perceived as expensive in comparison to a regular product purchase (Mont, 2002a; Schenkl *et al.*, 2014). Therefore awareness for the life cycle costs of an offering must be raised on the customer's side, since they are often not aware about the life cycle cost of ownership (White *et al.*, 1999; Sundin, 2009). Examples like in the chemical industry show, that life cycle costs of a product can be multiple times higher than the price of the product itself (Votta, 2001).

HIGH LABOUR COSTS

A high service level for service-oriented solutions demands trained workforce whose labour costs are quite high. Hence PSS offering requires a different skillset than product sales (Tukker, 2004), the switch of employee mindset (Neely, 2008) and expenses for continuous employee training are significant. High personal costs have an effect on total PSS

offering price. Therefore, setting the right price and incentives is crucial for customer attraction. (Mont, 2002a; Tukker, 2004).

INTEGRATION PROBLEMS

Problems of integrating PSS and therefore the provider-integration into the customers processes may occur due to the required information, sensitive data-transfer or involved processes which are crucial for the customers firm (Mont, 2002a). By granting access to companies internal information, the customers perceived control may decrease and lead to a rejection of the PSS (Ng and Yip, 2009). To overcome this barrier, strong customer relationships and trust are required (Mont, 2002a).

LACK OF CARE (CUSTOMER SIDE)

When risk of ownership shifts from customer to provider, barriers for the provider may arise. Interviews with companies revealed that providers are concerned about the less careful use of products by the customer if they do not own the product (Mont, 2002a; Kuo, 2011). Furthermore products, which were rented, leased or shared instead of being sold in the traditional way, are getting returned prior to those which were sold traditionally (Matsumoto *et al.*, 2016). That may have a negative environmental impact due to less responsible usage (Tukker, 2004).

OPPOSITION OF THE PERSONNEL (PROVIDER/CUSTOMER)

As changes are made in servitizing firms, resistance from internal parties may occur, out of several reasons (Baines *et al.*, 2009). First, employees may not be aware of the potential value increase that can be delivered through services and the opportunities for the company (Barquet *et al.*, 2013; Oliva and Kallenberg, 2003). Therefore, different opinions within the company can slow down the process (Neely, 2008). Second, by providing solutions, a network of suppliers, provider and customers is created (Baines *et al.*, 2009; Baines *et al.*, 2007; Mont, 2002b). This new situation demands internal changes in organization and structure which can also cause resistance among internal stakeholders (Brehm and Klein, 2017).

A PSS business model brings also changes for the customer and its employees. Mont (2002a) describes a case where employee opposition

arose, when a service provider entered the company's activities. In this case, the staff was afraid, that the service provider could take over their tasks and functions and consequently take away their jobs. Another example for opposition on the customer's side was recorded by a case study where an integrated offering was introduced to the customers company. In this case a "not invented here" mindset blocked successful implementation of the PSS (Martinez *et al.*, 2010).

IV. DRIVERS AND CHALLENGES OF PRODUCT SERVICE SYSTEMS

By analysing literature for benefits and barriers of PSS, the terms drivers and challenges are also often mentioned. Therefore this section will describe the identified drivers and challenges of product service system application. In terms of drivers, there are several parallels to benefits, but also new perspectives and insights presented. The second part of this section describes challenges of PSS application. Challenges are strongly related to barriers. They are definite issues that have to be overcome in order to address the PSS barriers and successfully implement and run a PSS business model. The implementation process can be fostered by PSS drivers which can lead to innovation and the capitalization of PSS benefits.

IV.1. DRIVERS OF PSS

The literature describes several drivers for the shift towards product service offerings. Those drivers are closely related to PSS benefits which were mentioned in detail before. Strategic drivers like the generation of a competitive advantage or product differentiation are named by numerous authors (Baines *et al.*, 2009). The main arguments for this, are that services within a company's product offering can be used to enrich the existing offering, can make it harder for competitors to imitate the integrated offering (Oliva and Kallenberg, 2003) and therefore can be seen as a sustainability factor for the business and a new possibility for growth (Mont, 2002a; Kowalkowski *et al.*, 2017). The higher customer

utility and closer customer relations as well as customer process integration are customer related drivers (Mont, 2002a; Brax, 2005; Frambach *et al.*, 1997). Financial drivers for PSS are possible higher profit margins as well as a more stable and sustainable revenue stream and the potential of services to create a significant contribution to overall revenues (Wise and Baumgartner, 1999; Gebauer and Friedli, 2005; Sawhney *et al.*, 2004). Furthermore, PSS tend to be more resistant to economic cycles and a good economic opportunity for mature markets (Malleret, 2006; Brax, 2005; Gebauer and Fleisch, 2007; Baines *et al.*, 2009). A marketing related driver is the shift from transactional to relational marketing (Neely, 2008). The change in customer behaviour, a demand for customer problem solutions and the overall trend towards customer centricity drives PSS offerings, since they can be designed individually and customer centred (Mont, 2002a; Vandermerwe and Rada, 1988; Brehm and Klein, 2017). From a sustainability perspective there are also further drivers towards sustainability within legislation and as a stakeholder requirement for PSS offerings (Mont, 2002b; Mont, 2002a; Tukker, 2004).

IV.2. CHALLENGES OF PSS

With the transformation to a PSS provider, companies as well as customers are faced with several challenges. As shown in Figure 1, challenges mainly occur on organizational level and in developing and delivering services and integrated solutions.

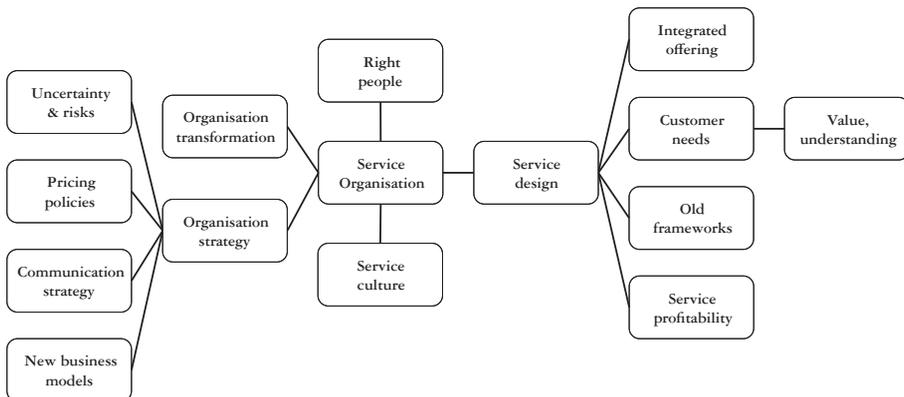


FIG. 1 – Challenges of product service systems.

One important challenge is to build up a service organisation in which the service culture, the service values and the capabilities to design and deliver services are embedded (Gebauer and Fleisch, 2007; Neely, 2008). By doing so, a conflict between the product culture and the service culture can be avoided (Gebauer and Fleisch, 2007). By shifting from product to PSS provider, a mindset and cultural change within the company is required, which is different from traditional manufacturing culture and represents a passion for service (Pessoa and Becker, 2017; Mathieu, 2001a, 2001b; Martinez *et al.*, 2010; Brax, 2005). Additionally, a mindset change on the customers side is necessary too, because both, provider and customer have to overcome resistance in order to provide a successful PSS with benefits for both parties (Kuo *et al.*, 2010). Since a PSS requires a different set of employee skills than product development and sales does (Tukker, 2004; Brehm and Klein, 2017), there is a need to train or hire the right people. A further challenge based on the right employee subject is the strategic setup of the company's human resource management (Matsumoto and Kamigaki, 2013) which is a part of the overall company strategy.

As mentioned above, there is a challenge in developing a service culture that is implemented into a service organisation. Furthermore, capabilities for the ability to deliver services rather than products must be build up (Neely, 2008). Especially for manufacturing companies, the transition to a PSS and the transformation of structures and processes are important challenges (Baines *et al.*, 2009; Mathieu, 2001b; Gebauer and Friedli, 2005; Oliva and Kallenberg, 2003; Gebauer and Fleisch, 2007). Research unveiled, that getting top level support might be challenging but is crucial for the strategic service transformation (Kuo *et al.*, 2010; Mont, 2002a). Also, a person or a group of people who are excited about the topic are necessary to develop PSS concepts and promote them within the company (Mont, 2002a). The implementation of such a new organizational model as well as new business model leads to change-related challenges and must hence be reviewed and refined to overcome those (Barquet *et al.*, 2013). Other challenges for this topic are a lack of strategic planning and a lack of an ideal management information system (Kuo *et al.*, 2010).

Further, especially strategic challenges like uncertainty and risks, pricing policies, communication strategy and new business models

must be overcome. The uncertainty and risks challenge deals with the transfer of product related risks from customer to provider (Azarenko *et al.*, 2009; Meier *et al.*, 2010). A good example for the transfer of risks is the case of leasing, where the provider has the financial risk burden and investment risk (Matsumoto *et al.*, 2016). And since a PSS is often provided by a consortium of firms, there are quite complicated contract and revenue-sharing modalities (Tukker, 2015) which can question the success of PSS. A further challenge is the purchase and finally the pricing of PSS. The purchase process can be complicated and customers are not familiar with paying for a product function instead of the product (Pessoa and Becker, 2017; Rexfelt and Ornäs, 2009). Therefore the focus of communication strategies must be on the description of the PSS value propositions which concentrate on the customer's needs (Mathieu, 2001a). Hence, the right communication of this issue is a further challenge, since traditional sales teams don't have the appropriate training for the sale of services (Tukker, 2004; Gebauer *et al.*, 2005). For being able to transfer knowledge to the sales teams, companies need to have a clear understanding of current business models and the mindset and tools to explore possible future business models to create successful PSS (Barquet *et al.*, 2013; Beuren *et al.*, 2013; Neely, 2008; Lightfoot *et al.*, 2013).

Service design is one of the most challenging subjects in PSS. Not just the service design itself, but also the provision of an integrated offering, the right understanding of the customer needs, old frameworks and concerns about service profitability challenge the adoption and implementation of PSS. According to Cavalieri and Pezzotta (2012) manufacturers are concerned about their lack of expertise with the design and delivery of services. Hence, services tend to be less well designed and non-efficient developed (Cavalieri and Pezzotta, 2012). The challenge here is an alignment and development of processes and frameworks for effective PSS development and provision (Martinez *et al.*, 2010). For many firms, the transformation from a product to a PSS provider is difficult, not well understood and a complex concept. Furthermore, in the literature, there is a lack for a process that targets servitization as a change process effectively (Martinez *et al.*, 2010). Also Cavalieri and Pezzotta (2012) argue that manufacturing companies still use traditional engineering tools and frameworks for the development

of PSS. Furthermore existing tools and methodologies for PSS design are typically rearrangements of the conventional tools (Cavalieri and Pezzotta, 2012) and will therefore hardly provide new results. Another challenging aspect for traditionally oriented companies is the understanding of customer needs and the creation of a value understanding for PSS on the customer's side. The firms aim should be, being able to read between the lines and understand the customer's thoughts ("[...]think like a customer [...]") (Martinez *et al.*, 2010)), the customer's view of the world, his/her existing preconceptions, the context the customer is in and what value is for him or her (Alonso-Rasgado *et al.*, 2004; Isaksson *et al.*, 2009; Cavalieri and Pezzotta, 2012). Regarding the customer, there is a communication challenge to overcome a lack of market acceptance (Kuo *et al.*, 2010) by convincing him/her of the PSS value, its potential and possibilities as well as benefits of ownerless consumption (Baines *et al.*, 2007; Pessoa and Becker, 2017).

CONCLUSION AND FUTURE RESEARCH NEEDS

By applying the introduced research methodology, a review of benefits, barriers and challenges in PSS application was carried out and the findings were presented, which answered RQ 1. RQ 2 targeted thematic changes over time. The presented findings show not much change in topics except the trend towards digitalization in PSS and the increasing integration of ICT components into products as well as the development of smart connected products. Also, in times of digitalization, the subjects of better monitoring of products and customer data use are growing in importance. Another mentionable finding is that firms still don't seem to have big interest in ownerless consumption even though the private sector increasingly adapts to this concept.

Further mentionable findings are those regarding barriers and company size as well as findings regarding challenges for PSS and digitalization. In Neely's (2008) conducted analysis, he argues towards a connection between a company's size as well as local circumstances and its servitization level. His findings also show that larger companies with more

employees and higher revenues servitize more than smaller firms (Neely, 2008). This argument can be endorsed due to the fact that most of the success stories in PSS are about big companies such as Rolls-Royce, IBM, Shell or Canon. Neely's findings indicate several challenges for SMEs, meaning that having many employees and hence being able to delegate the research and development of integrated offerings to many people on a project basis stands in contrast to SMEs capacities and capabilities for the development of innovative integrated offerings. Therefore, SMEs tend to struggle with the development of own PSS.

Concerning the combination of PSS and new challenges like digitalization, the literature argues that companies use old frameworks for the development of integrated offerings and therefore struggle with the results of their projects. Moreover, new challenges in terms of digitalization, product-ICT-integration and smart connected products arise. As stated by numerous authors (Exner and Stark, 2015; Cavalieri and Pezzotta, 2012; Baines *et al.*, 2007; Beuren *et al.*, 2013; Lerch and Gotsch, 2015; Sassanelli *et al.*, 2015), many PSS methodologies and tools exist. But they are usually a rearrangement of conventional methodologies, which are quite theoretical and do not address an integrated PSS development properly. Hence, there seems to be a need for a framework that offers methodologies and tools which can integrate product and service design aspects as well as consider the challenges of digitalization and therefore help companies to develop digital product service systems (dPSS). Those tools should be designed to be easily usable, understandable and applicable in order to also support small and medium sized companies on the transformation path towards becoming a dPSS provider.

Future research directions should also focus on the practical implementation strategies and case studies in order to provide best practice examples and identify success factors (Cavalieri and Pezzotta, 2012; Beuren *et al.*, 2013; Pessoa and Becker, 2017; Mourtzis *et al.*, 2016; Exner and Stark, 2015). Furthermore, an increasing number of authors argues, that customer and product data use provides benefits for PSS and also serves as an enabler for new services and business models within the PSS field (Neely, 2008; Beuren *et al.*, 2013; Mourtzis *et al.*, 2016; Brehm and Klein, 2017). There is also a need for more research on digital services, which have the ability to create added value in future PSS applications (Mourtzis *et al.*, 2016). Therefore, more research on the field of digitally

enabled and supported PSS is required. Another research direction can be an evaluation of environmental (Aurich *et al.*, 2010; Beuren *et al.*, 2013) and social consequences (Rexfelt and Ornäs, 2009) of servitization and PSS application. Finally, from a research field perspective, bringing together different research communities (e.g. PSS, Service Science, Service Management, Service Marketing and Operations Management) might also be desirable target for the future (Lightfoot *et al.*, 2013).

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