Value Drivers in Product-Service Systems: An Empirical Study of Two Sharing Business Models

Suzana Regina Moro
Post-graduate Program in Production Engineering
Federal University of Santa Catarina
Florianópolis, SC, Brazil
suzana.moro19@gmail.com

Paulo Augusto Cauchick-Miguel
Department of Production and System Engineering, Post-graduate Program in Production Engineering
Federal University of Santa Catarina
Florianópolis, SC, Brazil
paulo.cauchick@ufsc.br

Abstract

Product-Service System (PSS) offers value propositions to customers while achieving better results for organizations. To contribute to sustainability, the PSS business model should be designed to cover improvements in economic, environmental, and social dimensions. Nevertheless, how to deliver the solutions' value remains a gap in PSS literature. In this context, this work aims to analyze value drivers or sources of value creation in PSS business models. A set of four PSS value drivers was firstly defined based on a literature analysis: 'novelty', 'effectiveness', 'complementarities', and 'loyalty'. Opportunities to add value to the PSS business model were also identified in the literature to enhance PSS design. The theoretical analysis was followed by an empirical study to identify value drivers of two sharing systems business models. The results evidenced the lack of knowledge by PSS developers about PSS sources of value creation. To create maximum value, the solution needs to integrate innovative technologies and effective processes as primary value drivers. 'Complementarities' (e.g., services complementing products) could also lead to a more profitable solution. As a consequence, those cited value drivers could lead to long-term customer satisfaction and may enable loyalty to be present as a value driver to achieve PSS economic viability.

Keywords
Product-Service System, Integrated Product-Service, Servitization, Sources of Value Creation and Sustainable Business Model

1. Introduction
Product-service system (PSS) is a way of offering value-in-use propositions to customers (Akbar and Hoffmann 2019), which may pose a new perspective for organizations to become more profitable (Yang and Evans 2019). PSS is a business model innovation that integrates combinations of products and services (Ceschin and Gaziulusoy 2016). It is usually considered as sustainable business model (Bocken et al. 2014, Evans et al. 2017, Sousa-Zomer and Cauchick-Miguel 2019), which implies delivering simultaneously economic, environmental, and social benefits (Halme et al. 2004) in the so-called triple bottom line (TBL), the term coined by Elkington (1998). There is also a need to create value throughout the whole system life cycle (Yang et al. 2017, Akbar and Hoffmann 2019).

Business model design perspective is relevant as it deals with the creation of economic value of a solution (Chesbrough and Rosenbloom 2002), since an organization cannot afford to engage in sustainable operations if

financial results were not positive (Van Wassenhove 2019). Moreover, PSS as a business model and its value creation are pointed out as hot research topics (Lee et al. 2018). Nevertheless, relatively little attention has been given in the PSS literature to the planning of business models and its implementation (Reim et al. 2015). How sustainable PSS can be designed, managed, and targeted remains a research gap (Ceschin and Gaziulusoy 2016). The literature still lacks comprehensive and detailed analyses of PSS business model mechanisms to value creation, delivery, and capture (Pallaro et al. 2017, Akbar and Hoffmann 2019). In this sense, value creation in production must be rethought for a transition towards a more sustainable society (Kaihara et al. 2018). Aligning and balancing the TBL, operations management could help companies to design innovative business models and deal with scarce resources (Van Wassenhove 2019).

Besides the value proposition, which is the essential business unit, operational or process advantages generate performance benefits when an adequate deployment of resources leads the company to achieve superior efficiency or effectiveness, affecting its profitability (Mcgrath 2010). New value can be created in a business model by the way transactions are activated, and it depends on four interdependent dimensions or sources of value creation: 'novelty', 'lock-in', 'complementarities', and 'efficiency' (Amit and Zott 2001, Zott and Amit 2010); those terms are detailed further ahead in this paper. These sources of value creation could also be called value drivers (Visnjic et al. 2017), which refer to any element that raises the total value created by the business model (Amit and Zott 2001, Visnjic et al. 2017). Total value created means the value that is established for all stakeholders which are part of the business model: focal company, customers, suppliers, and other trading partners (Amit and Zott 2001, Zott and Amit 2010).

1.1 Objectives

The present paper aims to analyze what are the value drivers in a PSS business model, and the relations among them. It is worth bringing up that this work is within the context of operation management view when designing a sustainable business model. The work was carried out by firstly reviewing the literature, and later on, by empirically analyzing two PSS business models. After this introduction, Section 2 describes the research methods and procedures, and section 3 shows the outcomes of literature analysis related to PSS value drivers. Section 4 presents and discusses the analysis of two PSS business models and, section 5 depicts some practical implications and opportunities to create value in PSS business models. To end with, section 6 draws some concluding remarks from both the literature as well as the empirical studies.

2. Research Methods

Current PSS body of knowledge count on no literature review that was conducted focusing on how to add value to PSS business models or exploring PSS value drivers. Reim et al. (2015) was the first literature review to analyze PSS as a business model, by presenting how business models are implemented and their associated tactical practices. However, although the term 'business model' is widely used in PSS literature, most studies still use it superficially, as already identified elsewhere (e.g., Reim et al. 2015, Adrodegari and Saccani 2017, Baines et al. 2017). Value drivers were not explored in those PSS business model publications as well. For this reason, a "scoping review" focusing only on PSS value drivers was conducted. Scoping or mapping literature reviews examines emerging research topics, assessing what is covered in the literature, providing an initial indication of the potential size and nature of the available literature on a given topic (Arksey and O'Malley 2005, Petersen et al. 2015).

2.1 Literature Review

Scopus and Web of Science databases were used to search the literature in this work because they cover the most important publishers and have been used in other PSS literature reviews (e.g., Reim et al. 2015, Brambila-Macias et al. 2018, Moro et al. 2019). As recommended by Petersen et al. (2015), keywords were extracted from known papers. Keywords to be used as search strings and related to 'value' (e.g., in Amit and Zott 2001 and Zott and Amit 2010) were combined with 'product-service system' (e.g., based on Reim et al. 2015 and Pallaro et al. 2017). The strings were searched in title, abstract, and keywords with no time limit. As it is shown in Table 1, some keyword tests were conducted, as recommended by Petersen et al. (2015).

Table 1. Number of publications obtained in databases search

Search string	Scopus	Web of Science
"Product-service system*" AND value[1]	783	534
"Product-service system*" AND ("NICE design theme*" OR "source* of value creation")	0	0
"Product-service system*" AND "value driver*"	1	2
"Product-service system*" AND efficiency	185	128
"Product-service system*" AND (complementarities OR complementarity)[2]	2	2
"Product-service system*" AND lock-in	0	0
"Product-service system*" AND loyalty[3]	12	10
"Product-service system*" AND novelty	16	10
(servitization OR servitization) AND ("NICE design theme*" OR "source* of value creation" OR "value driver*")[4]	5	4

Notes: [1] this string was not included in the final search results because the publications obtained were not related to research objectives; [2] singular form was also included; [3] loyalty was included because none publication using lock-in, thus by analyzing its definition, this keyword was included (see section 3.1); [4]servitization related keywords were included ensure that the topic was covered.

As it can be perceived, although many publications point out PSS as a way of offering value propositions to customers, how this value is created and its sources or drivers were not explored. The following step in the literature review was selecting the publications. The publications were limited to articles and reviews in English, published in peer-reviewed journals. A total of 192 publications meeting these requirements remain (approximately half in each database). Those publications were organized with Endnote™ support. The duplicated publications were excluded by using the software, remaining 150. Then, by reading the title, keywords, and abstract, 115 were selected. After full reading, a final portfolio of 30 articles related to PSS value drivers, and/or explore one value driver specifically were considered for analysis.

2.2 PSS Business Model Empirical Analysis

Two sharing systems business models offered in South of Brazil were analyzed as a pilot study to verify PSS value drivers. These kind of business models are offered on-demand to many small buyers to brief usage periods (Benjaafar and Hu 2020), in a Business-to-Consumer (B2C) context. The business models analyzed are classified as use-oriented PSS (see Reim et al., 2015 for PSS business model types). They offer customers short-term access to products for a fee rather than providing ownership (Akbar and Hoffmann 2019). Both business models are related to micro-mobility, which is one of Brazil's worst problems.

PSS business models, named "A" and "B", were developed by small start-ups, that initiated to operate innovative business models. PSS "A" is based on a 3-wheel electric vehicle offered through a sharing system. PSS "B" is a bicycle sharing system offered to city halls or companies that charges a monthly fee for operating the system. The organizations were not responsible for the product production, but for the technology and delivery processes involved.

Semi-structured interviews were conducted with the PSS business model developers (owners) in May 2019. Websites, folders, presentations, and other materials were accessed for document interpretation. Data triangulation was applied, as recommended by Yin (2003). Based on the information collected, a representation of the PSS business models was elaborated, including their value drivers. The PSS representations were verified with PSS developers in December 2019.

3. Literature Background of PSS Value Drivers

The so-called NICE design themes (Amit and Zott 2001, Zott and Amit 2010): Novelty, lock-In, Complementarities, and Efficiency are emphasized in literature as sources of value creation in e-business. However, none publication dealing with these sources of value creation in PSS business models was found in this review. Two publications identified (Visnjic et al. 2017, Bressanelli et al. 2018) are related to servitization, which refers to a transformation in manufacturing from a business model focused in a product to a service-centric one (Rabetino et al. 2018). Generally,

the new business model designed by the company, in this case, is a PSS. Therefore, these two publications were described in the sequence.

Visnjic et al. (2017) analyzed the sources of value creation or value drivers in outcome-based contract providers, which is one type of servitization. The authors analyzed four Business-to-Business (B2B) solutions using the same conceptual basis (Amit and Zott 2001, Zott and Amit 2010) as this work, and presented a set of five value drivers identified encompassing the four NICE value drivers and also pointed out another value driver labeled as 'accountability value'. This value driver seems to be more compatible with the B2B solutions analyzed in the authors' publication. Bressanelli et al. (2018) explored circular economy value drivers in servitized business models. The circular economy drivers adopted by the authors were: increase resource efficiency, extend life span, and close the loop. Those value drivers were based on the Ellen MacArthur Foundation's recommendation (Ellen MacArthur Foundation 2016), which differs in content from the conceptual basis of this present work. In some PSS business models, they may apply, but not haphazardly. Some opportunities for value creation suggested by Bressanelli et al. (2018) were included in section 5. Each value driver (Amit and Zott 2001, Zott and Amit 2010) and their advisability in PSS are described in the following sections.

3.1 Novelty

PSS has intrinsic features of novelty and complexity (Rodríguez et al. 2020). The novelty of the PSS business model is offering added-value services by a network of suppliers (Copani and Rosa 2015). Novelty, in this sense, refers to expanding the locus of innovation from the product to the business model (Zott and Amit 2010). Although technology is important, Chesbrough (2010) argues that the choice of business model is more valuable. The novelty characteristic of PSS has also been pointed out as a barrier to its diffusion (Pacheco et al. 2019). Therefore, using PSS novelty features as a source of value creation needs to emphasize its benefits, aiming to increase PSS usage.

3.2 Lock-In

Lock-in mechanisms refer to keep business model actors attracted by it, using switching costs or network externalities (Zott and Amit 2010). It also refers to the action of making somebody unable to move to competitors. However, value creation in PSS depends on a diverse number of stakeholders, which can also include the PSS competitors. As can be seen in Table 1, none publication related to lock-in in PSS was found in the literature search. Furthermore, the value in services is related to both short-term (transaction-based) and long-term (relationship-oriented) perspectives (Stamenkov and Dika 2019). Therefore, 'loyalty' was used to refer to this value driver. In PSS business models analysis (section 4), this point of view is better explained. Customer loyalty or retention is one of the important factors that make organizations move towards offering a PSS solution (Pan and Nguyen 2015). Kimita et al. (2009) proposed a method to estimate PSS customer satisfaction at the conceptual design stage and pointed out that there was a need to integrate loyalty in it. Therefore, loyalty is a PSS value driver, that can include strategies such as lock-in, decreasing prices due to higher utilization, promotions, etc.

3.3 Complementarities

When a bundle of activities within a system yields more value than one activity apart, 'complementarities' exist in a business model (Zott and Amit 2010). 'Complementarities' could exist between product and service, between technologies, and between activities (Amit and Zott 2001). Complementarity is one intrinsic characteristic of PSS, as it offers a bundle of products and services. However, more complementarity among products and services could lead to a more valuable solution, as it allows extending existing offers.

3.4 Efficiency

Since the emergence of the PSS, issues related to efficiency, especially concerning environmental impact, have been raised, referring to as eco-efficiency (e.g. Vogtländer et al. 2001, Heiskanen et al. 2003, Halme et al. 2004). Eco-efficiency issues reinforce what has been pointed out in the literature (e.g. Matschewsky et al. 2018) regarding the need for specific approaches to designing and developing the PSS, encompassing economic and environmental benefits. The nature of PSS - providing functionality or results to customers, as opposed to products - makes companies responsible for economic, environmental, and social issues during and after the product use phase (Evans et al. 2017). Moreover, while the emergence of the PSS concept in the late 1990s focused on reducing materials, now, a focus on circular economy is needed, which inserts multiple life cycles into the product involved in PSS, including e.g. reuse, remanufacturing and recycling (Ceschin and Gaziulusoy 2016). In responding to human needs in terms of social, environmental, and economic dimensions, production must become more effective (Kaihara et al.

2018). Service-dominant logic has also changed companies' focus from efficiency to effectiveness (Green et al. 2017). In this sense, all aspects involved in the PSS solution need to be considered systematically to achieve effectiveness, encompassing service efficiency, longevity, reuse, remanufacturing, and recycling and disposal (Moro et al. 2019). In this sense, in this work, 'effectiveness' was used as a value driver, instead of efficiency.

By the literature analysis, 'novelty', 'effectiveness', 'complementarities', and 'loyalty' were defined as PSS business models value drivers. They were therefore verified in the two sharing systems analyzed in this work, as further depicted.

4. Empirical Analysis of PSS Business Models Value Drivers

PSS "A" and PSS "B" value drivers are described in this section based on the interviews with the PSS business model developers, as follows.

4.1 PSS Business Model "A"

Table 2 shows the value drivers identified in the PSS "A" business model.

Table 2. Value drivers in the PSS "A"- 3-wheel electric vehicle sharing system

Value drivers	PSS "A"
Novelty	• Domestic production vehicle • Low cost of operation and maintenance • Shared use of a 3-wheel electric vehicle
Effectiveness	System efficiency • Modular design • Solid waste reduction (e.g., battery) • Light vehicle (less energy use) • Use of sensors to indicate when preventive maintenance is required Longevity • Use of lithium battery that lasts about 20 years Reuse • Battery reuse for energy storage (when its energy density is low)
Complementarities	• Solar power generation for vehicle charging at the station itself
Loyalty	• Reduced customer acquisition costs • Pre-aggregated demand as a result of targeted community group characteristics • Non-use of technology imprisonment (i.e., not making the customer dependent on only the organization system) • Promotional offers - charge less with increased use or travel to less-car-friendly locations

As can be seen in Table 2, the battery longevity is a strong benefit. In this sense, only the battery's life cycle is optimized because of its high costs (more than half of vehicle cost). In this case, the batteries are used in the car until they have a good energy density to allow a good vehicle autonomy, and, later on, they are reused to energy storage.

PSS "A" business model was developed to be connected with other similar systems (e.g., electric car or bike-sharing providers). In the case of sharing systems, it is believed that it is attractive to the PSS to be integrated with other systems to increase the number of vehicles available for the customers. The system uses a standard outlet for charging the vehicle. An interesting feature of the PSS business model related to 'complementarities' as a source of value creation is the integration with energy generation systems, which in turn would ensure the financial viability of the system, in addition to representing a competitive advantage due to the high current costs of fuel.

Company's "A" director recognized the PSS value drivers could be a great tool to easily visualize the business model value, which could help them to explore the benefits of the solution. According to him: "The proposed model represents a reliable tool for an organization to identify the variables relevant to its interests correctly".

4.2 PSS Business Model "B"
PSS "B" bicycle sharing system is generally provided free of charge to users. Table 3 shows the value drivers identified in the PSS "B" business model.

Table 3. Value drivers in the PSS "B" - bicycle sharing system

Value drivers	PSS "B"
Novelty	• The solution is affordable for small cities and companies • No cell phone or card required for use
Effectiveness	System efficiency • Operation efficiency • Reduction of environmental pollution provided by the system Longevity • High bike durability
Complementarities	• Integration between system and operation
Loyalty	• Through system maintenance and operation • Monthly report about the system usage

Other companies in Brazil also produce bike-sharing solutions similar to PSS "B" (e.g., see Sousa-Zomer and Cauchick-Miguel 2019). The company's novelty is that it uses domestic technology and provides customized solutions to small buyers (e.g., cities with less than 250.000 inhabitants, condominiums, and small companies). Another essential competitive factor linked to 'novelty' is that the user unlocks the bicycle with his identification number and password, upon prior registration in the system. There is no need to use a cell phone or card to take the bike for use, which contributes to enhancing the safety of the solution.

From the interviews, PSS "B" developers perceived that the knowledge about PSS value drivers could help them to identify new value in their offerings. They would then improve their experience related to value drivers to further design new PSS business models.

4.3 Discussion
In PSS "B", the business model is generally offered free of charge to users. Most of the current systems offered are not like this, for instance, Bike Rio system (Sousa-Zomer and Cauchick-Miguel 2019). In the case of a free business model, additional sources of revenue are required to cover both the initial costs of the PSS and its operating cost. Therefore, 'complementarities' related to advertisers could be explored by the company (Moro et al. 2018). Data collected about PSS usage allowed the company to developed know-how about the users' profile. This information could also help to identify the best advertisers to be contacted based on the system's usage.

Regarding revenue sources, prices in sharing systems should be dynamically adjusted based on the capacity available (Benjaafar and Hu 2020). In PSS "A" it is noticed that the concept of lock-in does not apply, as in other cases of sharing. In business models related to sharing, it is interesting that the system is integrated with others to allow a greater availability of products, which will contribute to increasing the system usage. Most car-sharing systems in Europe have partnerships with other providers, e.g., the German 'Flinkster', the largest car-sharing provider, with a diverse fleet of vehicles ranging from popular small cars to vans, has partnerships with more than 20 providers (Flinkster 2020). This system has 'complementarities' with others that offer different types of products, such as bicycles, scooters, etc.

The organization that offers PSS "B" developed the technology of the station operation (see Table 2). This technology is the core source of value creation of the organization business model, related to 'novelty'. It may be used to provide other types of products in the same station (e.g., scooters) that can be 'complementarities' of their business model.

When conducting the interviews, it was perceived that entrepreneurs lack knowledge about the product lifecycle, which may include, e.g., reuse, remanufacturing, and recycling. As a result, the effectiveness of the system can be considered poorly explored in both systems "A" and "B". By understanding the concept of effectiveness, they could

enhance the system efficiency and longevity. As a result, they could identify opportunities to reuse, remanufacture, and recycle (e.g., components or products).

Lindström et al. (2018) state that when dealing with novelty business models, it is easier for small companies to make changes that are required during the solution development when compared to large companies. In this sense, as both PSS business models analyzed were developed by small companies, their business models could be easily enhanced by understanding the PSS sources of value creation. For instance, effectiveness that was previously mentioned.

5. Practical Implications

Firstly, it is worth stating that there is still no widespread adoption of PSS (Liedtke et al. 2015). As a consequence, value drivers should be identified to enhance PSS business model design. Visnjic et al. (2017) noted that while in product business models there is a trade-off between value drivers, in outcome business models, value drivers create a synergistic interplay, mutually reinforcing each other. In PSS business models, integration of the value drivers was also perceived. Figure 1 illustrates PSS business model value drivers adopted in this work extracted from the literature analysis.

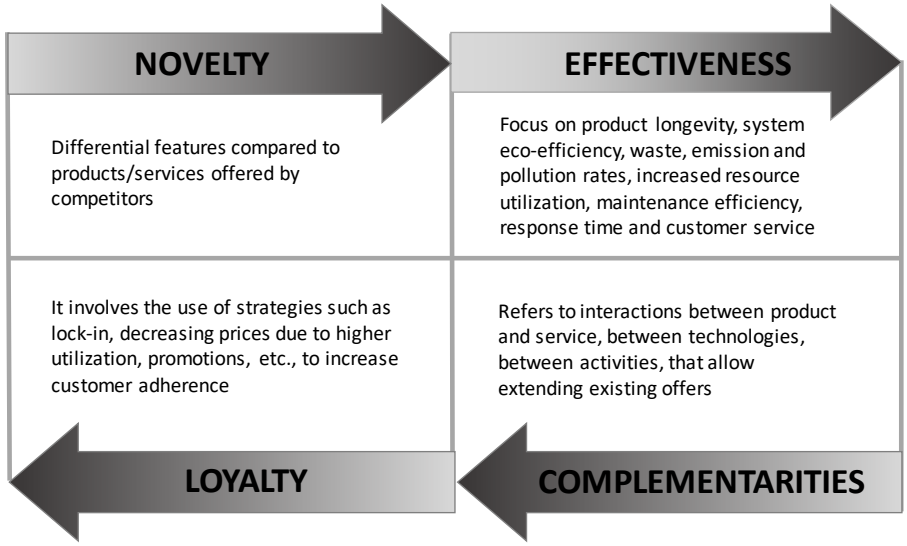

Figure 1. Value drivers in PSS business models

Notes: The definitions of each value driver were extracted from literature (e.g., Amit and Zott 2001, Zott and Amit 2010, Copani and Rosa 2015; Green et al. 2017, Moro et al. 2019, Stamenkov and Dika 2019). The representation and the sequence were drawn up based on the empirical analysis of the two business models value drivers.

The analysis of the two business models allows verifying some relations among the four value drivers. Generally, 'novelty' is the primary source of value creation that guides others. 'Effectiveness' could be explored as a result of novelty (e.g., in PSS "A": national production vehicle). Novelty and effectiveness are overall related, and one can enhance the other, contributing to delivering a better solution. PSS effectiveness value may help to boost 'complementarities' and 'loyalty'. For instance, in PSS "A" battery reuse can allow storage of solar energy as a complementarity. Operation efficiency can increase users' loyalty, such as in PSS "B". Additional 'complementarities' offered by the business model can also strengthen customers' loyalty. Therefore, while novelty and effectiveness are related to PSS value delivery, 'complementarities' and loyalty allow value capture. In this sense, PSS value drivers can be drawn up in the sequence shown in Figure 1. The cyclical shape of the representation indicates that value drivers' design should be recurrently rethought and changed, as the value drivers are interconnected among each other.

5.1 Opportunities to Add Value in PSS Business Models

By the literature analysis, a set of value opportunities that could represent sources of value creation to the PSS business model is presented in Figure 2.

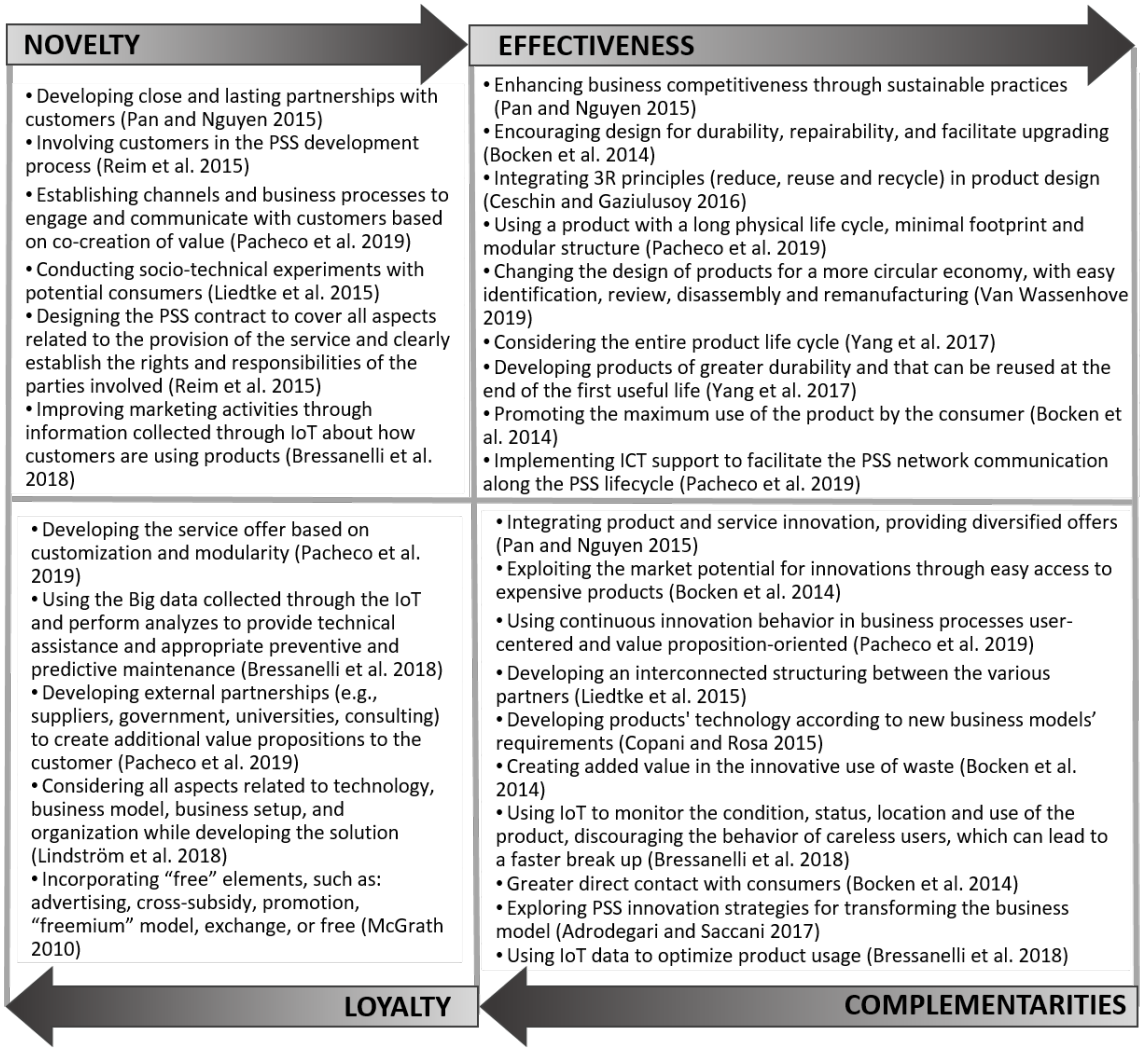

Figure 2. Opportunities to create value in PSS sharing business models

From the perspective of sustainable business models, it is also assumed that no sustainable value can be created for customers without creating value for a broader range of stakeholders (Yang et al. 2017). Value co-creation is the future perspective in production by providing products and services in and for society (Kaihara et al. 2018). Therefore, the value drivers must be continuously rethought and changed by value co-creation. In this sense, their representation adopted in this work has a cyclical shape, and interactions among stakeholders are needed to improve the PSS business model value propositions.

6. Summary and Concluding Remarks

This study is a work-in-progress analysis of value drivers in the context of product-service systems. These value drivers have not been yet explored in the PSS body of knowledge, as shown by the results of the literature review conducted in this study so far. Therefore, by the scoping literature review, a set of four PSS value drivers was raised: 'novelty', 'effectiveness', 'complementarities', and 'loyalty'. They should be designed in this sequence, regarding their relationships. Generally, the first source of value creation to be thought is 'novelty'. Effective process of delivering can be later established. 'Complementarities' could be present as a consequence of previous value drivers. Finally, 'loyalty' is an important long-term result that would also emerge in a PSS business model as a value driver, and in which it is important to increase the lifetime value (i.e., how much money the customer generates for the company during the relationship with it). Consequently, the revenues from the business model will be higher in a long-term relationship with customers.

By the empirical analysis of the PSS business models, it was perceived that PSS developers have little explored possible sources of value creation while designing their PSS. Then, as a practical contribution, this work suggested some opportunities to value creation in PSS business models, such as using a modular design and 3R principles to reduce, reuse, and recycle components and parts.

The design of PSS business model value drivers should be recurrently rethought and occur in a cyclical way because changes in one value driver can demand adjustment of other value drivers. They should also be co-created to allow the development of more sustainable PSS value propositions that will deliver superior value to customers.

Considering that this is an on-going work, some opportunities could be future explored. Other value drivers could be verified in PSS business models (e.g., related to accountability value, circular economy). Value drivers in other types of PSS business models rather than use-oriented and sharing systems could also be analyzed, and therefore, the results could be cross-analyzed among different PSS business model types. Another opportunity is to establish metrics for each value driver and thus perform a quantitative analysis of them for decision-making of best opportunities to add value to the business models.

Acknowledgements

The authors thank National Council for Scientific and Technological Development (CNPq) to financing a research project [428946/2018-6] and providing a doctorate grant [140460/2016-0].

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Biographies

Suzana Regina Moro recently finish her doctorate at Federal University of Santa Catarina (UFSC) in Brazil, Post-graduate Program in Production Engineering, within the Operations Management Group, under the supervision of Associate Professor Paulo A. C. Miguel. She earned a B.S. in Production Engineering from State University of Maringá (UEM), Brazil and a master degree in Production Engineering from Federal Technological University of Paraná (UTFPR), Brazil. She has industrial experience in planning and developing production processes, and also worked as a fellow of Industrial Technological Development of CNPq- National Council for Scientific and Technological Development, Brazil (2012-2013). Her current research interests are product-service systems, mobility sharing systems, sustainable business models, and literature review methods in operations management.

Paulo Augusto Cauchick-Miguel is an Associate Professor in the Department of Production and Systems Engineering at Federal University of Santa Catarina (UFSC) in Brazil. He holds a PhD in manufacturing engineering from The University of Birmingham, UK. He was also a former Visiting Professor at University of Technology Sydney, Australia (2016-2017); and Guest Researcher in the National Institute of Standards and Technology - NIST, USA (2004). His industrial experience includes working as a manufacturing engineer for automotive and machine-tools companies in Brazil. Current research interests include product-service systems, servitization, engineering education, and research methodology in operations management.