The Adoption of Product-Service System Business Models: A Multiple Case Study

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Abstract

This study aimed to analyze the adoption of product-service system (PSS) business models, focusing on adoption and perception aspects of PSS, as well as elements intrinsic to the design of the PSS business model itself. A qualitative method was employed through a multiple case study, utilizing semi-structured interviews and secondary data analysis. The findings suggest that companies embracing PSS share a common drive for innovation. Moreover, PSS is adopted and perceived as a means to meet customer needs and provide efficient, customized products. Furthermore, the value proposition of the PSS business model emphasizes sustainability. For managers, this study offers insights into the workings of PSS business models and suggests strategies for managing their key components effectively.

Keywords: business model; PSS; product-service system; sustainability.

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Introduction

Global environmental challenges, such as the negative impacts of industrialization on the environment and the increasing consumption and subsequent improper disposal of waste, necessitate responses from businesses, governments, and society. In this context, several mechanisms, such as the 2030 Agenda, have emerged to minimize these effects. Sustainable development is a global concern, and its pursuit of a better future faces economic, social, and environmental decisions. Such worries result in new strategies (Mont, 2002), new business models (Labbate *et al.*, 2020), and changes in business model purposes (Bocken, Short, Rana and Evans., 2014) that reduce the use of natural resources.

In this sense, a product-service system can be a path to meet these demands and stimulate sustainable production and consumption. PSS is a system in which producers provide their clients with the use of services instead of a product or with the combination of the sale of a product jointly with the offer of a necessary service during the use of a product (Goedkoop, Van Halen, Te Riele, and Rommens., 1999; Mont, 2002; Tukker, 2004).

The adoption of a PSS business model consists of adding service or product elements to a company's operations (Reim, Parida and Örtqvist, 2015). Baines and Lightfoot (2013) and Beuren, Ferreira and Miguel (2013) pointed out that PSS is a business model innovation focusing on projecting and selling systems of tangible products and intangible services. this model seeks to meet the client's demands. The literature about PSS suggests that the implementation of such a business model is a vital strategy for companies to compete in their globalized economic system (Hong, Kim and Cin, 2015) and has positive environmental effects when compared to traditional businesses (Roy, 2000). Therefore, PSS is understood in the literature as a type of business model whose adoption constitutes a differentiation strategy for companies.

Some studies indicate benefits, drivers, and barriers to PSS adoption. Beuren, Ferreira and Miguel (2013) identified benefits directed to stakeholders, the environment, and society. The increase in competitiveness and innovation potential of suppliers, planning of the system life cycle, reduction in the use of natural resources, and creation of new jobs are some of the benefits highlighted in their literature review (Beuren, Ferreira and Miguel, 2013).

In this sense, Yang and Evans (2019) cite some potential benefits of PSS use, such as a significant reduction of negative environmental impact, economic benefits with better service to the client's needs, stronger relationships with clients, differentiation, increase in income, and social benefits, especially concerning the increase in job number. These authors point out that the PSS archetyped can result in various positive impacts at an environmental and economic level.

Studies on PSS have been carried out in various contexts and generally deal with topics such as the characteristics of PSS (Kanda and Matschewsky, 2018; Orellano, Neubert, Gzara, and Le-Dain, 2017; Överholm, 2017), PSS development support methods (Evans *et al.*, 2017; Widmer, Tjahjono and Bourlakis, 2018; Scafà, Carbonari, Papetti, Rossi and Germani, 2018; Kampker, Stich, Jussen, Moser and Kuntz, 2019; Kim, 2020), implementation benefits and barriers (Jesus Pacheco *et al.*, 2019; Beuren, Ferreira and Miguel, 2013), the transition to the PSS business model (Adrodegari, Pashou and Saccani, 2017), and others.

Considering the research field comprehension as a whole, Barravecchia, Franceschini, Mastrogiacomo and Zaki (2021) analyzed twenty years (1999-2018) of PSS research and demonstrated the main study topics on the PSS theme and the future tendencies for PSS research. The results

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pointed out eight topics with the foundation in PSS research, such as - PSS design; PSS environmental and social impact; PSS and servitization process; Sustainable PSS; PSS business models; PSS performance analysis; analysis of the requirements of PSS and industrial PSS. The most discussed themes regarding the number of published studies are PSS design and PSS environmental and social impact, corroborating the literature review carried out by Annarelli, Batistella, and Nonino (2016).

For the future of PSS research, Barravecchia *et al.* (2021) conclude that one can expect the continuation of studies in the identified topics, investigating specific aspects and providing operational tools to implement, evaluate and improve PSS over time. In addition, new topics will likely be fostered by emergent technological aspects making it significant for the next years.

Considering the various drivers and barriers affect the process of adopting PSS business models, this study analyzes the aspects concerning PSS adoption and perception, in addition to the inherent features of its business model design. Therefore, this paper stands out for covering the aspects concerning PSS adoption and perception jointly with the business model.

Thus the following question arises - How does the adoption of product-service (PSS) business models work? Based on this question, the development of this research aims to analyze how the adoption of PSS business models occurs. This paper carries out a multiple case study in four companies with PSS in their portfolio to answer the research problem. The results aim to theoretically contribute to the existing literature by revealing how PSS business models work at a practical level, and by demonstrating that the adoption of PSS business models is an alternative to creating innovative and sustainable business models to contribute to sustainable development at a social level.

This paper is divided in the following manner - after this introduction, it discussed the theoretical basis and methodological procedures, subsequently analyzing and discussing the results. In the end, it presents the main conclusions, suggestions for future works, and research limitations.

Theoretical Basis

PSS consists of a combination of an integrated mode of products and services. This concept arises from tendencies seeking the development of more sustainable business models and the replacement of business sale activities to provide services as a standing-out strategy before the competitors and to render personalization to the users. In this regard, the adoption of PSS covers comprehends the sale of a product's functions instead of just the product itself.

In this perspective, the PSS concept emerged in Scandinavia at the end of 1990 meaning "Product-service system". Its first mention was in a report named Product-Service Systems, Ecological and Economic Basics in 1999 (Goedkoop *et al.*, 1999). PSS appears due to competitiveness in product sales (Sakao and Lindahl, 2009), through which traditional companies see the combination of products and services as a way to deal with market changes and to ensure higher profits (Sawhney, Balasubramanian and Krishnan, 2004). In addition, it could offer a service to meet specific needs instead of providing the ownership of a product, thus reducing the use of materials and energy (Sakao and Lindhal, 2009) and creating economic and environmental benefits.

PSS has become known over the years (Tukker, 2015; Li, Kumar, Claes and Found, 2020) since Goedkoop *et al.* proposed its first definition (1999). Consequently, many authors also presented concepts as shown in Table 1.

Table 1: PSS Definitions.

Definition	Authors
"[...] is a marketable set of products and services capable of jointly fulfilling a user's need".	Goedkoop et al. (1999, p. 18)
"[...] PSS is a system of products, services, supporting networks, and infrastructure designed to improve competitiveness, satisfy customer needs with lower environmental impact than traditional business models."	Mont (2002, p. 239)
"A Product-Service System can be defined as the result of an innovation strategy, changing the business focus from designing and selling only physical products, to selling a system of products and services that together are able to meet specific customer demands."	Manzini and Vezzoli (2002, p. 4)
"A pure product system is one in which all ownership rights are transferred from the product provider to the customer at the point of sale, and there is no interaction between the customer and the provider after the point of sale. [...] A pure service system is one in which all ownership rights remain with the service provider and customers retain no rights other than to consume the service. [...] A product-service system (PSS) is a mixture of the two systems described [...]. It requires that ownership rights remain distributed between the customer and the provider, requiring more or less interaction during the operating life."	Hockerts and Weaver (2002, p. 14)
"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."	Tukker and Tischner (2006, p. 1552)
"PSS consists of a mix of tangible products and intangible services designed and combined so that together they are able to meet the needs of the end customer."	Baines *et al.* (2007, p. 1545)
"PSS is a business model focused on providing a set of marketable products and services designed to be economically, socially, and environmentally sustainable, with the ultimate goal of meeting customer needs."	Annarelli, Batistella and Nonino (2016, p. 1017)

Source: prepared based on the cited authors.

Table 1 demonstrates that the definitions have lines of interest, such as strategic, environmental benefits, and concern with the customer. In this sense, some relevant topics are (i) PSS arising from an innovation strategy (Manzini and Vezzoli, 2002), in which clients and suppliers receive the ownership rights differently during PSS operating life (Hockerts and Weaver, 2002); (ii) it seeks meeting the client's needs (Goedkoop *et al.*, 1999; Mont; 2002; Manzini and Vezzoli, 2002; Tukker and Tischner, 2006; Annarelli, Batistella and Nonino, 2016); (iii) add value (Baines *et al.*, 2007); (iv) and promote sustainability (Annarelli, Batistella and Nonino, 2016).

Therefore, PSS is a business strategy with the potential to create the necessary environmental, social, and economic benefits for sustainable development. In this sense, knowing the companies using PSS is vital to a better understanding of the real advantages created by PSS. The following discussion analyzes the PSS classifications found in organizations.

The literature reveals many PSS classifications, which are outlined below. The most accepted approach considers the proportion of the service and the ownership of the products (Hockerts and Weaver, 2002), grouping PSS into three archetypes - product-oriented PSS, user-oriented PSS, and result-oriented PSS.

Tukker (2004, p. 248) studies these three main archetypes and develops subcategories for each archetype presented as follows.

- **Product-oriented PSS:** It focuses on product sales, but the provider can add services to the offer. The provider can offer
    - Services related to the product; and
    - Consultancy and assistance services.
- **Use-oriented PSS:** this business model does not focus on product sales. The product's ownership is kept by the provider and it is made available to the user in different ways. User-oriented services operate as follows:
    - Product lease;
    - Lease/sharing; and
    - Product pooling.
- **Result-oriented PSS:** it does not involve any pre-defined product. Rather, the client and provider agree on a result. It can work as follows:
    - Activities management or outsourcing;
    - Payment by service unit; and
    - Functional result.

According to Tukker (2004), by placing the first archetype to the latter - product-oriented PSS, user-oriented PSS, and result-oriented PSS - the product becomes a minor component in the PSS, and the service becomes a main one in the result-oriented services. In each case, the provider has more freedom to meet the client's needs, which in turn are growingly abstract. The author points out that the abstract nature often precludes transforming such demands into performance indexes. In addition, it hampers providers from determining what they can offer their clients.

From this perspective, Neely (2008) developed an additional classification based on Tucker's classification (2004). He added two new archetypes - integration-oriented PSS and service-oriented PSS. Integration-oriented PSS operates when companies downstream and introduce vertical integration (Neely, 2008). The product ownership is transferred to the client, but the provider seeks vertical integration. In turn, service-oriented PSS occurs when companies embody services to similar products, integrating such services into the product itself (Neely, 2008). Service-oriented PSS is similar to product-oriented PSS, the difference is that the added services are an integrating part of the offer.

Another classification proposed by Mont (2002) classifies PSS into five archetypes based on the product and service combination in different states of the product lifetime, covering the different conceptions for product use. Mont (2002) proposes the following archetypes - combined or replaced products/services, services at the point of sale, product use divided into use-oriented and result-oriented, maintenance services, and revaluation services.

In turn, Van Ostaeyen, Van Horenbeek, Pintelon and Duflou (2013) expanded the literature by revisiting the most common classifications (use-oriented, product-oriented, and result-oriented PSS) and propose a four-archetype categorization - based on input, based on availability, based on use, and based on performance. The author defines the archetypes by the performance orientation of the dominant revenue mechanism within the PSS and the level of integration between the product and service components. According to the author, the classification allows one to distinguish essential characteristics in defining a PSS, such as which products and services are part of the offering, the integrated, and their revenue mechanisms.

The classifications proposed by the literature have some similarities and differences. Some categorizations derive from others, different authors repeat others, while some present innovative PSS approaches. A resemblance found in most classifications is the product or service orientation, which has different names in each categorization. In this sense, Yang and Evans (2019) point out that most of the proposed archetypes in the literature can fit into product-oriented PSS, use-oriented PSS, or result-oriented PSS archetypes, and that may be a reason why these three archetypes are the most prominent in the PSS business model.

In a way to contribute to PSS development and aiming to facilitate PSS adoption, some authors developed business models focusing on PSSs based on previous research. They point out that considering the concept of business models enables adopting a PSS (Tukker and Tischner, 2006), and it is unmatched to bring success to the usage (Mont, Dalhammar and Jacobsson, 2006; Kindstrom, 2010; Tan, 2010; Reim, Parida and Örtqvist, 2015). In addition, considering the business model when conceptualizing PSS is important because the success of a company depends on its operations, strategies, and network (Schuh,

Schittny and Gaus, 2009), and these are factors considered in the business model. However, the PSS definition covers elements that impact and transform traditional business models in different ways.

The adoption of a PSS by a company consists of the addition of service or product elements in the company's operations, which works in a variety of different ways leading to distinct results even if they opt for similar strategies (Reim, Parida and Örtqvist, 2015). Implementing a PSS business model means adopting a value proposition focused on meeting the needs of the final user and not focusing on the product. Such logic projects systems with lower environmental and social impacts and has the potential to modify consumption and production patterns, which may accelerate the change for more sustainable practices and societies.

As for business, the PSS implementation provides market opportunities due to differentiation (Baines *et al.*, 2007), and efficient production and consumption (Cook, Bhamra and Lemon, 2006; Armstrong *et al.*, 2015; Beuren, Sousa-Zomer and Miguel, 2017), given that PSS aims to have a long lifecycle allowing its best exploitation and lowering the production of residues. These benefits promote an increase in revenue and cost reduction. In addition, the differentiation enables a higher gain and lower cost impact through the lifecycle, remanufacture, and reuse. Moreover, Weking *et al.* (2018) and Yang and Evans (2019) pointed out that a well-structured PSS enables new revenue flows and a better competitive advantage for the company.

The literature shows that companies must redesign their business model when they use a PSS and not only adapt their offer (Baines *et al.*, 2009; Slepniov, Waehrens and Johansen, 2010; Kindstrom and Kowalkowski, 2014). Tan (2010) believes that adapting the PSS to the business model is the answer because it is beneficial to compare the performance of the product-service offer to the offer previous to the PSS adoption. However, some companies opt to create additional businesses to implement PSS, not modifying their current business (Mont, 2004). In this context, one must decide between adapting their business model or creating a new one.

Research framework

This study arises from Adrodegari *et al.*'s framework (2017), which developed a two-level hierarchical structure, mostly motivated by the appeal for a deeper understanding of the business model application to PSS. The first of the proposed levels consists of the PSS business model framework based on the business model literature and uses the Canvas business model (Osterwalder and Pigneur, 2010) which provides a holistic representation of a PSS business model. At the second level, a set of 25 variables describes each dimension of the business model. The proposed framework contributes to a more intense formalization of the PSS business models, identifying their main components and relevant variables to characterize each component. According to Adrodegari, Pashou and Saccani (2017), the proposed model can provide an analysis of different business models, and can consider significant aspects, differences, and similarities of each model.

Adopting PSS is a great challenge to companies aiming at a sustainable competitive advantage and seeking to satisfy their clients' needs. Companies have the complex task of modifying their business model to overcome that challenge, especially concerning their value proposition, which begins focusing on the use and not the product's ownership.

Methodological procedures

This paper is a qualitative study seeking to analyze "[...] concrete cases in their local and temporal specificities based on people's expressions and practices in their local contexts" (Flick, 2009, p. 37). This is an exploratory study aiming to understand the adoption of PSS business models to promote a better understanding of the research problem (Malhotra, 2011). As for the method, this research has the structure of multiple case studies (Yin, 2015).

This paper identifies the analysis units with at least one of the PSS archetypes proposed by Tukker (2004) in his business model to choose the analysis units integrating this study. The classification proposed by Tukker (2004), widely recognized in the literature, is based on three archetypes: product-oriented, use-oriented, and result-oriented, providing a comprehensive and well-founded approach to economic, environmental, and competitive benefits and proving to be suitable for the context of this study.

In this context, we searched companies on specific websites and rankings about innovation registered at the National Association of Research and Development of Innovative Companies (ANPEI), in Brazil, besides searching in journals with Verification and Economic Value. Companies with PSS offers in their portfolio were selected after the initial search on specific pages. We carried out a preliminary survey on the company's web pages or other sources, such as available news, to verify the company's adequacy to the objective of this paper. Therefore, the criteria sampling technique was used, and cases were selected based on pre-defined criteria (Patton, 1990). The saturation point of the first sampling stage (selecting companies suitable for research) was based on the precepts of Glaser and Strauss (1968), in which new data no longer provide substantially new information.

Subsequently, the selected companies were invited to partake in the study. Finally, four companies accepted to participate in the research. As for data protection, we the names of the analyzed companies, and some of the respondents were hidden, then received the names Alfa, Beta, Delta, and Gama. The respondents were named Respondent 1 (R1), Respondent 2 (R2), Respondent 3 (R3), and Respondent 4 (R4).

The process of data collection was carried out through semi-structured interviews and documental research. The theoretical scope of this study allowed the creation of the interview protocol, which composes of open questions and is divided into three blocks - respondent profile, company characterization, and adoption of the PSS business model (see Appendix). The instrument was previously verified by specialists from the field of innovation and sustainability to ensure the clarity and relevance of the questions.

The respondents were people responsible for the companies' current management or innovation/sustainability fields, considering convenience and accessibility criteria, between October 2021 to January 2022, with the support of technological resources, such as Google Meet. The respondents authorized the recording and its transcription aiming for a better understanding of its content.

The data analysis followed the content analysis method (Bardin, 2011), respecting the three fundamental stages proposed by the author - (1) pre-analysis; (2) Material exploration; and (3) Processing of the results, inference, and interpretation. The pre-analysis stage enabled thorough contact with the transcriptions and collected documents. In this sense, it was possible to systematize the initial ideas and organized the collected documents. Subsequently, the material exploration consisted of the element coding and evidence categorization into previously defined categories based on the theoretical scope. Finally, the last stage consists of the inferential interpretation or processing of the results, covering the qualitative analysis and comparisons of the evidence interpretation. NVivo 12 software aided in the data analysis, codifying, filtering, searching, questioning, and categorizing of the data. It also facilitated categorizing and triangulating the data through the transcription of the interviews and visualizing the remaining documents used as secondary data sources.

Results analysis and discussion

The discussions and analysis of this study are presented in two parts. First, the cases are individually described and characterized. Secondly, the evidence demonstrated and discussed focusing on the PSS type and the PSS business model adopted.

Characterization of the cases

The Alfa company is from the mobility sector. It designs, manufactures, and rents electric motorcycles for professional use. Founded in 2017 and located in Brasilia (DF), its PSS corresponds to the rental of electric motorcycles and is classified as use-oriented in the product rental subcategory.

The Beta company is from the sector of entertainment and education activities and operates with board games and this is the PSS offered. It was founded in 2013 and it is located in Porto Alegre (RS). Its PSS is use-oriented in the product rental/sharing subcategory.

The Delta company is an industry for health and education materials in retail and wholesale founded in 1924 and located in Santa Cruz do Sul (RS). It offers the following PSS - assistive technology resource kits with courses and maintenance of canes, crutches, and walkers. Both classify as product-oriented. As for their subcategories, the first one is classified as consultancy and assistance services, and the second one is classified as services related to the product.

Finally, the Gama company is an industry working on injection, blow molding and plastics retro molding, and wood processing. It is located in Santa Cruz do Sul and was founded in 1947. Its PSS offered corresponds to the development and manufacture of manufacturing molds and parts, and it is classified as product-oriented in the product-related services subcategory.

Table 2 presents the main characteristics of the researched companies concerning the following organizational features - founding year, location, sector, number of employees, gross operating revenue in 2020, responsibility for the innovation activity, certificates, internationalization, the introduction of new products/services in the last 5 years, and the PSS type.

Table 2: Characterization of the analyzed companies.

Organizational features	Alfa	Beta	Delta	Gama
Founding year	2017	2013	1924	1947
Location	Brasília (DF)	Porto Alegre (RS)	Santa Cruz do Sul (RS)	Santa Cruz do Sul (RS)
Sector	Mobility	Entertainment and education	Health and education.	Plastic and wood processing
Number of employees	30 employees	0 employees*	650 employees	600 employees
Gross operating revenue	R$500.000,00	R$60.000,00	R$85.000.000,00	R$180.000.000,00
Responsibility for the innovation activity	The company is the sole responsible.	Innovates in partnerships with other companies.	It innovates in partnerships with universities and other companies.	It innovates in partnerships with universities and other companies.
Introduced innovation in products/services in the last 5 years	Yes	Yes	Yes	Yes
Certificates	ISO 9001	-	ISO 9001	ISO 9001, INMETRO, Cleanest production, Child-friendly company.
Stage of internationalization	-	-	Low	Low
PSS type	Use-oriented	Use-oriented	Product-oriented	Product-oriented

The company is composed of a founding partner, but did not have any employees at the moment of the survey.
Source: Elaborated by the author from the data collected.

The analysis of the main organizational features demonstrates two largely experienced companies and two young ones. The sector of each one is different - one operates in the mobility sector, the other one in entertainment and education, another in health and education, and, finally, the other one in wood and plastic processing. In this context, it is noticeable that the Beta company is not an industry, but we kept it because of its informational accessibility and, especially, for the features of its PSS that brought interesting evidence for this study.

Based on the gross operating revenue (BNDES, 2022), Alfa is considered a small business, Beta is a very small business, and Delta and Gama are both medium-sized companies. Therefore, the analyzed organizations have different sizes, which can be interesting for the analysis of the PSS business model from distinct perspectives.

Alfa is the only company that does not innovate in partnership with other organizations. Still, all companies introduced innovations to the market in products/services in the last five years, which shows that innovative activity is important for the studied companies. Corroborating with the literature (Tukker, 2004; Baines and Lightfoot; 2013; Beuren, Ferreira and Miguel, 2013) in a sense that the adoption of PSS business models is an innovation strategy seeking to modify the traditional business approach and offers integrated products and services that meet the consumer's needs.

All the organizations but Beta has the ISO 9001 certificate. Delta also has the following certificates - INMETRO, Cleanest Products, and Child-friendly Company.

Only Delta and Game operate in international markets, and both have a low degree of internationalization, according to the respondents.

As for the PSS type adopts, Alfa and Beta work with use-oriented PSS, and Delta and Game the product-oriented one. Delta and Gama companies modified their business model to offer a PSS, according to Kolling *et al.* (2022), in the implementation of this type of business model, the creation of a new business or the adaptation of an existing model may occur. In this line, the transition to a PSS business model is a complex process, which is why many companies choose to add services related to one of their products (Oliva and Kallenberg, 2003; Parida *et al.*, 2014), in Delta and Gama, probably because they are activities closer to its core value proposition.

Therefore, the researched organizations have the necessary profile to meet the objectives proposed by this study due to their organizational features, enabling the analysis of their behavior regarding the adoption of the PSS business models.

Analysis of the PSS business model

The analysis of the evidence regarding the PSS types adopted, their motivators, and the respondents' perception concerning the PSS and the PSS business model enabled the creation of Figure 1.

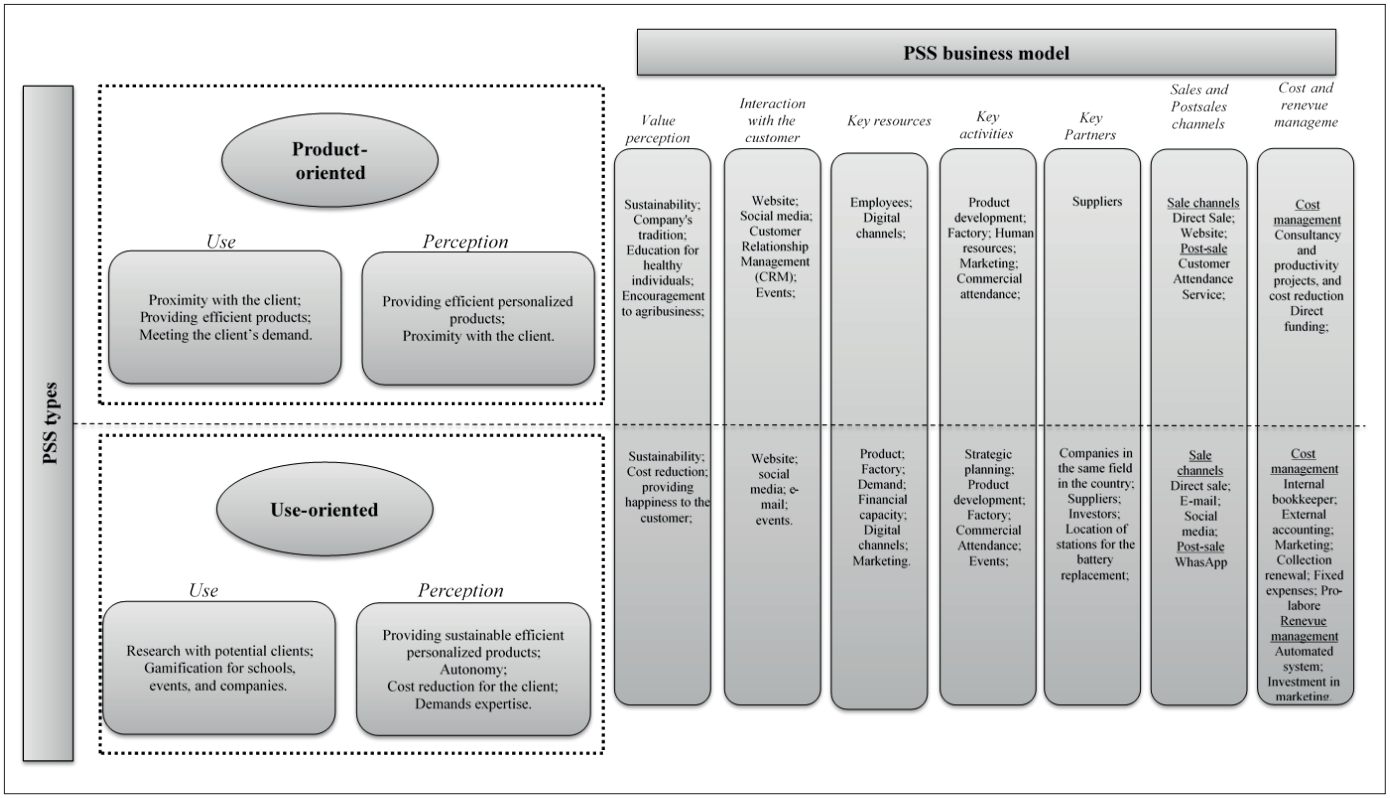
Figure 1 demonstrates that the adoption and respondents' perception of the PSS are mostly focused on meeting the client's needs, meeting what most of the PSS concepts in the literature propose (Goedkopp *et al.*, 1999; Mont, 2002; Manzini and Vezzoli, 2002, Tukker and Tischner, 2006; Annarelli, Batistella and Nonino, 2016). It also corroborates with the literature concerning the main driver for the adoption, residing in the strengthening and prolonging the relationship with the clients (Tukker, 2004; Adrodegari *et al.*, 2015), and the main barrier - the difficulty in understanding the PSS business model (Annarelli, Batistella and Nonino, 2016; Beuren, Sousa-Zomer and Cauchik-Miguel, 2017; Lee, Seo and Geum, 2018; Jesus Pacheco *et al.*, 2019; Labatte *et al.*, 2020), demonstrated by the speeches of E1, E2, and E3.

> "To decide to do the all-inclusive rental model, still at the foundation we decided to do a series of interviews with potential customers, to understand what are the main pains they feel or use combustion motorcycles in day-to-day operation [...]" (R1)

> "It is a business model for those who understand, it is not a business model for just anyone, from the moment you work with something that not everyone knows, you have to have a very big tact of what you are doing. [...]" (R2)

> "With these service offerings we aim to be always close to the consumer so that he can use the products efficiently and always have a product in the best possible way, that does not get worn out, ugly, and unsafe for the user." (R3)

Figure 1: Summary of PSS business model types



(Authors, 2024)

As for the PSS business model, Figure 1 demonstrated some common points in the business model of the studied companies, especially the value generation focused on sustainability, and interaction with consumers mainly through digital channels, the main key resources are the product and the digital channels, the most cited key activity is commercial attendance, all of them see their suppliers as key partners, the sale channels operate directly and also through the digital channels, while post-sale works mainly through digital channels. An overview corroborates the business model structure proposed by Adrodegari, Pashou and Saccani (2017).

In this context, with respect to value generation, evidence confirms that the potential offered by PSS regarding the positive impact on the environmental and social dimensions of sustainability is a drive/benefit of adopting the PSS business model (Tukker and Tischner, 2006; Baines *et al.* 2007; Tan, 2010; Annarelli *et al.*, 2019). Still, it is worth noting the concern about the generation of value focused on customer needs, corroborating with Baines *et al.* (2007), according to the author, in business strategies based on PSS the value proposition is focused on the needs of the final users and not on the product itself. Such arguments can be observed in the following statements.

> "We bring to the customers an alternative that is sustainable, compared to what we have today, which is the combustion motorcycle, and at the same time, it is cheaper and solves several problems that they didn't even know they had." (R1)

> "I want my client to be happy as much as possible. [...]" (R2)

> "[...] another aspect that strengthens the issue of value generation is our current positioning, which has existed for about 12-13 years related to sustainability, [...]" (R3)

> "[...] always seeking sustainability in everything we put on the market, the company has this very strong in its values and in its employees, from the conception of the product to the delivery of the final product." (R4)

In addition, note that all the companies worry about interacting with the customers and use the internet as a tool to keep in touch, either through social media or their website. In PSS, the relationship with clients is a critical success factor according to Tukker (2004), Kindström (2010), and Reim, Parida and Örtqvist (2015), once a good interaction between clients and companies is important for the PSS development and offer management.

Conclusions

This study mainly focused on the operation of PSS business models. To reach that goal, it used a qualitative approach through a multiple-case study in Brazilian companies, holding semi-structured interviews with representatives from four companies. Secondary data analysis was performed during the interviews to complement the information collected.

Considering the characterization of the researched companies regarding their profile and PSS used, the results showed that the studied companies have different sizes, and sectors, and their main common feature is the pursuit of innovation.

As for the adoption of PSS business models and based on the evidence found, PSS is perceived and used with the goal of meeting the client's needs and providing personalized efficient products. Also, the Beta company perceives PSS as a model that requires knowledge to operate.

As for the PSS business model itself, the findings reveal that the PSS value generation of the studied companies is focused on sustainability. Besides, all the respondent companies use digital channels for sales and interaction with the clients, and suppliers are deemed their main partners. In addition, commercial attendance and the marketing sector are cited as the key activities for the PSS offer.

The findings contribute to the progress of the literature because it covers the aspects related to PSS adoption and perception jointly with the business model, besides promoting paths that confirm the current literature. Practically, the research promotes the understanding of the PSS business model operations and provides insight into the management of the main components of the PSS business model. Finally, at a social level, this study contributes to the perception of the adoption of the PSS business model as an alternative for creating innovative and sustainable business models aiming to contribute to sustainable development.

The main limitations of this study are the understanding of the phenomenon based on the perception of a sole respondent of each company and not the direct observation, which could be useful for future analyses.

Another limitation consists of the companies' opening regarding strategic topics, for some issues were not deepened by the respondents.

It suggests that future studies should carry out quantitative research on the adoption of the PSS business model based on the perception of businesspeople and clients. Another suggestion is the construction and validation of a survey for a qualitative analysis of the phenomenon.

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Appendix
Interview protocol

Block I - Respondent's profile

1. Company name:
2. Responsible for the information:
3. Position:
4. Length of time in the company:
5. Length of time in office:
6. Academic formation
7. Contact phone number:
8. Email:

Block II - Characterization of the company

1. Time of existence of the company (years):
2. What is the company's field of activity?
3. What are the products/services offered by the company?
4. What is the company's gross operating revenue in 2020?
5. What is the total number of employees in the company?

Block III- Adoption of the PSS business model

1. How does the company define its business model?

PSS type

1. What is the predominant type of PSS adopted by the company (product-oriented PSS, use-oriented PSS or result-oriented PSS)?
2. How does the PSS work in your company? How was it adopted? What is your perception of the PSS?

PSS Business models

1. How does the company observe the generation of value from its services and products? How is product ownership established in the company's offerings?
2. What interactions does the company have with consumers?
3. What are the company's key resources for the PSS offering?
4. What are the company's key activities for the PSS offering?
5. Who are the company's key partners for the PSS offering?
6. How does the company manage its sales and after-sales channels?
7. How is cost managed with PSS offers?
8. How is revenue managed with PSS offers?