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Consumer adoption of access-based product-service systems: The influence of duration of use and type of product

Vivian S. C. Tunn¹ | Ellis A. Van den Hende¹ | Nancy M. P. Bocken^{1,2,3} | Jan P. L. Schoormans¹

¹Faculty of Industrial Design Engineering, Delft University of Technology, Delft, The Netherlands

²School of Business and Economics, Maastricht Sustainability Institute, Maastricht, The Netherlands

³School of Business and Management, Lappeenranta University of Technology, Lappeenranta, Finland

Correspondence

Vivian S. C. Tunn, Landbergstraat 15, 2628 CE, Delft, The Netherlands.
Email: vivian.tunn@gmail.com

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Abstract

Access-based product-service systems (AB-PSS) are business models that can potentially decouple the satisfaction of consumer needs from environmental impacts. Hence, they have been promoted for the circular economy. Their sustainability potential has not yet been realised because consumer adoption is lagging. Although this challenge has been studied for two decades, knowledge to identify and address AB-PSS adoption barriers that matter to consumers is lacking. We hypothesise that the *duration of use*, the time a consumer obtains exclusive access to a specific product (short-term vs. long-term) and the *type of product* (bicycles vs. clothing) moderate the importance of AB-PSS adoption barriers to consumers. We compared several adoption barriers across four AB-PSS and found that the duration of use and the type of product significantly moderated the importance of some AB-PSS adoption barriers. More specifically, the Effort to access has a higher influence on consumer preference for short-term AB-PSS, whereas Product quality has a higher influence on consumer preference for long-term AB-PSS. We also found that Effort to access and Product characteristics were more important for bicycle AB-PSS, whereas Contamination and Product quality were more important for clothing AB-PSS. These insights help companies to identify and design out key AB-PSS consumer adoption barriers.

KEYWORDS

access model, bicycle sharing, clothing sharing, conjoint analysis, product-service system (PSS), sustainable business model, sustainable consumption, temporality

1 | INTRODUCTION

Sustainability challenges such as climate change, plastic pollution and declining biodiversity are increasingly pressing. Predictions suggest that the effects of negative human-induced impact on the planet will become irreversible soon without urgent business and policy response (IPCC, 2018). The circular economy promises sustainable production and consumption practices through the cycling of products, components, and materials (EMF, 2013).

Several scholars translated circular economy principles into business models that simultaneously achieve economic and environmental benefits (e.g., Bocken et al., 2016; Lewandowski, 2016; Tunn et al., 2019) or analysed pathways towards sustainable and circular business models (e.g., Perey et al., 2018; Schaltegger et al., 2012; Zucchella & Previtali, 2019). In this context, product-service systems (PSS) have emerged as popular business models with the potential to address sustainability and circularity issues (Tukker, 2015).

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PSS satisfy consumer needs through bundles of products, services and infrastructure, potentially decoupling needs satisfaction from resource consumption (Bocken et al., 2016; Stahel, 2010; Tietze & Hansen, 2013; Tukker, 2015). One category of PSS, access-based product-service systems (AB-PSS), promises to deliver this by providing products that consumers can access through rental, leasing or sharing services. AB-PSS are business models at the intersection of the circular economy and the sharing economy debates. They have been hailed for their potential to achieve greater levels of sustainability in a business context (Tukker, 2004) whether this broader context is a future circular economy (Lewandowski, 2016; Tukker, 2015) or sharing economy (Boons & Bocken, 2018). The circular economy will be used as a context for the present study, as a paradigm which has received increasing policy and business support as a driver for environmental and economic prosperity (Geissdoerfer et al., 2017; Ghisellini et al., 2016) in contrast to the sharing economy concept which is more contested and less institutionalised (Curtis & Lehner, 2019).

A lack of consumer adoption is a major challenge for organisations to realise the sustainability potential of AB-PSS and thereby transition towards the circular economy (Tukker, 2015). Indeed, despite success in the business-to-business context, adoption of AB-PSS in the business-to-consumer context is lagging (Vogtlander et al., 2017). Reasons for consumers to adopt AB-PSS have been studied extensively in case studies, reviews, and conceptual papers (e.g., Armstrong et al., 2016; Edbring et al., 2016; Lamberton & Rose, 2012; Rexfelt, & Hiort af Ornäs, 2009; Tunn et al., 2021). Despite over two decades of research, the importance of adoption barriers to consumers remains little understood. More knowledge on consumer adoption barriers can help support AB-PSS pursuing organisations to design out potential barriers.

With this study, we contribute a quantitative analysis of AB-PSS adoption from a consumer perspective and determine factors influencing the importance of AB-PSS adoption barriers. This research aims to explore which type of adoption barriers are important and in what circumstances to identify the barriers that are crucial for the adoption of specific AB-PSS. More specifically, this study aims to reveal how the duration of use of a product by one consumer through an AB-PSS and the type of product impact the importance of AB-PSS adoption barriers in consumers' decision-making processes. Through conjoint experiments, we simulate the choice among several AB-PSS configurations to elicit consumers' preferences and to thereby determine the importance of the adoption barriers in different AB-PSS.

2 | BACKGROUND

In this section, barriers and key concepts related to consumer adoption of AB-PSS are presented. First, an overview of AB-PSS adoption barriers found in literature is provided. Then the duration of use and the type of product are introduced as two factors that are likely to moderate the importance of AB-PSS adoption barriers. To this end, the differences between AB-PSS that allow consumers to use

products for a short time and those AB-PSS that allow consumers to use products for a long time are presented. Thereafter, the differences in consumer perception of AB-PSS involving bicycles and clothing are outlined. Finally, we present the conceptual model of this study.

2.1 | Barriers to consumer adoption of AB-PSS

Plenty of research has been conducted to better understand consumer adoption of AB-PSS, and many adoption barriers have been identified. In a previous study, the authors have reviewed consumer barriers to the adoption of AB-PSS in the literature (Tunn et al., 2021). Next, they clustered the adoption barriers according to the five innovation attributes of Rogers (1995) innovation diffusion model, namely, relative advantage, compatibility, complexity, trialability and observability. Tunn et al. (2021) found that many of these barriers relate to the perceived relative advantage of AB-PSS compared with the available alternatives. The present research uses the adoption barriers identified by Tunn et al. (2021) as the starting point. While reviewing the identified AB-PSS adoption barriers, it became clear that the adoption barriers relate to different consumption phases or the AB-PSS concept itself. We clustered the barriers in four barrier categories that are explained in the following and presented in Table 1.

First, some barriers relate to the touchpoints with AB-PSS providers; touchpoints 'form the link between the service provider and the customer, and in this way, touchpoints are central to the customer experience' (Clatworthy, 2011, p. 16). One touchpoint-related barrier is contamination as consumers usually access products previously used by others through AB-PSS (e.g., Baxter & Childs, 2017; Hazée et al., 2019). Second, other barriers related to the use phase of products in AB-PSS. For example, some consumers doubt the quality of the products and anticipate a decreased use experience in AB-PSS compared to ownership (e.g., Camacho-Otero et al., 2017; Durgee & O'Connor, 1995). Third, some barriers link to the concept of AB-PSS such as the lack of ownership. Fourth and final, some barriers relate to the touchpoints and the use. Some consumers lack trust others; they fear that AB-PSS providers or other AB-PSS users might inhibit them from accessing products or from having a positive use experience (e.g., Bardhi & Eckhardt, 2012; Rexfelt, & af Ornäs, V.H., 2009). While a large number of AB-PSS adoption barriers have been identified in the literature, it is less clear what factors determine the importance of these barriers in specific AB-PSS.

2.2 | Importance of the duration of use of accessed products

AB-PSS comprise services that provide consumers with different durations of product use. Indeed, Bardhi and Eckhardt (2012) already proposed temporality as one dimension of AB-PSS; temporality refers to the duration of use of one product and the use frequency of the service. Products accessed through sharing or renting services are usually used for a short time, ranging from less than 1 h for shared

TABLE 1 Barriers to consumer adoption of AB-PSS from literature (adapted from Tunn et al., 2021)

Barrier	Description	References
Touchpoint-related barriers		
Effort to access product	Additional or undesirable activities required in order to select offer and to obtain access to products via AB-PSS.	Meijkamp (1998), Tukker (2004), Catulli (2012), Fishman et al. (2014), Baumeister and Wangenheim (2014), Pedersen and Netter (2015), Hazée et al. (2017) and Camacho-Otero et al. (2017)
Contamination	Concerns or negative perception of product due to prior use by other consumers.	Bardhi and Eckhardt (2012), Hazée et al. (2017), Durgee and O'Connor (1995), Catulli (2012), Catulli et al. (2013), Vezzoli et al., 2015, Armstrong et al. (2015), Edbring et al. (2016), Baxter and Childs (2017), Lidenhammar (2015), and Camacho-Otero et al. (2017)
Concerns about product availability	Products are available and can be accessed when they are needed.	Mont (2004), Rexfelt, and Hiort af Ornäs (2009), Lambertson and Rose (2012), Catulli (2012), Baumeister and Wangenheim (2014) and Camacho-Otero et al. (2017)
Lack of flexibility	The need to plan in order to ensure access to a product when needed.	Meijkamp (1998), Schrader (1999), Littig (2001), Mont (2004), Rexfelt, and Hiort af Ornäs (2009), Baumeister and Wangenheim (2014), Vezzoli et al. (2015), Tukker (2015) and Poppelaars et al. (2018)
Touchpoint- and use-related barriers		
Lack of trust in others	Lack of trust in the provider and other users leads to uncertainties regarding quality and outcome of using the AB-PSS.	Rexfelt, and Hiort af Ornäs (2009), Lambertson and Rose (2012), Catulli (2012), Bardhi and Eckhardt (2012), Catulli (2012), Armstrong et al. (2015), Catulli et al. (2017a), Catulli et al. (2017b), Hazée et al. (2017), Poppelaars et al. (2018) and Cherry and Pidgeon (2018)
Change required	Implications AB-PSS adoption has for everyday life and behaviour.	Mont (2004), Rexfelt, and Hiort af Ornäs (2009), Mylan (2015), Vezzoli et al. (2015), Antikainen et al. (2015), Camacho-Otero et al. (2017) and Santamaria et al. (2016)
Use-related barriers		
Quality of product	Concerns regarding low quality product either because of low end brands or because of increased utilisation.	Durgee and O'Connor (1995), Mont (2002b), Mont (2004), Catulli (2012), Lidenhammar (2015) and Camacho-Otero et al. (2017)
Specific product characteristics	Characteristics that make a product more or less suitable for access, for example their material, the importance of fashion, or their monetary value.	Schrader (1999), Tukker (2015), Antikainen et al. (2015), Edbring et al. (2016) and Poppelaars et al. (2018)
Effort to use product	Learning to operate the products placed in AB-PSS, taking additional care during use, cleaning and maintaining them.	Rexfelt, and Hiort af Ornäs (2009), Lambertson and Rose (2012), Mylan (2015), Baumeister and Wangenheim (2014), Catulli et al. (2017a) and Poppelaars et al. (2018)
Lack of intangible value	Limited use time of products, no or little signalling of personality and status, or lack of positive associations and enjoyment.	Littig (2001), Mont (2002a), Mont (2004), Catulli (2012), Bardhi and Eckhardt (2012); Baumeister and Wangenheim (2014), Armstrong et al. (2015), Tukker (2015),

TABLE 1 (Continued)

Barrier	Description	References
		Vezzoli et al. (2015), Edbring et al. (2016), Santamaria et al. (2016), Catulli et al. (2017b), Camacho-Otero et al. (2017) and Cherry and Pidgeon (2018)
Concept-related barriers		
Lack of ownership	External or internal negative feelings because of not owning the product such as lower social status, embarrassment and feeling of insecurity.	Littig (2001), Mont (2002a), Rexfelt, and Hiort af Ornäs (2009), Bardhi and Eckhardt (2012), Baumeister and Wangenheim (2014), Tukker (2015), Armstrong et al. (2015) and Cherry and Pidgeon (2018)
Complexity	Consideration of value product and service components rather than just a product.	Schrader (1999), Mont (2002b), Rexfelt, and Hiort af Ornäs (2009), Lambertson and Rose (2012), Catulli (2012), Vezzoli et al. (2015), Armstrong et al. (2015), Hazée et al. (2017) and Poppelaars et al. (2018)
Reluctance to commit	Reluctance to enter into contractual commitment or regular payments.	Rexfelt, and Hiort af Ornäs (2009), Catulli et al. (2013), Lidenhammar (2015) and Poppelaars et al. (2018)
Financial aspects	Perception of high price or lack of financial advantage.	Durgee and O'Connor (1995), Schrader (1999), Mont (2002b), Rexfelt, and Hiort af Ornäs (2009), Catulli (2012), Baumeister & Wangenheim, 2014 (Vezzoli et al. (2015), Armstrong et al. (2015), Edbring et al. (2016) and Poppelaars et al. (2018)

Abbreviation: AB-PSS; access-based product-service systems.

bicycles to several weeks for a rental car during vacation, for instance. Leasing services generally provide products for a longer time. For example, car leasing contracts typically last 2 years or longer.

Adapting Bardhi and Eckhardt's (2012) terminology, we use the *duration of use* to refer to the time during which one consumer obtains exclusive access to a product through an AB-PSS. The duration of use indicates the length of the use phase; it starts when an AB-PSS user obtains access to a product from the AB-PSS provider and ends when the consumer releases the product so that it becomes available for others to use. Belk (2014) also differentiated short-term renting, from long-term renting and leasing, arguing that they lead to different consumer-product relationships and several researchers found that attitudes were more positive towards short-term use AB-PSS than towards long-term use AB-PSS (Durgee & O'Connor, 1995; Edbring et al., 2016; Lidenhammar, 2015). Bicycle sharing is such a short-term use AB-PSS; consumers typically find a bicycle when they need it, obtain access (e.g., through a smartphone application) and use it for anything between 10 min and a whole day. Then they release the bicycle for other consumers to use (Fishman et al., 2013).

The main difference between short-term and long-term use AB-PSS lies in the frequency of consumer-provider touchpoints and the length of the use phases. Short-term use AB-PSS has frequent touchpoints and short use phases, whereas it is exactly the opposite

for long-term use AB-PSS; these typically have few consumer-provider touchpoints and long use phases. Hence, touchpoint-related barriers are likely to be more important for consumers in short-term use AB-PSS and the use-related barriers in long-term use AB-PSS. Consumers' commitment also differs between these AB-PSS; their commitment is generally lower in short-term use AB-PSS as the use of a product, and the AB-PSS can be immediately ended any given moment. In contrast, the consumers' commitment is higher in long-term use AB-PSS as these usually require bilateral contracts and regular payments. A summary of the differences between long-term use AB-PSS and short-term use AB-PSS is provided in Table 2.

Short-term AB-PSS are characterised by a limited duration of use of one product and frequent touchpoints with the providing organisation. These touchpoints can be physical or digital service encounters. Hence, touchpoint-related barriers are very important to consumers in short-term use AB-PSS. We hypothesise that duration of use moderates the effect of touchpoint-related adoption barriers on consumer AB-PSS preference (the selection of the barriers is described in Section 3.1.1). More specifically:

H1a. The touchpoint-related barrier Effort to access has a larger effect on consumer preference for short-term use AB-PSS than for long-term use AB-PSS.

TABLE 2 Differences between short-term use AB-PSS and long-term use AB-PSS

Differences	Short-term use AB-PSS	Long-term use AB-PSS
Duration of product use	Short use phases: A few minutes up to a few weeks	Long use phases: Several months or even years
Touchpoints with provider	Frequent touchpoints with AB-PSS provider	Infrequent touchpoints with AB-PSS provider
Number of users	Many users use the products sequentially	A few users use the products sequentially
Sustainability potential	Increased utilisation and decreased idle times (Tukker, 2004)	Extended product lifetimes because of product redesign, professional maintenance and repair (Tukker, 2004)

Abbreviation: AB-PSS; access-based product-service systems.

H1b. The touchpoint-related barrier Contamination has a larger effect on consumer preference for short-term use AB-PSS than for long-term use AB-PSS.

Long-term use is characterised by an extended period of use during which the consumer interacts with the same product (Tukker, 2004). Touchpoints with the AB-PSS provider are thus infrequent and limited to the initial information seeking, contract signing and product pick-up, potential maintenance and repair during the use. Eventually, after several months or even years, consumers terminate the contract and return the bicycle that is then passed on to another user. We hypothesise that duration of use moderates the effect of use-related adoption barriers on consumer AB-PSS preference. More specifically:

H2a. The use-related barrier Product quality has a larger effect on consumer preference for long-term use AB-PSS than for short-term use AB-PSS.

H2b. The use-related barrier Product characteristic has a larger effect on consumer preference for long-term use AB-PSS than for short-term use AB-PSS.

2.3 | Different consumer perceptions of bicycle AB-PSS and clothing AB-PSS

Some studies have shown that AB-PSS adoption barriers depend on the products placed in AB-PSS. Bardhi and Eckhardt (2012) proposed that AB-PSS can be differentiated by whether physical or digital products are accessed and whether the products are functional or experiential. It is thus more likely that consumers access functional products than products with emotional value (Schrader, 1999). This is elaborated on by Baumeister and Wangenheim (2014), who argue that AB-

PSS should be described by their typical purchase price, durability, visibility of consumption and main consumption goal. They also advise researchers to study at least two AB-PSS involving different products to generate generalisable findings.

In this research, we study clothing and bicycles. Bicycles are typically more expensive and durable than clothing items. The visibility of clothing use is higher than that of bicycle use as they are typically worn for several hours. Consumption goals of clothing typically include intangible benefits such as expression of one's identity and status (Armstrong et al., 2016) beyond the functional value of providing coverage, protection and warmth. On the other hand, the main consumption goal of consumers using city bicycles in the Netherlands is functional, getting from one location to another. Research has suggested that AB-PSS involving products that provide intangible benefits are likely to face consumer resistance (Armstrong et al., 2016; Catulli et al., 2017b; Cherry & Pidgeon, 2018; Schrader, 1999).

Contamination has been mentioned as an adoption barrier for shared mobility (Bardhi & Eckhardt, 2012; Hazée et al., 2017) and clothing AB-PSS (Armstrong et al., 2015). However, contamination is likely to be more prominent for clothing than for bicycles because clothes are close to the body (Hazée et al., 2019) and contaminations cues are more visible for clothing (Argo et al., 2006). The material properties of products also influence consumers' perception of contamination (Edbring et al., 2016); products made from soft materials such as clothing are more susceptible to lead to perceived contamination than products made from hard materials such as bicycles. Previous research has found that some consumers find clothing too personal to rent (Antikainen et al., 2015) and that consumers would never rent undergarments (Armstrong et al., 2016).

The effort to access the products is likely to be a more important adoption barrier for bicycles than for clothing. Consumers have a low threshold regarding the distance they are willing to walk to reach shared bicycles (Fishman et al., 2014). A higher effort to reach and access shared bicycles directly decreases the functional value of the shared bicycles. While a long distance to reach rental clothing impacts the convenience of the AB-PSS (Pedersen & Netter, 2015), it is not crucial for reaching the main consumption goals. Yet, the importance of the effort to access has not been quantitatively compared across AB-PSS involving different products.

The extant literature provides insights for hypotheses development for the relationship between product type and two touchpoint-related adoption barriers: contamination and effort to access. However, for product quality and product characteristics (use-related barriers) and trust (touchpoint and use-related barrier), extant literature did not provide insights for a priori expectations. Nevertheless, there might also be moderation effects by the type of product; in other words, some use-related barriers might be more important for some products than for others. Thus, we figured that formally testing the product type moderation for specific touchpoint-related barriers, while exploring the product type moderation for the other barriers would sufficiently demonstrate the effect of the type of product. We hypothesise that the type of product moderates the effect of

touchpoint-related adoption barriers on consumer AB-PSS preference. More specifically:

H3a. Effort to access has a larger effect on consumer preference for bicycle AB-PSS than for clothing AB-PSS.

H3b. Contamination has a larger effect on consumer preference for clothing AB-PSS than for bicycle AB-PSS.

2.4 | Research gap and conceptual model

Despite two decades of research, it is still unclear which adoption barriers are important and in what circumstances AB-PSS adoption barriers are important to consumers. This might impede the widespread uptake of such models which have the potential to contribute to a future circular economy (Tukker, 2015). There is an urgent need to understand this to improve consumer adoption of AB-PSS. Besides, the context of AB-PSS has changed over the last decade due to digitalisation, but this seemingly has not been considered in AB-PSS research so far. Prior studies of AB-PSS largely investigated single product categories and did not compare short-term use and long-term use AB-PSS. Furthermore, current literature mainly provides qualitative insights that require further quantitative testing. Recently, Poppelaars et al. (2018) researched car sharing (short-term use) and smartphone leasing (long-term use). They investigated both AB-PSS qualitatively but did not mention the duration of use as a key difference. This study is set in the era of digitalisation and provides and tests a model that elucidates the differences in the importance of AB-PSS adoption barriers among AB-PSS by identifying the duration of use and the type of product as moderating variables.

The present study compares the importance of five adoption barriers across hypothetical short-term use AB-PSS and long-term use AB-PSS for bicycles and clothing. Testing multiple AB-PSS for different product types quantitatively answers the call for more generalisability of AB-PSS research (Baumeister & Wangenheim, 2014). While previous qualitative research largely focused on identifying AB-PSS adoption barriers, the quantitative

design of our study enables us to determine the importance of specific barriers for consumer AB-PSS preference that can aid the better design of such services in the future. Based on the literature discussed in the previous sections, we developed a conceptual model that visualises how we expect the duration of use and type of product to moderate the effect of touchpoint-related and use-related barriers on consumers' AB-PSS preference (see Figure 1).

3 | METHOD

We conducted four conjoint experiments of hypothetical short-term and long-term use AB-PSS for bicycles and clothing to test the hypotheses. Conjoint experiments were chosen as these simulate the decision between different options that consumers face in the real world. Rao (Rao, 2014, p. 40) explained that 'conjoint methods are intended to "uncover" the underlying preference function of a product in terms of its attributes'.

Conjoint experiments have been applied to products and services in different sectors, for example, to optimise health care and financial services (see Dauda & Lee, 2015; Jan et al., 2000). We conducted four conjoint experiments in parallel and explored the data using conjoint analyses and tested the hypotheses using linear regression. Similarly, Okechuku (1994) compared the results of four separate conjoint analyses with a between-subjects design to determine differences in attribute importance between consumers from different countries.

Although the studied AB-PSS are hypothetical, comparable offers are available in the Netherlands. Table 3 provides an overview of the methodological steps of this study, upon which the following sections elaborate.

3.1 | Design of stimuli

We chose to study bicycle and clothing AB-PSS, as both involve consumer products that are often idling and would thus benefit from AB-PSS. Following Kjaer et al.'s (2019) argumentation, placing these

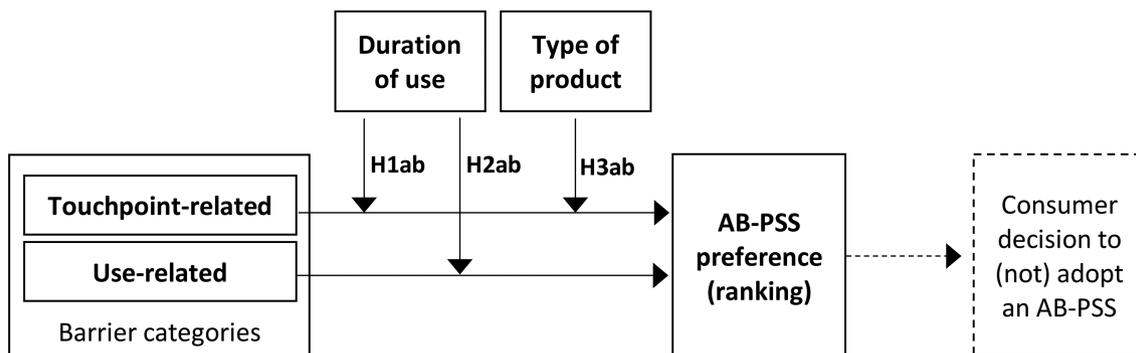


FIGURE 1 Conceptual model of duration of use and type of product moderating the effects of the touchpoint/use-related access-based product-service systems (AB-PSS) adoption barriers on consumers' AB-PSS preference

TABLE 3 Overview of the methodological steps of this research, their purpose, process and outcome

Step	Purpose	Process	Outcome
1. Design of stimuli	Design of stimuli to test four AB-PSS, this step is crucial to ensure that the results are comparable.	Barrier selection, translation into attributes, and then determining appropriate attribute levels through online surveys (n = 74).	Four scenarios with five comparable attributes and two attribute levels.
2. Conjoint experiments	Obtain consumer preferences and thereby the importance values of the levels of the five attributes for each of the four AB-PSS.	Participants (n = 47) ranked profiles of two AB-PSS (e.g., bike share and clothing lease) from most to least preferred.	Participants' preference rankings of the AB-PSS profiles and basic demographic information.
3. Conjoint analyses	Reveal the relative importance of adoption barriers to consumers in four different AB-PSS.	Analysis of the rankings of barriers for the four AB-PSS (bike share, bike lease, clothing rental, clothing lease) in SPSS.	Participants' individual part-worth utilities and overall utilities of attributes for the four AB-PSS.
4. Regression analysis	Obtain significance of the results to test the hypotheses.	Regressing rank orders on the dummies for barriers, duration of use, the type of product, and their interactions.	Significant effect of the duration of use, the type of product, their interaction on the importance of AB-PSS adoption barriers.

Abbreviation: AB-PSS; access-based product-service systems.

products in AB-PSS could improve sustainability because fewer products would be needed. Further, the mobility and textile industries both cause high environmental impacts (Ivanova et al., 2016; WRAP, 2012). Besides, we sought for the hypothetical AB-PSS to resemble existing ones without naming any making them more believable and imaginable for respondents (Rao, 2014). For example, OV-fiets (www.ns.nl/en/door-to-door/ov-fiets) offers shared bicycles at Dutch train stations and Swapfiets (<http://www.swapfiets.nl>) provides bicycles for lease. Similar AB-PSS are available for clothing; LENA the fashion library allows consumers to rent clothes for a day or several days (www.lena-library.com), and MUD jeans (www.mudjeans.eu) offers leasing jeans. Consumers pay a monthly fee for 12 months for the jeans; during this time, MUD jeans takes care of repairs; thereafter, consumers can choose to keep using the jeans or to swap them in for a new pair. MUD jeans then reuses or recycles the returned jeans depending on the state of the jeans. We focused on outerwear for the clothing AB-PSS, as products close to the skin proliferate consumers' hygiene concerns (Armstrong et al., 2016).

3.1.1 | Selection of barriers

We selected a subset of the AB-PSS consumer adoption barriers found in the literature (Tunn et al., 2021) for the main experiments. We decided to focus on the first three AB-PSS adoption barrier categories, as concept-related barriers are either inherent to the AB-PSS, require extensive information of consumers or mindset changes. Three rationales influenced the selection of AB-PSS adoption barriers for this study. First, we aimed to test those barriers that seemed likely to differ among the bicycle and clothing AB-PSS according to literature (see Section 2.3). Second, due to developing a conjoint set-up, only a limited number of barriers could be tested; conjoint experiments typically include only a few attributes as the task otherwise gets too complex and lengthy for participants (Rao, 2014).

Third, we designed the experiments to test our hypotheses which required comparability across the four AB-PSS. The selection criteria to ensure comparability across the four AB-PSS are presented in Table 4.

By following the aforementioned rationales, five AB-PSS adoption barriers were selected. Based on their relevance in literature, the two touchpoint-related barriers *Effort to access* and *Contamination* were selected. The *Product quality* and *Product characteristics* are the two use-related barriers that were selected because they are relevant to all four AB-PSS and can be translated into attributes with several attribute levels. We included the touchpoint and use-related barrier *Trust* as a control barrier to test whether it is indeed equally important in short-term and long-term use AB-PSS.

3.1.2 | Translation of adoption barriers to AB-PSS attributes

The selected barriers needed to be translated into relevant product or service attributes for all four AB-PSS. The selection of attributes and attribute levels is a crucial step in the design of conjoint experiments (Rao, 2014). We selected attributes that can be varied in severity, have high face validity and are as similar across the four AB-PSS as possible. For example, attributes for the barrier *Contamination* were cleaning frequency or cleaning intensity for the bicycle AB-PSS and wear and tear for the clothing AB-PSS.

The barrier *Effort to access* is represented by the attribute time to reach that refers to the time it takes consumers to obtain the product through an AB-PSS. This follows Fishman et al. (2014) who determined the distance of bicycle sharing docking stations to potential users' homes and offices as an important adoption barrier. As mentioned above, the attributes for *Contamination* are cleaning frequency or cleaning intensity for the bicycle AB-PSS and wear and tear for the clothing AB-PSS.

TABLE 4 Ensuring comparability across the four AB-PSS through the conjoint experiments

Barriers	Relevant barrier for all four AB-PSS	Valid attributes for all four AB-PSS	Multiple attribute levels
Touchpoint-related barriers			
Effort to access product	Yes	Yes	Yes
Contamination	Yes	Yes	Yes
Concerns about product availability	Yes	Yes	No
Lack of flexibility	Yes	Yes	No
Touchpoint- and use-related barriers			
Lack of trust in others	Yes	Yes	Yes
Change required	Yes	No	-
Use-related barriers			
Quality of product	Yes	Yes	Yes
Specific product characteristics	Yes	Yes	Yes
Effort to use product	Yes	No	-
Lack of intangible value	Yes	Yes	No

Abbreviation: AB-PSS; access-based product-service systems.

Lack of trust in others was translated to the source of reviews as Edbring et al. (2016, p. 12) suggested that ‘creating a clear structure and introducing mechanisms for peer review and feedback can greatly increase trust between people and thereby enable greater sharing of resources’. User reviews are a major source of trust-building for consumers, but the level of trust in reviews depends on the review platform (Filieri, 2016).

Product quality is represented by the attribute product brand (Rao & Monroe, 1989). The attributes for the barrier *Product characteristics* are inevitably somewhat dissimilar for clothing and bicycles. For clothing, we chose the attribute comfort because according to Rusinko and Faust (2016), it is an important determinant of consumer perception of fibres and is thus likely to influence garment preference. For bicycles, we chose the number of available gears, because it is an attribute of bicycles that influences cycling comfort. The selected attributes are a combination of categorical and continuous attributes. Although the price is an important factor in consumers' decision making, we intentionally disregarded the price as an attribute as we aimed to determine the importance of the previously mentioned adoption barriers in different AB-PSS in this study rather than economically optimise specific AB-PSS configurations.

3.1.3 | Definition of attribute levels

We defined two levels for each of the five attributes of the four AB-PSS. Choosing comparable attribute levels for the variables across the four AB-PSS is detrimental for the results to be comparable (Orme, 2010). The selection of an extreme value for one level of a variable could inflate the importance of that variable in the results (Orme, 2010). We conducted online surveys to determine the attribute levels for the AB-PSS profiles in the main experiment. Seventy-four participants residing in the Netherlands completed these online

surveys (age 22–64 years, mean age = 36 years, 54% female). The four surveys included the scenarios that were also used in the main experiment. Each participant read one of the four AB-PSS scenarios and then evaluated several levels of each attribute in the context of that scenario (three to six levels depending on the attribute). They could indicate how they perceive the different attribute levels on a 4-point scale with 1 (preferred), 2 (still acceptable), 3 (undesirable), and 4 (unacceptable).

Averages of consumers' evaluations of the attribute levels were used to select two attribute levels for the AB-PSS profiles. The two attribute levels, level A and level B, should differ in preference without being in themselves a reason for rejection of the AB-PSS. The criteria applied were that the average for level A should be 1–1.5 and the average for level B 2–2.5. Further, the score difference between level A and level B should be as close to 1 as possible to avoid larger/smaller impacts of one attribute merely being caused by a larger/smaller difference between the attribute levels. The continuous attributes followed a linear model within the relevant range of values. For some of the continuous attributes, the difference between the levels A and B was too large; by fitting linear regression functions to the results of the survey, we calculated the values for an evaluation of 1.25 for level A and 2.25 for level B and rounded them appropriately. The categorical attribute levels were selected based on the averages, and their phrasing was slightly adjusted if the differences between levels A and B were significantly smaller or larger than 1. An overview of all attributes and attribute levels is provided in Table 5.

3.1.4 | AB-PSS profiles

Levels A and B of the different attributes were combined to create short AB-PSS descriptions. The possible number of combinations

TABLE 5 Barriers from literature and corresponding attributes and levels for the four AB-PSS scenarios (attribute levels are presented: preferred/still acceptable)

	Bicycle		Clothing	
	Short-term	Long-term	Short-term	Long-term
Barrier	Effort to access product (touchpoint-related)			
Attribute	Time to reach	Time to reach	Time to reach	Time to reach
Levels A/B	4 min/9 min	9 min/19 min	4 min/9 min	12 min/22 min
Barrier	Contamination by others (touchpoint-related)			
Attribute	Cleaning frequency	Cleaning intensity	Wear and tear	Wear and tear
Levels A/B	Every 4 weeks/Every 8 weeks	Deep cleaning/Basic cleaning	Like new/Minimal wear and tear	Like new/Minimal wear and tear
Barrier	Lack of trust in provider and service (touchpoint and use-related)			
Attribute	Source of review	Source of review	Source of review	Source of review
Levels A/B	Independent/company website	Independent/company website	Independent/company website	Independent/company website
Barrier	Quality of product (use-related)			
Attribute	Brand	Brand	Brand	Brand
Levels A/B	High-end/simple mid-range brand	High-end/simple mid-range brand	High-end/simple mid-range brand	High-end/simple mid-range brand
Barrier	Specific product characteristics (use-related)			
Attribute	Number of gears	Number of gears	Comfort	Comfort
Levels A/B	Seven gears/one gear	Three gears/one gear	Highly comfortable/comfortable	Highly comfortable/comfortable

Abbreviation: AB-PSS; access-based product-service systems.

would have been too large to present them to participants. We thus applied an orthogonal design with a fractional factorial analysis. This method combined and equally distributes the different attribute levels, reducing the number of combinations (see Appendix B). We obtained eight different combinations of the attribute levels, referred to as AB-PSS profiles. These eight profiles represent eight different configurations of the AB-PSS. We followed this process for all four AB-PSS with the same seed value (2345) resulting in four times eight AB-PSS profiles, with one profile having only level A attributes. Below (Figure 2), we provide an exemplary AB-PSS profile as used in the experiments.

3.2 | Participants

The participants of the main experiment were sampled from a consumer household panel of the Delft University of Technology ($n = 47$, 26–75 years, mean age = 44 years, 62% female). This sample was culturally homogenous which prevents concerns regarding varying attitudes towards AB-PSS because of cultural differences (Iran et al., 2019). The large majority of participants used smartphones (98%) and 74% of participants had utilised an AB-PSS in the 6 months before the experiment. We excluded one participant from further analyses because of misinterpretation of the rank order task; only this participant ranked the AB-PSS

Bicycle sharing company #

Details of the bicycle sharing company:

- User reviews on an independent **review platform** (like Consumentenbond)
- **9 minutes walking** to the bicycle
- **High-end brand** shared bicycles
- **Single speed** bicycles
- Bicycles are cleaned every **8 weeks**

#

FIGURE 2 Exemplary access-based product-service systems (AB-PSS) profile as used in the experiment [Colour figure can be viewed at wileyonlinelibrary.com]

description with only level A attributes (i.e., attributes all pretested as preferred) as the least preferable clothing AB-PSS and the second least preferable bicycle AB-PSS.

3.3 | Procedure

The experiments were conducted in May 2019. In an individual task, each participant first read a bicycle AB-PSS scenario and then

ranked eight bicycle AB-PSS profiles from most preferred to least preferred. This procedure was repeated for the clothing AB-PSS. The scenarios use storytelling techniques, describing a relatable character in a context that depicts the rationale for and benefits of the AB-PSS (Van den Hende et al., 2012). Stories enabled participants to imagine themselves in the situation of the main character and make decisions in the described situation (Van den Hende & Schoormans, 2012). This storytelling method allowed us to let participants experience the AB-PSS vividly through narrative transportation (Green & Brock, 2000). Thereby, participants could evaluate AB-PSS that were new to them (Van den Hende & Schoormans, 2012). See Appendix A for the four AB-PSS scenarios.

Each participant evaluated an AB-PSS with a short duration of use and an AB-PSS with a long duration of use to minimise cross-over effects. Thus, each participant evaluated two AB-PSS. The preference rank orders were documented with photographs. Thereafter, participants reported demographic information and their AB-PSS experience in a questionnaire. Participants received a small financial compensation for their effort.

4 | RESULTS

We conducted four separate conjoint analyses to explore the importance of the adoption barriers within the four AB-PSS. We then used linear regression to compare the effects of the adoption barriers across the four AB-PSS to test our hypotheses.

4.1 | Conjoint analyses for exploration

The conjoined experiments simulated consumer choice in the market; the data were analysed using conjoint analysis to obtain the utilities of the attributes. The four separate conjoint analyses resulted in respondents' part-worth utilities for each attribute level and overall importance values that describe the extent to which the attributes and thus the underlying barriers influence preference for the AB-PSS. Respondents' part-worth utilities are hereafter referred to as utilities. A high utility value for an attribute level indicates high consumer importance of that attribute level (Rao, 2014). Each attribute in the study was equipped with a 'preferred' and a 'still acceptable' level

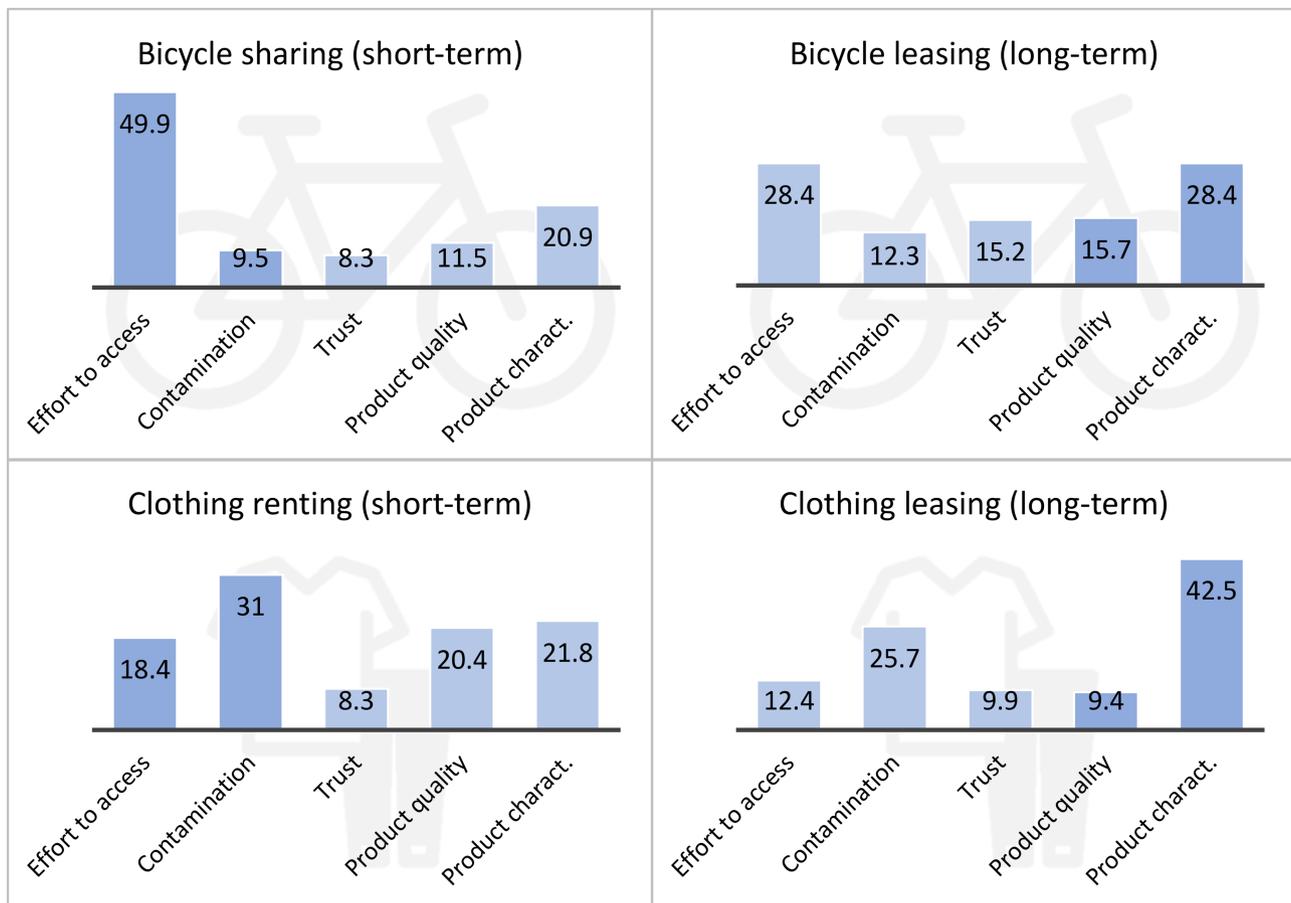


FIGURE 3 Relative importance (in percent) of the barriers for the four access-based product-service systems (AB-PSS). In the short-term AB-PSS the touchpoint-related barriers are highlighted; in the long-term AB-PSS the use-related barriers are highlighted [Colour figure can be viewed at wileyonlinelibrary.com]

(e.g., for time to reach: 4 and 9 min). See Figure 3 for the average importance values for all barriers per AB-PSS. The utility values for Effort to access are negative because higher effort decreases consumer preference. Thus, the large negative utility-mean indicates that Effort to access is more important in short-term than in long-term use bicycle AB-PSS.

The preference for short-term bicycle AB-PSS (Bicycle sharing) was primarily determined by Effort to access (49.9%). Product characteristics (number of gears) influenced 20.9% of preference, and the remaining barriers had less influence (see Figure 3). In the case of long-term bicycle AB-PSS (bicycle leasing), consumer preference was primarily determined by the Effort to access and Product characteristics (number of gears), both obtained importance values of 28.4%. The remaining barriers were less important in determining preference (12.3%–15.7%). All importance values for long-term bicycle AB-PSS are visualised in Figure 3.

For short-term clothing AB-PSS (Clothing renting), consumers found Contamination (wear and tear, 31%) most important. The barriers Effort to access, Product quality and Product characteristics also had some influence on preference (18.4%–21.8%); all importance values are presented in Figure 3. Consumer preference for long-term clothing AB-PSS (Clothing leasing) was to 42.5% determined by Product characteristics (comfort level). The second most important determinant of preference for long-term clothing AB-PSS was Contamination (25.7%); the other barriers had only a minor influence (see Figure 3).

Overall, the relative importance of Effort to access seems higher in bicycle AB-PSS and Contamination in clothing AB-PSS. There also appear to be differences between the short-term and the long-term use AB-PSS; for both short-term use AB-PSS, one of the touchpoint-related barriers (Effort to access and Contamination respectively) seems most important in determining preference. Similarly, the use-related barrier Product characteristics appear to be a major determinant of preference for long-term use AB-PSS. However, in the case of the long-term bicycle AB-PSS, the touchpoint-related barrier Effort to access was equally important.

4.2 | Hypotheses testing

We used linear regression to test the hypotheses. First, we converted the five AB-PSS adoption barriers into dummy variables that signified the 'preferred' attribute level A. Hence, we coded level B attributes as 0 (e.g., Level B of Effort to access: the longer time to reach the product) and coded level A attributes as 1 (e.g., Level A of Effort to access: the shorter time to reach the product). The duration of use dummy variable was coded 0 for short-term use (i.e., renting/sharing) and 1 for long-term use (i.e., leasing). Finally, we dummy-coded the type of product as 0 for bicycle AB-PSS and 1 for clothing AB-PSS. Consumer rankings of the eight AB-PSS served as the dependent variable, coded 1 (least preferred AB-PSS), to 8 (most preferred AB-PSS). We included consumer rankings as a measure of consumer preference.

We conducted a linear regression analysis in which the five barriers, duration of use and type of product predicted consumer rankings, as well as the interactions between the five barriers and the duration of use and the interactions between the five barriers and the type of product. Table 6 presents the effects of the duration of use, product type, adoption barriers, and their interactions. The first model consists of the main effects only, which explain 47.2% of the variance in consumer preference (Model 1: $R^2 = .472$). Next to entering the main effects, in Model 2 we entered the duration of use*adoption barrier interactions (Model 2: $R^2 = .492$), and in Model 3 we entered the product type*adoption barriers interactions (Model 3: $R^2 = .568$). Model 4 includes the main effects and all interactions (Model 4: $R^2 = .589$). Models 2–4 explain additional proportions of variance in consumer preference (49.2%, 56.8% and 58.9%, respectively). We detail Model 4 below and test our hypotheses.

Main effects. The main effects of the adoption barriers provide support for the general importance of the selected barriers. Effort to access ($\beta = 3.36$, $p < .001$), Contamination ($\beta = .82$, $p < .001$), Trust ($\beta = .58$, $p < .01$) and Product characteristics ($\beta = 1.40$, $p < .001$) are all important for the AB-PSS, while Product quality seems to be unimportant ($\beta = .27$, $p > .16$). The β coefficients indicate the influence of the attributes on rankings and thus the importance of the adoption barriers for consumers' AB-PSS preference. Overall, four out of the five barriers that we selected and manipulated were found to have a significant effect on consumer preference.

Duration of use. The moderation effect of duration of use on the effect of the touchpoint-related barriers on consumer preference is significant for Effort to access ($\beta = -.97$, $p < .001$). The negative β indicates that Effort to access has a higher influence on consumer preference for short-term AB-PSS than for long-term AB-PSS, supporting H1a. For Contamination the moderation effect has the same direction; however, it does not reach significance ($\beta = -.24$, $p > .27$), thus rejecting H1b. This is likely because Contamination has a high influence on consumer preference for short-term and long-term use clothing AB-PSS.

The duration of use significantly moderates the effect of the use-related adoption barrier Product quality on consumer preference ($\beta = .75$, $p < .001$), supporting H2a. Product quality is thus more important for long-term AB-PSS than for short-term AB-PSS. Duration of use does not affect the relationship of Product characteristics and consumer preference ($\beta = .19$, $p > .40$) thus rejecting H2b. This use-related barrier is not significantly more important for long-term AB-PSS than for short-term AB-PSS. This is surprising considering the high relative importance of Product characteristics in long-term use AB-PSS derived through the conjoint analysis.

The touchpoint-related and use-related adoption barrier Trust served as a control barrier in this study, for which we anticipated no moderation effect of the duration of use. Indeed, the duration of use did not moderate the effect of the adoption barrier Trust on consumer preference ($\beta = .37$, $p > .09$). While not significant, our analysis suggests a trend; trust seems to potentially have a higher influence on

TABLE 6 Effects of duration of use, product type, adoption barriers and their interactions, on consumers' AB-PSS preference

Tested effects	Model 1			Model 2			Model 3			Model 4			Hypothesis conclusion
	β	(SE)	Sig.										
Main effects													
Duration of use (DoU)	.00	(.12)		-.05	(.30)		.00	(.11)		-.05	(.27)		
Product type (PT)	.00	(.12)		.00	(.12)		-.23	(.27)		-.23	(.27)		
Effort to access	1.96	(.12)	***	2.48	(.17)	***	2.88	(.16)	***	3.36	(.19)	***	
Contamination	1.37	(.12)	***	1.49	(.17)	***	.70	(.16)	***	.82	(.19)	***	
Trust	.66	(.12)	***	.48	(.17)	**	.76	(.16)	***	.58	(.19)	**	
Product quality	1.47	(.12)	***	1.10	(.17)	***	.64	(.16)	***	.27	(.19)		
Product characteristics	1.20	(.12)	***	1.11	(.17)	***	1.49	(.16)	***	1.40	(.19)	***	
Duration of use moderation													
DoU*Effort to access				-.97	(.24)	***				-.97	(.22)	***	H1a supported
DoU*Contamination				-.24	(.24)					-.24	(.22)		H1b rejected
DoU*Trust				.37	(.24)					.37	(.22)		
DoU*Product quality				.75	(.24)	**				.75	(.22)	**	H2a supported
DoU*Product characteristics				.19	(.24)					.19	(.22)		H2b rejected
Product type moderation													
PT*Effort to access							-1.77	(.22)	***	-1.77	(.22)	***	H3a supported
PT*Contamination							1.35	(.22)	***	1.35	(.22)	***	H3b supported
PT*Trust							-.20	(.22)		-.20	(.22)		
PT*Product quality							1.66	(.22)	***	1.66	(.22)	***	
PT*Product characteristics							-.58	(.22)	*	-.58	(.22)	**	
Constant	1.15	(.18)	***	1.17	(.22)	***	1.27	(.20)	***	1.29	(.23)	***	
R square	.472			.492			.568			.589			

Note: Dummy coding duration of use (DoU): 0 = short-term use, 1 = long-term use. Dummy coding product type (PT): 0 = bicycle, 1 = clothing. Abbreviation: AB-PSS; access-based product-service systems.

* $p < .05$. ** $p < .01$. *** $p < .001$.

consumer preference for long-term use AB-PSS than short-term use AB-PSS. This could be because long-term use AB-PSS generally imply a contractual relationship between consumer and AB-PSS provider, whereas short-term AB-PSS are purely transactional and can be terminated by consumers at any moment.

Product type. We hypothesised that product type moderated the effect of touchpoint-related barriers on consumer preference. Effort to access has a larger effect on consumer preference for bicycle AB-PSS than clothing AB-PSS ($\beta = -1.77, p < .001$), supporting H3a. Contamination, on the other hand, has a larger effect on consumer preference for clothing AB-PSS than bicycle AB-PSS ($\beta = 1.35, p < .001$), supporting H3b. Product type did not moderate the effect of the adoption barrier Trust on consumer preference ($\beta = -.20, p > .37$), in line with expectations. As discussed before, we had no a priori expectations regarding the moderation effect of the type of product on consumer preference of use-related adoption barriers, due to lack of documented effects of these barriers.

Our results indicate that the use-related adoption barrier Product quality has a significantly larger effect on consumer preference

for clothing AB-PSS than for bicycle AB-PSS ($\beta = 1.66, p < .001$). Apparently, consumers deem high-end brands more favourable for clothing than for bicycle AB-PSS. This could be because consumers have different associations with the selected attribute 'brand' for bicycles and clothing, potentially because industries and organisations position brands differently (Bhat & Reddy, 1998). As outlined in the background section, clothing is used to express ones' identity and status which high-end branded clothes can enhance. For bicycles, a high-end brand is likely associated with robust, long-lasting bicycles. This might be less important to consumers as AB-PSS providers are generally responsible for repairing and replacing faulty products. It is thus possible that participants' interpretation of AB-PSS attributes differs between products which in turn again emphasises how product-dependent the perception of AB-PSS configurations is.

We also found that product characteristics have a larger effect on consumer preference for bicycle AB-PSS (i.e., number of gears) than for clothing AB-PSS (i.e., comfort) ($\beta = -.58, p < .01$). This adoption barrier is inherently product-specific, and we chose attributes that for

the products that relate to the both use comfort. Yet, participants might have perceived the difference between the attribute levels to be larger or clearer for the bicycle AB-PSS than for the clothing AB-PSS despite the pretest thus leading to Product characteristics having a larger influence on rankings of the bicycle AB-PSS than of the clothing AB-PSS.

5 | DISCUSSION AND CONCLUSIONS

We analysed how the importance of a set of consumer adoption barriers differs across four AB-PSS. We found that in short-term use AB-PSS (access up to a few weeks), the barriers that relate to touchpoints have a major influence on consumer preference, whereas barriers that relate to the use phase influences consumer preference for long-term use AB-PSS (access for months or years). The importance of adoption barriers to consumers is also moderated by the type of product. Contamination is more important for clothing AB-PSS, and Effort to access is more important for bicycle AB-PSS. Our findings can help AB-PSS designers pinpoint the most important adoption barriers for different consumer AB-PSS.

5.1 | Contributions to theory

Despite significant knowledge generated on AB-PSS, the implementation (Ritala et al., 2018) and adoption (Tukker, 2015) of such business models in practice are still limited. While many studies examined consumer adoption of AB-PSS, practical aspects of the design of AB-PSS have been lacking attention. In addition, the role of digitalisation has not been widely considered and the present study focused on touchpoints with the user, enabled by digitalisation. Moreover, the current literature in this field has not tested which barriers are important for consumers in different AB-PSS.

We contribute to this field by identifying moderating factors from theory and testing these with consumers. Our study is a first step in addressing the understudied field of the practicalities of the design of AB-PSS. Our study contributes to the field by identifying the duration of use and the type of product as factors influencing the importance of AB-PSS adoption barriers in consumers' decision-making processes. While these factors have previously been presented by Bardhi and Eckhardt (2012) as two out of six dimensions to describe AB-PSS, we tested how these factors impacted the effect of adoption barriers on consumer preference. Therewith, we are contributing a quantitative study that elucidates practical aspects of AB-PSS design.

In addition, the design and implementation of the conjoint method are novel in the circular business model context. To the best of our knowledge, this is the first study of AB-PSS adoption that simulated real-world choices through conjoint experiments. We also have found no prior research in this area that takes consumers' digitalisation as a frame. This makes our findings highly relevant to providers and developers of contemporary AB-PSS.

5.2 | Managerial implications

Our study provides some practical guidance for AB-PSS developers. The duration of use and the type of product are important factors for AB-PSS developers to identify crucial consumer adoption barriers. The duration of use has implications for consumers' expectations of accessed products. In AB-PSS that grant consumers access to products for a short time, the service aspects are crucial while the product needs to be primarily functional. For example, consumers expect to quickly find shared bicycles and easily obtain access to them (Tunn et al., 2020). In contrast, consumers seem to evaluate long-term use AB-PSS similarly to ownership, valuing products with superior product characteristics during use, such as bicycles with multiple gears and highly comfortable clothing.

Aspects that are in general important for a product or a product category are also highly important in AB-PSS. Hence, contamination is very important to consumers in clothing AB-PSS but less important in bicycle AB-PSS. Yet, for clothing, consumers are willing to invest more time to access the AB-PSS than for bicycles.

5.3 | Limitations and avenues for future research

The research design we chose implies some limitations. The participants ranked AB-PSS profiles according to their preference. Rank orders were thus a measure of participants' attitudes towards the choices rather than their actual behaviour. Whether the duration of use and the type of product influence consumers' AB-PSS adoption behaviour as predicted based on their attitudes towards AB-PSS needs to be tested in future research. Although we only analysed two products, it is likely that the duration of use and the type of product are generally highly relevant factors of AB-PSS for consumers. Future research could further test these factors.

Another limitation is the operationalisation of the adoption barriers. For example, we used 'brand' as an attribute for Product quality; however, 'brand' might spark different associations in participants for different products. We recommend to pretest the operationalisation of adoption barriers more extensively in future studies. Moreover, our results are based on a relatively small sample and for all tested adoption barriers; apart from Effort to access, the utilities of the attributes varied greatly among participants. A larger sample could enable a better understanding of how the importance of adoption barriers differs between consumer segments.

A final limitation is that we did not include the price in our analysis to be able to focus on testing and comparing the importance of the selected AB-PSS adoption barriers. Future research may look at different price points and trade-offs with factors such as Effort to access or level of contamination. For example, are customers willing to go through more effort if the price of a service is dropped? This type of research can be of value to business model developers seeking to expand their markets, or local policymakers in cities, seeking to increase the adoption of new bike-sharing schemes.

To conclude, the sustainability potential of AB-PSS and digital aspects supporting these services served as the frame of this study. Neither of these aspects individually nor their interrelation has received sufficient attention in the literature so far. Further research into these topics is crucial to support the design of sustainable AB-PSS that are attractive to consumers. For example, the incorporation of digital technologies in bicycle sharing systems has accelerated their growth (Shaheen et al., 2010). Consumer digitalisation and other emerging technologies can likely help to better embed AB-PSS in consumers' routines and lifestyles (Tunn et al., 2020). However, reducing AB-PSS adoption barriers can also come at the cost of sustainability. For example, to lessen the product availability concerns of consumers, a short-term bicycle AB-PSS provider might place a large number of bicycles in a city. This can result in an over-supply of bicycles which end up idling and thus neither reduce relative nor absolute resource consumption (Kjaer et al., 2019). Thus, we encourage more research into factors that foster AB-PSS acceptance, while also considering the sustainability performance of such services.

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APPENDIX A: AB-PSS SCENARIOS

A.1 | Scenario 1: Short-term bicycle sharing

Ingrid lives in a city in the Netherlands and works for a company in her town. Twice per month, she has appointments with clients in another city. The best way for Ingrid to get to the clients' office is to catch a bus and then use a bike. In the city where her clients are based, several bicycle sharing companies are operating. All available bicycle sharing offers are supported by a smartphone application and website. Ingrid can find user reviews of the short-term bicycle sharing companies online. GPS data on the companies' websites and in the smartphone application help her to find the nearest bicycle. She has to decide which bicycle-sharing company to choose. Please help Ingrid to evaluate the different bicycle sharing companies for her client visits twice per month.

A.2 | Scenario 2: Long-term bicycle leasing

Ingrid lives in a city in the Netherlands. She would like to cycle to work. She is very busy at work and not good at fixing bicycles herself. She is considering leasing a bicycle for her daily commute to work. For a monthly fee, Ingrid would get a bicycle, and the company takes care of standard maintenance and repair during the leasing period. The maintenance and repair services are provided at a convenient location, for example, outside Ingrid's home or office. All available bicycle leasing offers are supported by a smartphone application and website. Ingrid can find user reviews of the long-term bicycle-leasing companies online. GPS data on the companies' websites and in the smartphone application help her to find the nearest service points where bicycles are issued. She has to decide which bicycle-leasing company to choose. Please help Ingrid to evaluate the different bicycle-leasing companies for her daily commute to work.

A.3 | Scenario 3: Short-term rental clothes

Ingrid lives in a city in the Netherlands. She works for a company with a casual dress code. Twice per month, she has meetings with clients

from the financial sector. She needs to wear formal clothes during these meetings. She is considering rental clothes as they would allow her to change outfits frequently, and she would only have to pay for the clothes for the limited time when she needs them. When clothing is returned, it is cleaned professionally. Rental clothes typically maintain their shape, colour and feel throughout many washing cycles and are in a visually attractive state. All available rental clothes offers are supported by smartphone applications and websites. Ingrid can find user reviews of the short-term rental clothes companies online. GPS data on the companies' websites and in the smartphone application help her to find the nearest location for picking-up and returning clothes. She has to decide which rental clothes company to choose. Please help Ingrid to evaluate the different rental clothes companies to rent formal clothes for client meetings twice per month.

A.4 | Scenario 4: Long-term leasing clothes

Ingrid lives in a city in the Netherlands and needs three to four different jackets per year to match the different seasons. She has little storage space in her home and is considering to lease jackets according to the seasons. For example, when spring starts Ingrid would receive the corresponding jacket and return the winter jacket. When clothing is returned by a customer, it is cleaned professionally. Leasing clothes typically maintain their shape, colour and feel throughout many washing cycles and are in a visually attractive state. All available leasing clothes offers are supported by smartphone applications and websites. Ingrid can find user reviews of the long-term clothing-leasing companies online. GPS data on the companies' websites and in the smartphone application help her to find the nearest location for picking-up and simultaneously returning clothes. She has to decide which clothing-leasing company to choose. Please help Ingrid to evaluate the different clothing-leasing companies for leasing jackets for the different seasons.



APPENDIX B: ORTHOGONAL DESIGN

Card	Code	Effort to access	Contamination	Trust	Product quality	Product characteristics
1	*	Level B	Level B	Level B	Level B	Level A
2	+	Level A	Level A	Level B	Level B	Level B
3	=	Level A	Level B	Level B	Level A	Level B
4	?	Level A	Level B	Level A	Level B	Level A
5	!	Level A	Level A	Level A	Level A	Level A
6	/	Level B	Level A	Level B	Level A	Level A
7	#	Level B	Level B	Level A	Level A	Level B
8	<	Level B	Level A	Level A	Level B	Level B

Note: Seed value: 2345. Level A: favourable version of attribute (e.g., 4 min walking to access shared bicycle). Level B: slightly worse version of attribute (e.g., 9 min walking to access shared bicycle).