Adoption of product-service system and the potential as a sustainable solution: A literature view in the fashion industry

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Abstract

Fashion industry is highly dependent on natural resources, which are consumed to produce, distribute and to maintain its products in high frequency and disposability, being of high environmental concern. The adoption of Product-Service Systems (PSS) can provide to industry a mechanism to increase factors such as product quality and longevity, while providing alternative consumption models that reduce environmental impact. In this context, the purpose of this paper is to identify the existing models of PSS in the literature on fashion industry, its characteristics, and sustainable potential. Content analysis of 25 articles was performed, which are discussed according to the feasibility of operation and its environmental impact. There were identified 11 types of PSS applied in fashion industry and seven types of green practices observed in the publications examined.

Keywords
Fashion industry; Product-service system; PSS; environmental impact.

1. Introduction

According to McKinsey Global Fashion Index - MGFI (2018), the fashion industry encompasses six groups consisting of clothing, footwear, sportswear, handbags and luggage, watches and jewellery, and other accessories. This report also discusses the impacts of the unstable global economy on the industry, the growing of Asian market and its mode of consumption, interconnectivity and unsustainability on the mode of production in the segment.

In 2018, the sector expects moderate growth (between 3.5 and 4.5%), mainly driven by emerging markets in Asia, Europe and Latin America and sales from fast fashion segment (growth of 20% in the last 3 years). The demand in this area includes products with short life cycle and intensive use of material to meet the needs of high-volume clients and emphasis on diversified products (Armstrong et al., 2015; MGFI, 2018).

In addition, there is a growing consumer interest in more sustainable products as shown by 65% of emerging market consumers actively sought sustainable fashion in 2016 (MGFI, 2018). This concern demonstrates that environmental
impacts and fashion-life planning and production achieving are not restricted to retailers and manufacturers, but depends on within the whole supply chain in a complex range of variables (Janigo, Wu, 2015). Thus, finding more effective ways to meet exclusive purchasing with fewer products is important in the fashion segment because its environmental impact is significant in all phases of the product life cycle, from the extraction of the raw material, to the production processes, to care and to maintenance and its disposal (Armstrong et al., 2015).

A sustainable alternative model is Product-Service System (PSS), which uses the concept of rent, redesign, maintenance, or sharing to reduce dependence on natural resources and increase product longevity (Tukker 2004). The PSS models applied to the fashion industry can provide a mechanism to increase factors such as product quality and longevity, while providing alternative consumption models that reduce redundant consumption (Armstrong et al., 2015).

Therefore, the objective of this study are to identify the models of PSS applied to the fashion industry and its characteristics, as well as to identify the sustainable potential within the PSS models found in the literature. Paper intention is also to contribute to a better understanding of the models applied to the sector and to direct the research for the viability of the analysed business from the perspective of the sustainability.

2. Research methods

The methods applied in this work were adapted from Franco (2008), Bardin (2010), and Garza-Reys (2015). The procedures were delimited based on the criteria of location, selection and validation of the material, synthesis and analysis of contents, and presentation of the results, as illustrated in Figure 1.
2.1 Location, selection, and validation

The ISI Web of Science, Scopus, and Elsevier databases were accessed for the location of the articles, and EndNote® software was used to import the selected publications. For searching, the following keywords was used to select the articles: “product-service system”, “PSS” and “cloth*”, “cloth* industry”, “fashion”, “fashion retail”, “fashion industry”, “apparel industry”, “textile retail”, “garment retail”, “garment industry”. The criteria compiled to search were: (i) no restriction of year established; (ii) based on search in titles, abstracts, and keywords; (iii) no conferences, books or book chapters, as well as technical articles, and (iv) only articles written in English. The material was collected in March 2018, comprising publications up to that time.

After completing the search using the twelve keywords in the three databases, one 199 publications were selected. In order to exclude articles outside the subject, a screening procedure was performed: (i) PSS must have been addressed in the context of the following segments: apparel, footwear, handbags, sportswear, and accessories (belt, gloves, caps, and hats) and (ii) not considered sustainable potential related to the social and economic aspects.

Duplications were discarded. Titles, abstracts, and key-words were read in order to identify association with the research subject. During this process, articles that not deal with PSS applied to the fashion industry were removed from the set of publications. This resulted in 19 articles aligned to the research subject and five other articles were selected from the previous set by checking the references, summing up 24 publications for the next step, described next.

2.2 Synthesis and analysis

Content analysis was chosen as a appropriate method, adapted from Bardin (2010), who adopted coding and extraction of contents from the material: (i) registration units, and (ii) thematic axes. Excel® supported data processing. The terminology of the registry units and thematic axes were based on the studies by Sarkis (2001), Mont (2004), Tukker (2004), Armstrong (2015), Hvass (2015), Mejía-Gutiérrez et al. (2015), Zhu; Sarkis and Lai (2015), and Retamal (2017).


The models of PSS applied to fashion industry were organized in: (a) a table with the characteristics, PSS type and PSS model applied to fashion industry; (b) discussion of the feasibility of the business with theory. The issues related to sustainable potential was organized, and discussed according to the green practices addressed by Zhu; Sarkis and Lai (2015) as well as Sarkis (2001).

3. Literature Review

3.1 PSS practices in fashion industry

The fashion market is characterized as an industry focused on the resource-intensive product that is needed to produce, distribute and maintain fashionable items, which take years to fully utilize (Armstrong et al., 2015; Petersen, Risberg, 2017). In addition, the emotional nature of these goods combined with the desire for novelties has resulted in an increase in the consumption of fashion products and subsequent disposability (Lang et al, 2016).

These requirements are facilitated by a fast fashion system, which enables consumers to purchase apparel products at a higher frequency rate thus putting pressure on industry to produce shorter life-cycle times (Lang et al., 2016; Ræbild, Bang, 2016). Besides that, finding more effective ways to meeting these exclusivity needs with fewer
fashion products consumed and discarded could solve environmental issues associated with overproduction, consumption and disposal (Lang et al., 2016).

A product-service system (PSS) can provide the fashion industry a mechanism to increase factors such as product quality and longevity, while providing alternative consumption models that reduce redundant consumption and the environmental impact of production (Armstrong et al., 2015). There are three types of PSS that incorporate dematerialization from low to a very significant level: (i) product-oriented, (ii) use-oriented, and (ii) results-oriented. The PSS product-oriented reflects the less radical model and is more easily implemented for consumer products with embedded services that add value to sales, while PSS results-oriented models represent the greatest possibility of dramatic environmental impact through dematerialization (Tukker, 2004).

Despite services have long supported the use and maintenance of clothing products, these activities have not necessarily been used as means to achieve durability, sustainability, and dematerialization to apparel market (Armstrong, 2015). For example, the use of take-back service has been recurring in major fashion retailers such as H&M and C&A, although they are often used in exchange for discounts without worrying about the destination, disposal or reuse of the collected items (Armstrong, 2015; Pal, 2016; Corvellec, Stal, 2017).

PSS product-oriented or use-oriented models can provide a conceptual guide for the industry to combine these service concepts with apparel products to develop innovative and revenue-generating offerings that extend life, avoid waste, and increase product marketing (Armstrong, 2015). In the fashion industry, there are already practical models of PSS product-oriented such as take-back (with retailers Zara, H&M), repair and redesign (implemented by clothing company Patagonia) (Armstrong, 2015; Pal, 2016). The redesign of used clothing has been a common strategy used to stimulate interest in used products while increasing the longevity of the material. With the use of recyclable fabrics, for example, it is possible to reduce dependence on natural resources and increase the intensity of the use of the product (WRAP, 2017).

The use-oriented PSS models are characterized by the lack of transfer of ownership of the product. They have recently appeared in the fashion industry, such as the Nopsa Fashion Library, which offers consumers clothing and shoes based on monthly subscriptions and Beibambo, which leases Children's clothing made of bamboo material. This is advantageous for growing children who can only wear their clothing for a short period of time (Armstrong et al., 2015). Some others related schemes such as the Clothing Swap Meet Ups in New York are also emerging as a way to trade items among participants and thus provide a less intensive way of wearing clothes while increasing the durability of items (Pedersen; Andersen, 2015).

Although considered old practices in the apparel industry, laundry services and second-hand retailing have had shape a new way for companies suit their operations to more sustainable prospects. Companies such as Brastemp (a brand from Whirlpool) and Ariel (line of laundry detergents), have sought to offer the benefit of keeping clothes in the best condition for as long as possible in partnership with laundries (Mont, 2004; Hvas, 2015; WRAP, 2017).

However, it is important to note that the PSS study in the fashion industry is incipient and presents models that relatively few companies have put into practice (Adam et al., 2017). It is also argue that product-oriented model is the one of stands out among the existing models, since it does not imply higher risks for companies (Adam et al., 2017). Moreover, the same garment can pass through PSSs several times, in several loops, for example, being firstly repaired and then reused or recycled, or rented and then sold as a charitable item (Corvellec; Stal, 2017).

3.2 Sustainability and PSS

Even though studies approach PSS as a way of preventing waste generation, it is hard to say that product-service systems can meet expectations for an economy that requires less material and, therefore, be more sustainable (Mont, 2004; Tukker, 2004; Hvas, 2015). These PSS models need to relate to the details of the consumer's prevailing behaviours and waste infrastructures for collection and processing, so that the environmental effect is not dealt with in a superficial way (Corvellec and Stal, 2017).

In order to include the reduction of its environmental impacts, PSS seeks to increase product longevity from concepts such as: product rent, redesign, maintenance or sharing of items (Pal, 2015). In an operational context, activities aimed at reducing the negative ecological impact of products and services as well as improving the
environmental efficiency of their operations are called ‘green practices’ (Zhu, Sarkis and Lai, 2008; Garza-Reys, 2015).

Examples of the role of environmental practices and their consequent performance within a model of PSS applied to the fashion industry are (Hvass, 2015; Pedersen; Andersen, 2015; Yan; Song; Tong, 2017): the reuse of fabrics, the increase in second-hand retail, the designers new strategies (long life guarantee and product satisfaction), the partnerships between laundry services, appliance industry and cleaners brands, and the major fashion brands co-responsibility on since raw materials production to the final disposal of garments. Therefore, there is a need to identify the PSS that adds value to the product and service offered, taking into account the characteristics of the business (infrastructure, network, institutionalization), as well as its viability of implementation so that, at the same time, it can provide benefits to the customer, reduce superfluous consumption and provide an environmental improvement for all (Mont, 2004, Armstrong et al., 2015).

4. Results and Discussion

4.1 PSS models applied in the fashion industry

From the 24 articles that investigated PSS applied to the fashion industry, 13 were case studies. They focused on specific areas such as consumer research (Rexfelt; Ornas, 2009, Bianchi; Birtwistle, 2010), B2B business (Tomasin et al., 2013, Mejia-Gutierrez et al., 2015) and general operations (Retamal, 2017, Mylan, 2015, Stål; Corvelec, 2018). In addition, all articles in the portfolio cited issues related to sustainability.

Eleven PSS articles applied in the fashion sector were found and their characteristics and PSS type are described in Table 1. Content analysis of those articles showed that the PSS types ‘product-oriented’ and ‘use-oriented’ were the most cited, both types had 5 conceptual models mentioned. It is also important to note that from 11 models founded on literature, 10 had practice examples implemented and only one (fashion result model) did not have application, i.e., service applied in practice.

<table>
<thead>
<tr>
<th>PSS areas</th>
<th>Business profile – brief description</th>
<th>PSS type</th>
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<tbody>
<tr>
<td>Manufacturing monitoring</td>
<td>Digital platform for collaborative work between teams of designers and manufacturers of SMBs/SMEs in the links of product design, product detailing, prototype construction and product manufacturing</td>
<td>UO</td>
</tr>
<tr>
<td>Laundry</td>
<td>Washing, drying and ironing of garments by cycle wash or in a monthly package, in the categories: shared laundry or laundry service (including transport)</td>
<td>UO</td>
</tr>
<tr>
<td>Take-back</td>
<td>Shopkeepers offer the option of returning used clothing and users receive in return a discount for new clothes or a cash coupon</td>
<td>PO</td>
</tr>
<tr>
<td>Repair and redesign</td>
<td>Repair: provide repair service for clothing purchased for a fee and / or provide warranty service; redesign: maintenance service for a fee that includes repair and / or alterations to improve fit for a period</td>
<td>PO</td>
</tr>
<tr>
<td>Clothing rental</td>
<td>Fashion library it is an online service that customer signs a package to withdraw a certain number of pieces of clothing for a short period of time</td>
<td>UO/RO</td>
</tr>
<tr>
<td>Second-hand retail</td>
<td>Collection, sorting, donating or reselling of donated or purchased apparel from third parties</td>
<td>PO</td>
</tr>
<tr>
<td>Participatory customization</td>
<td>Boutique offers two custom design services: building a garment, selecting existing components and formats or working with an in-house designer to create a unique piece of clothing (creation, prototype, and execution)</td>
<td>PO</td>
</tr>
</tbody>
</table>
Consulting | Client can purchase an hourly session in person or by videoconference and receive style advice on use of items that the customer already owns | UO

Clothing swap | Shopkeepers organize a fashion event where customers buy tickets to attend a party night and exchange their clothing items in good condition | UO

Make it yourself (MIY) | Modular fashion kit order containing necessary fabric, trim, thread and tools for the preparation of the clothes in the desired way | PO

Fashion result | Customized consulting service where the client provides their sizes, style preferences, their destination within 24 hours before the event then the team creates the desired look, including clothes and aesthetic procedures (hair, makeup, pedicure and manicure) | RO

Notes: PO – product-oriented PSS; RO – result-oriented PSS; UO - use-oriented PSS.

The most discussed PSS in the literature was the rent of clothes (9 articles), followed by repair and redesign (8), take-back (6), laundry and second-hand retail (5), personalized and participatory design, consulting, clothing swap and MIY (2 articles each), and manufacturing monitoring as well as fashion result (1 article each). All articles were categorized in one category at least, while some of them were placed within two or more categories.

In general, the studies concentrate their analysis on issues related to the viability of the business in the segment (difficulties and opportunities). The rent of clothes, for example, is already applied in Scandinavian fashion digital libraries studied by Petersen and Netter (2015) and clothing brands such as the Swedish fashion brand Filippa K (Petersen; Riisberg, 2017). However, there is little awareness about consumer acceptance with this practice (Armstrong et al., 2016; Petersen; Netter, 2015) as well as the ability of this model to thrive and survive (Corvellec; Stal, 2017).

Some studies (e.g., Corvellec; Stal, 2017; Lang et al., 2016) have also shown the benefit to whom wish to satisfy brand recognition with an attendant requirement, as it indicates the quality of their product. For example, it can be explored in the repair and redesign PSS models since they can increase the longevity and quality of the products offered (Armstrong et al., 2015).

Although grouped as a same category, the repair and redesign PSS models differ in results (Armstrong et al., 2015), while the repair makes minor adjustments to the item, redesign modifies from small details to change the whole structure. The most widespread type of PSS in the fashion industry is repair (Strähle and Freise, 2017). Their ultimate concern is not to lose the aspect of exclusivity (Lang et al., 2016), a fact also addressed in relation to take-back practices.

The exclusivity in the take-back is linked to the return of the product to refer the perceived quality. Added to this, Corvellec and Stal (2017) studied the Boomerang and argued that using take-back system, the fashion brand had have succeed in promoting clearly the longevity of the material used. In some other publications, the concern it is in the operationalization of the model (Ekstrom; Salomonson, 2014), as the reverse logistics (Yang et al., 2017), screening (Adam et al., 2017), and destination (Pal, 2016).

In summary, within the life cycle of a product, there is a range of possibilities from the take-back PSS model (Goworek, 2012, Corvellec and Stal, 2017). Besides that, this work identified that in the models of rent, repair, redesign, and second-hand retail, the take-back system was the service responsible for providing the raw material of these activities. Although indirectly, the take-back can be considered one of the most widespread models of PSS in the fashion industry (Armstrong et al., 2015).

The second-hand retailing is an example of what can be done after the initial take-back screening, with possibilities such as selling, exchanging or donating items, although there is high risk of deterioration due to improper handling, bad adjustments, and difficulty for its operationalization (Bianchi and Birtwistle, 2014). In addition, it should be noted that many other PSS (swap, rent, and redesign) are second-hand retail types (Pal, 2016).
Looking forward, indirectly linked with clothing industry, there are the laundry services and their difficult on delivery logistics that can make the service unfeasible for both laundry services: (i) laundries that delivery and (ii) models that customers need to carry out transportation (Chiu et al., 2017). Other factors such as infrastructure (Retamal, 2017) and current legislation (Mont, 2004) may vary according to the needs of consumers.

It is also important to notice that the ability of companies make consumers purchasing services instead of purchasing a product differs depending on the nature of this product (Retamal, 2017). For instance, consumers do not buy household appliances as often as they consume garments, because usually consumers tend to fix old domestic appliances and tent to disposal old clothes and buy new ones, then business models such as custom and participatory design, consulting, clothing swamp, fashion result and MIY are still initial models with a few or no practical application.

Concerning custom design and ‘make it yourself’ (MIY), their higher time spent in elaboration can make it difficult to obtain acceptance in relation to more traditional consumers (Niinimäki and Hassi, 2011; Armstrong et al., 2015), as well as custom design, consulting and fashion result that are often use for specific occasions making it difficult to propose these services in usual situations. Although consumers still have the notion of disposability, these types of PSS are interesting from the point of their help to increasing product longevity (Lang et al, 2016).

According to Mejía-Gutiérrez et al. (2015), from the operational perspective, the reduction in consumption of raw material is focused on manufacturing monitoring where the implementation of the platform allowed for a lower incidence of unscheduled pauses such as repairs and order changes, leading to an improvement in product quality. In addition, services that escape the more traditional scope of consumption, usually the types of PSS aimed at the use, such as rent, consulting and swamp need education of the consumers for their effective accession, as well as traditional but considered business models little-personalized, such as redesign and second-hand retail, in addition to its recent application. In general, the most practical examples of PSS are those that do not imply greater risks to companies such as repair and take-back.

Moreover, services that seek greater dematerialization are few accepted in consumer surveys (Armstrong et al., 2016, Armstrong et al., 2015, Rexfelt, Ornas, 2009; Tukker, 2004), as the case of swamp, rent, and second-hand retail. Finally, it should be noted that consumers are less likely to invest time in clothing items (Adam et al., 2017) and are demanding perceived quality, design and brand experience (Petersen and Riisberg, 2017).

4.2 Sustainable potentials identified in PSS models

Table 2 shows the sustainable potentials of the PSSs addressed from the perspective of green practices, adapted from the studies of Zhu, Lai and Sarkis (2008) and Sarkis (2001). In the majority of publications, 5R and LCA were the most discussed practices. The results of the literature review also suggested that some of the PSS business models have emerged with a view to sustainability (e.g. Corvellec; Stal, 2017, Yan et al., 2017, Pal, 2016). This statement can supports product dematerialization from the reduction of individual consumption to the sharing of services, justifying the application of PSS in order to reduce its residual effect, noticed by Tukker (2004).

<table>
<thead>
<tr>
<th>Table 2. Green practices identified in PSS models applied to fashion industry</th>
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<tbody>
<tr>
<td>PSS areas</td>
<td>Green practices</td>
</tr>
<tr>
<td>Manufacturing monitoring</td>
<td>5R (focus on reduction)</td>
</tr>
<tr>
<td>Laundry</td>
<td>Cooperation with customers, 5 R (focus on reduction and reuse) and LCA</td>
</tr>
<tr>
<td>Take-back</td>
<td>5R, customer cooperation, regulations</td>
</tr>
<tr>
<td>Repair and redesign</td>
<td>5R, customer cooperation</td>
</tr>
<tr>
<td>Clothing rental</td>
<td>Green purchasing, Life Cycle Analysis (LCA), 5R (focus on reduction and reuse)</td>
</tr>
<tr>
<td>Second-hand retail</td>
<td>5R, customer cooperation</td>
</tr>
</tbody>
</table>
Therefore, if the objective of the PSS is to reduce its residual effect and contribute to dematerialization, companies should focus on prioritize waste prevention and building a business model with adequate material flows from the post-retail perspective, prioritizing: (1) collection; (2) sorting and, (3) final destination to collected garments (how much to resell or recycle for instance) (Corvelec; Stal, 2017).

The collection and sorting systems were also discussed in the context of recycling, which is widely discussed in the take-back, repair, and redesign models. The recycling services are outsourced by large retailers in the take-back, and the responsibility for the collection, separation and destination of the material is worked by the recycling company (Adam et al., 2017). On the other hand, in the business models as repairs and redesign, the companies make the textile remanufacturing process in addition to indicating that the recycling services are also interested in redesign and retail of second hand (Ekstrom; Salomonson, 2014).

Another concern is about the disposability of products that take years for their full use and it has also raised questions about circularity (in the context of circular economy). As exemplified by Stal and Corvelec (2018), Swedish companies works together in the Textile Recycling Network, with the aim of creating joint solutions for the circular economy and drawing the attention of consumers to the environmental footprint of wasted clothing.

Looking into communication and education of the consumers to the new practices of PSS was much approached in renting, take-back, repair, redesign, swamp, and second-hand retail. Goworek et al. (2012) discussed that increasing consumer awareness of sustainability with a view to improving its sustainable practice with regard to clothing could be facilitated by governments and retailers that offer such clothes donation campaign, potentially in collaboration with the mass media.

In the case of laundries, marketing activities undertaken by cleaning products or washing machines related to socio-environmental issues on clothing industry produced positive effects on the consumers, such as more informed choice and more engaged action by the laundries users (Mylan, 2015). From the life cycle analysis, laundry systems also demonstrate to have a greater environmental impact than washing at home, because people tend to dry their clothes when washing in a laundry room (Mont, 2004). The studies of Mylan (2015) and Chiu et al. (2017) point out that low-temperature washing, the frequency of washing cycles and the lean mode could contribute because it would reduce energy and water consumption.

The sample has shown that LCA was more cited in the PSS use-oriented, which may be related to the purpose of the business model to total using of the product before its disposal. Those PSSs product-oriented have focused more on the practice of 5Rs and have been more discussed with practical cases of large retailers such as H&M and Boomerang, as they may be more affected by regulations (such as the EU Waste) or could be understood as a marketing activity to promote brand value.

To put in a nutshell, all these aspects indicates that companies that integrate sustainability as business value tend to be more concerned about the impact of clothing products. The rent business model was the one with the greatest debate about the acquisition of the raw material, development, and commercialization of the products (Raebild and Bang, 2017; Ornas, 2009). In summary, a return system driven by a fast-fashion company like H&M is different from the rental system run by a company committed to lasting quality, such as Vigga, even though the two end up offering to recycle the fabrics for apparel use. (Corvelec, Stal, 2017).

Nevertheless, although there are already green practices in the PSS models implemented, more managerial models such as internal environmental management, eco design, and equipment dismantling were not mentioned. This can be illustrated due to the characteristics of the current models being recent and less widespread, so it is possible that
with the evolution of the types of PSS implemented, the sustainable potential has a greater impact on the actions of the evaluated businesses.

5. Conclusions
The studies that deal with PSS in the fashion industry concentrate their analysis on issues related to the viability of the business in the segment (difficulties and opportunities) such as: operationalization, consumer behaviour, and production methods applicable to the fashion industry. In this context, this work identified and characterized the existing business models of PSS in the fashion industry, as well as its sustainable potential, from the green practices perspective.

In this research, 11 PSS practices were found in the fashion industry, such as: manufacturing monitoring, laundry, repair and redesign, take-back, participatory customization, make it yourself, consulting, fashion result, clothing rental, clothing swap, and second-hand retail.

The most discussed PSS in the literature was the rent of clothes. Although indirectly discussed, the take-back model was also present, being considered the supplier of raw material for other types of PSS such as rent, second-hand retail, and repair and redesign. In addition, the literature indicates a trend towards implementation of PSS that do not imply greater financial risks for companies such as repair and take-back.

Regarding sustainable potential, studies have shown that PSS models have emerged with a view to sustainability and aimed at reducing the residual effect of business impact. The most widespread green practices in the literature were life cycle analysis and 5R (especially material recycling). Besides, internal environmental management, eco-design, and disassembly of equipment were not quoted at any of those publications. The product dematerialization, consumer education and the life cycle assessment were arguments used to justify the practical effectiveness of the models in relation to economic and environmental benefits.

Finally, the characteristics of current models still encompass more reactive practices, such as recycling and remanufacturing, than activities that actually promote the reduction in the use and disposal of garments, although there were companies who already concerned with the circularity of the materials inside of the productive model. For this reason, the possibility of new work confronting the theoretical analysis with a practical case are relevant and using scenario models to verify the viability and evolution of the types of PSS implemented.

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