SUSTAINABLE FASHION FROM PRODUCT SERVICE SYSTEM PERSPECTIVE: A LITERATURE REVIEW

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Abstract

Fast fashion perpetuates the perception that clothing products are cheap and are easily disposed of. Consequently, the fashion industry contributes great concern for environmental impact. Product-service system (PSS) may serve as an integrated product-service solution to support sustainable fashion. While there is an increasing trend in PSS studies, the literature studies in fashion PSS remains limited. This paper aims to explore the research topics in fashion PSS studies by examining topics addressed in fashion PSS literature, how PSS may contribute to sustainability in the context of the fashion industry, as well as positive and negative value perceived consumers in adopting PSS fashion. The research is conducted through literature review retrieved from Scopus and analyzed according to the aim of this paper. The results show that topics addressed in fashion PSS are related to potential drivers and barriers to adopt PSS fashion, business model, environmental impact, and life cycle analysis. The role of PSS in the fashion context is product and use-oriented. The consumer perception on adopting PSS fashion is classified as emotional, functional, social, financial, environmental, and psychological aspects.

Keywords*: product-service system; fashion; literature review; sustainability*

1. Introduction

Nowadays, industries are increasingly under pressure to conduct their business in a sustainable way. The fashion or clothing industry represents one of the industries with increasing concern for its environmental impact (Costa, Azoia, Silva, & Marques, 2020). The industry focus on fast fashion relies on frequent updates on clothing products, perpetuating the products as cheap and disposable (Birtwistle & Moore, 2007). The consumption of fashion in Europe has increased by 40% in a few decades (Sajn, 2019), while China has shown an increase of 60% in less than a decade (Zhang & Dong, 2021). Clothing accounts for 2-10% of the environmental impact of the EU, but the impact is often suffered in the third countries as the common production sites (Sajn, 2019). There were approximate 14m tons of textile products were disposed to landfills in the US (US Environmental Agency, 2014).

The product-service system (PSS) may provide an effective framework to address these concerns. PSS has increasingly gained attention among researchers concerned with sustainability. Walther Stahel (1982) and Friedrich Schmidt-Bleek (1993) were among the pioneers who were among the first to recognize the benefits of the PSS idea in terms of sustainability and resource-efficiency (Tukker, 2015). Product-service system (PSS) is a form of offering as a conjunction of tangible and intangible products (Eppinger & Ulrich, 2015) which the form of business transition from initial product focus on value proposition (Baines et al., 2007) through the integration of product and service (Zheng, Wang, Chen, et al., 2019).

PSS has mostly been distinguished into three main categories Tukker (2004): product-oriented services, use-oriented service, and result-oriented services. From these three main categories, eight types of PSS emerged. Firstly, product-oriented services cover product-related service and advice and consultancy. Secondly, use-oriented services entail product lease, product renting or sharing, and product pooling. Lastly, result-oriented services cover activity management/outsourcing, pay per service units, and functional results. PSS is expected to have a lower environmental impact than a traditional transaction in which a company produces goods and then transfers ownership and use to the customer (Baines et al., 2007).

Product service-system has been studied mainly in manufacturing related domains such as challenges for circular business implementation in manufacturing firms (Sousa-Zomer et al., 2018), transition from production to focus on use value (Ericson et al., 2014), PSS implementation in aerospace domains (Sun et al., 2017; Zhu et al., 2012), and PSS business model in electronic equipment (Sigüenza et al., 2021; Tasaki et al., 2006). The PSS research on consumer goods,

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Table 1. Scopus Keyword Search Result

Search	Main Keyword	Additional Keyword	Total Paper (Document type filter)	Total Paper (Abstract Filter)
1	"Product	"sustainability" AND "fashion"	31	16
2	service	"sustainability" AND "textile"	17	6
3	system"	"sustainability" AND "clothing"	18	8
4		"sustainability" AND "apparel"	8	2
5		"sustainability" AND "shoe"	4	1

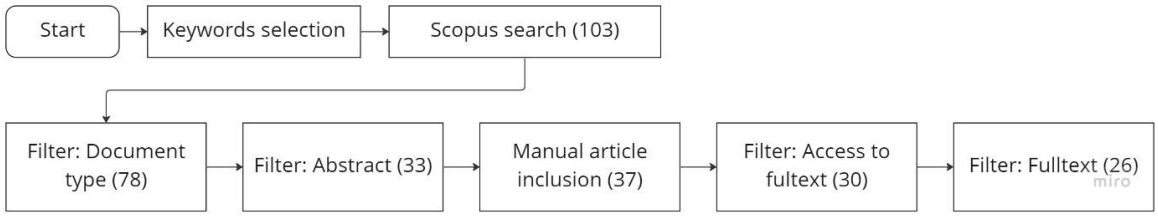

Figure 1. Process of Literature Collection

including fashion, is also growing but in a relatively smaller number (Borg, Mont, & Schoonover, 2020; Lee, Sakamoto, & Yoshizawa, 2021; Schoonover, Mont, & Klintman, 2022; Tunn, van den Hende, Bocken, & Schoormans, 2021). The current literature studies on PSS are also varied starting from literature review for product service system in general (Annarelli et al., 2021; Barravecchia, Franceschini, Mastrogiacomo, & Zaki, 2021; Cavalieri & Pezzotta, 2012; Lipiak, Kulesza, & Salwin, 2019; Xin, Ojanen, & Huiskonen, 2017), benefits and barriers (S. R. Moro, Cauchick-Miguel, & Mendes, 2020), digital technologies and smart product-service system (Alcayaga, Wiener, & Hansen, 2019; Pirola, Boucher, Wiesner, & Pezzotta, 2020; Sakao & Neramballi, 2020; H. Zhang, Ma, Sun, Lin, & Thürer, 2019), business model (Suzana Regina Moro, Cauchick-Miguel, & Mendes, 2022; Reim, Parida, & Örtqvist, 2015), circular concept (Alcayaga et al., 2019; González Chávez, Romero, Rossi, Luglietti, & Johansson, 2019), PSS in automotive industries (Mahut, Daaboul, Bricogne, & Eynard, 2017; Sabbagh, Ab Rahman, Ismail, & Wan Hussain, 2017), and PSS impact to sustainability (Hüer, Hagen, Thomas, & Pfisterer, 2018).

Although studies on fashion PSS have been growing, literature review addressing and discussing the underlying topics are still limited. Through literature review, this paper aims to understand the research topics in the context of sustainable fashion from the perspective of product-service system by answering the following research questions: 1) what topics are addressed in the studies of fashion product-service systems?; 2) What is the role of product-service system for sustainable fashion?; 3) What are the potential positive and negative values perceived by consumer to adopt fashion PSS?

The outcome of this study is to map PSS contribution in sustainability from the context of the fashion industry. The paper starts with an introduction followed by a method explaining how the literature review was conducted and analyzed. The subsequent section shows the result and discussion based on the literature review on PSS for sustainable fashion.

2. Method

The method of this study is literature review. Literature was collected through the Scopus database using relevant search keywords as the inclusion criteria. The keyword searches were conducted in five attempts with five inclusion criteria using the mandatory keyword search of "product service system" and two additional relevant keywords with the period of publications was 2012 to 2022. For example, the first inclusion criteria were "product-service system", "sustainability", and "fashion". The second inclusion criteria were "product-service system", "sustainability", and "textile". It should be noted that the difference was in the third keyword which is synonymous with fashion. The search was continued until five inclusion criteria as seen in **Table 1**. Then, the first filter applied was document type which only included journal articles and conference proceedings. The next filter was an abstract filter which resulted in a total of 33 final articles as seen in **Table 1**. In addition, four documents from Science Direct were manually added to the collection because of their relevance and to enrich the nuance of analysis. The publications that the author had no access to were eliminated. The relevance of the publications was further checked from the abstract and the full text which then resulted in 26 final documents. The overall method of literature collection is presented in **Figure 1**. The final collection of articles was then scrutinized to answer the research questions. To reveal topics addressed in literature, **Table 2** summarizes 26 articles in terms of the study aim and result. Further analysis was done to extract key information related to the role of PSS in sustainable fashion as well as the potential barriers and drivers.

3. Result and Discussion

Topics Addressed in Literature Review

The most common topics addressed in studies is related to: (1) adoption of sustainable fashion through product-service system (e.g., use-oriented) (Cosette M.

Table 2. Topics Addressed in Literature

No.	Author	Objective	Results
1.	Armstrong et al. (2016)	To evaluate use-oriented PSS from consumers' perspective	Themes include decreased consumption, desire for change, social, economics, product satisfaction, loss of supplier trust, and usability.
2.	J. Holtström et al. (2019)	To identify essential components of sustainable apparel consumption business model development.	Key features include continuous development, income streams and profitability, PSS development, collaboration, resources and capabilities, capturing change, barrier identification, efficiency, and customer viewpoints.
3.	Abreu et al. (2021)	To explore how business-to-business collaboration decides sustainable textile and garment solutions.	Corporate policy, stakeholder-based sustainable product-service systems, and a company strategy that creates economic, social, and ecological value.
4.	Borg et al. (2020)	To study how corporations promote u-PSS in consumer items (clothing, furniture, and eyewear).	Drivers are financial value, functional value, emotional value, social value as drivers
5.	Tunn et al. (2021)	To determine which adoption hurdles are crucial for AB-PSS adoption and under what conditions.	Touchpoints and usage are barriers. Clothing AB-PSS adoption is more important due to contamination.
6.	Petersen & Riisberg (2017)	A Danish subscription service under development is used to research cloth rental.	The challenges include the transition from ownership to usage, laundry regimens, sharing and teamwork, and clothing negotiation.
7.	Fani et al. (2022)	To discuss hybrid strategy to support fashion companies in building new business models that consider both customer and company perspectives.	Switching to renting fashion items, drivers and barriers linked to corporate process and customer behavior can be modeled by integrating DES and ABM paradigms.
8.	Monticelli & Costamagna (2022)	To analyze the environmental effects associated with the life cycle of formal garments.	Rental business model extends product life, reducing fashion industry environmental impacts.
9.	Corvellec & Stål (2017)	Scholars, producers, and consumers must discuss how to evaluate PSSs' actual effects.	The waste follows from its business model's material flows and consumer behaviors and garbage collection and processing infrastructures. Waste reduction options are explained via the European garbage hierarchy model.
10.	Lang & Armstrong (2018)	To determine if fashion leadership hinders or encourages sustainable clothes product-service system purchases (CPSS).	Fashion leadership increases customers' interest in each CPSS retail model, although age, income, and education moderate these associations. Fashion leadership increased attitude, subjective norms, and CPSS adoption intention.
11.	Fernandes, Honório, Cruchinho, Madeira, & Lucas (2020)	This post promotes knowledge as social innovation for sustainability week, introducing a business value proposition.	Product-service system design, linked to the fashion revolution, encourages social innovation, circularity, and behavior with social and environmental advantages through online platforms and apps.
12.	Zhang & Dong (2021)	To investigate the impact of virtual social capital on sustainable clothes consumption.	Virtual social capital and peer influence favorably affected BISCCP, peer influence partially moderated the connection, while face consciousness and consumer innovativeness negatively regulated it.
13.	Fischer & Pascucci (2017)	To understand how a circular economy creates new inter-firm organizational structures and sustainability-enhancing institutions.	Chain coordination, contracts, and financial mechanisms foster new organizational aspects of inter-firm cooperation and new rules for managing circular economy material flows.
14.	Piontek & Müller (2018)	Examine whether renting casual clothing has environmental	We discuss LCA studies, chemical data, technical advancement, the usage phase of

No.	Author	Objective	Results
		benefits over conventional consumption.	garments, and user behavior and methodological development.
15.	Khitous et al. (2022)	Examines (1) what benefits customers expect from PSSs and (2) how those benefits affect their involvement with various PSSs.	Customers' demographics and expected benefits (economic, pragmatic, cognitive, personal, hedonic, and societal) determine their participation with fashion PSS.
16.	Johnson & Plepys (2021)	Examines how user behavior and business model configuration affect the environmental impact of PSS business models in clothes rental.	Garment usage frequency, rental as purchasing substitution, and consumers' trip to rental store locations affect freshwater ecotoxicity, human carcinogenic toxicity, and global warming potentials.
17.	Bhamra, Hernandez, Rapitsenyane, & Trimingham (2018)	To educate designers, design managers, and policymakers on sustainable PSS development as a strategic innovation component.	Technical, financial, and operational hurdles and unfavorable business conditions are obstacles. However, SMEs valued collaboration and government help.
18.	Moreno et al. (2017)	To study how Re-Distributed Manufacturing (RdM) and Product-Service Systems (PSS) support the new economic paradigm.	The model shows that production recycling facilities close to customers are needed for robust facilities.
19.	Biedermann, López, Sáenz, & Martín (2022)	How to sustain the product-service system in: 1) apparel boutique sustainable improvements, 2) itinerary exhibition investigation.	Reducing clothing production by textile service providers and changing furniture design and distribution improve clothing.
20.	Stål & Jansson (2017)	To explore how organizations frame value propositions to shape sustainable consumption.	The study shows how companies leverage product, usage, and result-oriented PSS to offer the entire garment consumption cycle—purchase, use, and disposal. Eco-labels, washing advice, and take-backs affect consumer behavior
21.	Cosette M. Armstrong et al. (2015)	To determine clothes product-service system (PSS) obstacles and feasibility by identifying positive and negative perceptions.	Environmental benefit, emotional (product pleasure, experiential and social components, fashion needs), financial, design, ease of use, provider distrust.
22.	Adam (2018)	To compare manufacturing firms' HRM with PSS implementation.	PSS firms focus more on human capital, people management, and employee dedication than non-PSS firms.
23.	Becker-Leifhold (2018)	To demonstrate how consumers' beliefs and the theory of planned behavior affect their desire to adopt alternative fashion consumption patterns.	Collaborative consumption is explained by attitude, subjective norm, perceived behavioral control, and egoistic value. No effect of environmental and social issues on garments rental inclinations. Renting garments was unaffected by age, education, or cost.

Armstrong, Niinimäki, Kujala, Karell, & Lang, 2015; Cosette M. Armstrong, Niinimäki, Lang, & Kujala, 2016; Becker-Leifhold, 2018; Borg et al., 2020; Khitous, Urbinati, & Verleye, 2022; Lang & Armstrong, 2018; X. Zhang & Dong, 2021), (2) business model (Fani, Pirola, Bindi, Bandinelli, & Pezzotta, 2022; J. Holtström, Bjellerup, & Eriksson, 2019; Moreno et al., 2017; Petersen & Riisberg, 2017), (3) PSS in organization (Marcus Adam, 2018; Fischer & Pascucci, 2017), and (4) environmental impact (Corvellec & Stål, 2017) through life cycle analysis (Monticelli & Costamagna, 2022; Piontek & Müller, 2018).

Few studies address adoption of fashion PSS that includes clothing and other sectors. The study by Borg et al. (2020) examined what consumer value the most when adopting u-PSS of consumer goods companies in Sweden. Tunn et al. (2021) examined different barriers to adopt based on duration of access to certain products (e.g., short and long-term).

Business model is another popular topic in fashion PSS. Holtström et al. (2019) laid out key characteristics of sustainable business model innovation which includes continuous development, revenue streams and profitability, PSS development, collaboration, resources and capabilities, capturing change, identifying barriers, efficiency, and customer

perspectives. Challenges in the rental business model were also identified in the Danish subscription service, especially the shift from ownership to usership, laundry regimes, sharing and collaboration, as well as the wardrobe negotiation (Petersen & Riisberg, 2017). Re-distributed manufacturing business model was proposed to achieve increased energy efficiency and reduced resource utilization (Moreno et al., 2017).

Few studies in fashion PSS address the organization aspects. For instance, (Fischer & Pascucci, 2017) concluded that chain coordination, contracts, and financial procedures were pivotal organizational factors to shift into circular materials flows. On the other hand, Adam (2018) focused on the role of human resource management (HRM) in sustainable PSS which covers human capital, people management system, and employee's commitment.

The studies about environmental impact were aimed at finding evidence of environmental benefit from fashion PSS implementation. A PSS's waste effect is independent of its product, use, or result orientation because it derives from the interaction of its material flows with existing consumer habits and waste infrastructures (Corvellec & Stål, 2017). Piontek & Müller (2018) found quantified impact of fashion PSS to the freshwater ecotoxicity, human carcinogenic toxicity, and global warming potentials according to the garment use frequency, purchase substitution, and consumers' trip to store locations. On the other hand, based on analysis in the formal dress rental business model, packaging and dry cleaning were the most contributing factors that caused negative environmental impact, while transport of garments did not cause such high impacts (Monticelli & Costamagna, 2022).

The Role of PSS for Sustainable Fashion

Based on literature, the role of product-service system in sustainable fashion focused on (1) the categorization of PSS such as product-oriented, use-oriented, and access-based PSS (e.g., Cosette M. Armstrong et al., 2016; Borg et al., 2020; Tunn et al., 2021), (2) business model innovation (Johan Holtström, Bjellerup, & Eriksson, 2019; Monticelli & Costamagna, 2022; Petersen & Riisberg, 2017), (3) life cycle analysis (Piontek & Müller, 2018), (4) sustainable clothing PSS (Lang & Armstrong, 2018), and (5) sustainable clothing consumption model (Zhang & Dong, 2021).

Business model innovation allows the shifting from product ownership to use-oriented models such as rental or leasing (Petersen & Riisberg, 2017). The innovation of business models can be related to life cycle analysis. Life cycle analysis is useful to better understand the environmental effect of a product across its entire life cycle from production phase (production, confectioning, distribution), use phase (packaging, transport, washing), and end of life (disposal) (Monticelli & Costamagna, 2022). For instance, rental or leasing business models which extend the life of a product in terms of the number of uses may inhibit the environmental impact (Monticelli & Costamagna, 2022; Piontek & Müller, 2018). The study also found that environmental impact was contributed during the use phase, especially packaging and laundry (Monticelli & Costamagna, 2022).

The classification of PSS is based on (Tukker, 2004), namely product-oriented, use-oriented, and result-oriented. The PSS is product-oriented if it involves a transfer of ownership to customers and use-oriented if the company keeps ownership of the garments that consumers borrowed or leased (Monticelli & Costamagna, 2022). If the service was chosen by the consumer but the clothing was chosen by the service provider, the PSS was considered as result-oriented, as the garment itself plays a secondary role (ibid). The articles we analyzed commonly addressed product-oriented and use-oriented PSS. Product-oriented PSS covers repair, redesign, customized, "make it yourself" (Cosette M. Armstrong et al., 2016) take-back (Cosette M. Armstrong et al., 2015), clothing repair/alteration service (Lang & Armstrong, 2018), the sale of upgraded or redesigned second-hand clothing (Lang & Armstrong, 2018; X. Zhang & Dong, 2021). While use-oriented fashion PSS entails consultancy, renting, and swapping (Cosette M. Armstrong et al., 2015, 2016).

Both product-oriented and use-oriented fashion PSS support a sustainable clothing consumption model which implies that consumers should not only buy environmentally friendly products but also to buy less often and utilize ecologically friendly disposal methods (Zhang & Dong, 2021). Therefore, the studies about PSS, when contextualized in fashion, frequently suggests keyword of sustainable consumption (Becker-Leifhold, 2018; Hankammer, Hora, Canetta, & Sel, 2016; J. Holtström et al., 2019; Petersen & Riisberg, 2017; Stål & Jansson, 2017; X. Zhang & Dong, 2021) Hence, it can be concluded that one of PSS key roles is to alter consumers' consumption pattern through, for instance, renting and sale of second-hand clothing. The collaborative consumption is also the frequent theme among studies addressing fashion PSS (Abreu, Ferreira, Proença, & Ceglia, 2021; Becker-Leifhold, 2018; Fernandes, Lucas, Madeira, & Cruchinho, 2019; Petersen & Riisberg, 2017) as the PSS implementation works through reciprocal responsibility for firms and consumers (Stål & Jansson, 2017). Besides, use-oriented business models such as swapping and renting are similar to sharing-based business models which connect two or more stakeholders to participate.

Value Perception on PSS Fashion Adoption

Qualitative and quantitative studies provide insights to reveal positive (e,g., drivers) and negative value perceptions (e.g., barriers) in fashion PSS adoption as seen in **Table 3**. There are important values perceived by consumers for the adoption of PSS namely financial, functional, emotional, and social value (Borg et al., 2020). Financial is considered positive because fashion PSS allows cheaper prices from renting compared to buying new clothes (Fani et al., 2022) but becomes negative because of additional costs to accommodate the operations of PSS (Armstrong et al., 2016) or other uncertainty consequences (Borg et al., 2020). Functional value is perceived positively when the service can perform its

Table 3. Barriers and Drivers

Values	Sources
Financial value	
(+) Price (-) Financial risk	(Armstrong et al., 2015, 2016; Fani et al., 2022)
Functional value	
(+) Ease of use (-) Performance risk, item damage, ease of use	(Cosette M. Armstrong et al., 2015; Borg et al., 2020; Fani et al., 2022)
Emotional value	
(+) Design, product satisfaction, experience, fashion interest (-) Design	(Armstrong et al., 2015, 2016; Borg et al., 2020; Fani et al., 2022)
Social value	
(+) Social interaction, social influence	(C.M. Armstrong, Niinimäki, Lang, & Kujala, 2016; Borg et al., 2020)
Environmental value	
(+) Sustainability, environmental benefit	(Cosette M. Armstrong et al., 2015; Fani et al., 2022)
Psychological value	
(+) Reduced consumption, desire for change, attitude to rent, trust (-) Desire to own, lack of trust, uncertainty, hygiene, psychological risk	(Armstrong et al., 2016; Borg et al., 2020; Tunn et al., 2021)

intended function but becomes negative as it has performance risk and item damage (Fani et al., 2022). Emotional value is mainly discussed as positive perception in most literatures which cover product satisfaction, experience, and fashion interest (Armstrong et al., 2015, 2016; Borg et al., 2020; Fani et al., 2022). Social value is perceived positively as fashion PSS, for instance fashion consultancy, provides social interaction which can boost self-confidence (Armstrong et al., 2016).

Another social value is related to social responsibility communicated through peer or community influence (Borg et al., 2020). Besides, design and ease of use are also factors in consideration of fashion PSS adoption (Cosette M. Armstrong et al., 2015). Additionally, other barriers discussed in literature are lack of trust, uncertainty, desire to own (Armstrong et al., 2015, 2016; Borg et al., 2020), hygiene, and psychological risk (Fani et al., 2022; Tunn et al., 2021). Other drivers are reduced consumption, desire to change (Armstrong et al., 2016), and the awareness of environmental benefits (Cosette M. Armstrong et al., 2015; Fani et al., 2022).

A quantitative study indicated that fashion leadership positively affects consumers' inclination to use clothing product service systems, and also that age, income, and education moderate these associations (Lang & Armstrong, 2018). This TPB-based study demonstrated that fashion leadership positively affects attitude, subjective norms, and CPSS adoption intention. Another TPB-based study (Becker-Leifhold, 2018) found that constructs ATT, SN, PBC, and egoistic value orientations explain consumer intention to participate in collaborative fashion consumption. In contrast with two previous studies which focused on the internal aspect of an individual, a quantitative study by (Zhang & Dong, 2021) found virtual social capital, peer influence, face consciousness and consumer innovativeness affect the behavioral intention of sustainable clothing consumption patterns.

4. Conclusion

This study aims to reveal the discussion in sustainable fashion through the lens of the product-service system (PSS) by exploring the topics in fashion PSS studies, the contribution of PSS to sustainable fashion, and barriers and drivers to fashion PSS adoption. Topics addressed in literature are mainly related to adoption of sustainable fashion through product-service system (e.g., use-oriented), business model, PSS in organization, environmental impact, and life cycle analysis. The role of PSS in sustainable fashion is mainly related to use-oriented (e.g., renting, leasing, swapping) and product-oriented (e.g., repair, redesign, customization). Potential barriers and drivers are represented by the theme of financial value, functional value, social value, environmental value, and psychological aspects.

This study contributes to providing guidelines for the design of fashion PSS based on perceived customer value. Future research may benefit from this study's findings by applying them to models such as the perceived value model, in which consumers' adoption decisions are influenced by risk and benefit (Dodds & Monroe, 1985; Monroe & Chapman, 1987). Based on the analysis of this study, the implication to theories that the discussion of fashion PSS is typically associated with reduced consumption, which may result in reduced production (Joyner Armstrong, Connell, Lang, Ruppert-Stroescu, & LeHew, 2016; Radhakrishnan, 2020). However, explanations on how to stimulate adoption, environmental impact, and business growth on fashion or textile firms are scarce. Most research on fashion PSS uses the use-oriented and product-oriented models, but less is known about the result-oriented model and its environmental implications. Even though studies have discussed

fashion PSS as a business model, there are currently few studies on how to optimize the business model. Therefore, future study may address these gaps to enhance the landscape of sustainable fashion product-service system research.

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