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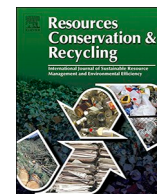To cite this publication, please use the final published version (if applicable).
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Digitalised product-service systems: Effects on consumers' attitudes and experiences

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ABSTRACT

Access-based product-service systems (AB-PSS) allow consumers to use products for a fee and might support the transition towards a circular economy. This type of business model could decrease negative impacts of consumption by reducing the number of products needed; either by extending products' lifetimes or by intensifying the use of products. Many AB-PSS in consumer markets are highly digitalised; they utilise digital platforms, have sensors embedded in the products, and rely on users' smartphones. To better understand how digitalisation impacts consumers' attitudes and use experiences in mobility AB-PSS, we applied a mixed-methods approach consisting of a survey (n = 47) and interviews (n = 10). Our findings suggest that many short-term AB-PSS, such as bicycle sharing, owe their recent success to digitalisation. Further, consumers' digital confidence influences their attitude towards short-term AB-PSS. During the use of AB-PSS, users value the convenience and flexibility enabled by the digital aspects. Digitalisation also made short-term mobility AB-PSS susceptible to disruptions because the AB-PSS rely on the functioning of many digital aspects. Users seem to dislike phoning customer service and increasingly depend on their smartphones. We also provide a brief outlook of what 5G mobile networks might imply for mobility AB-PSS. With this paper, we contribute a consumer perspective on the digitalisation of services. Our findings help service designers, user experience designers, and app developers to design digitalised AB-PSS for consumer markets.

1. Introduction

To tackle the sustainability crisis, researchers and businesses have been searching for opportunities to conduct business more sustainably. In recent years, the circular economy concept has gained traction as it presents a pathway to simultaneously attain economic and environmental goals (Geissdoerfer et al., 2017; Kirchherr et al., 2017). To support the transition towards a circular economy, research has strived to identify and describe business models that help achieve these goals (e.g., Bocken et al., 2016; Lüdeke-Freund et al., 2019; Urbinati et al., 2017).

For instance, Urbinati et al. (2017) investigated to what extent companies have implemented circularity in their business models while Tunn et al. (2019a) explored how business models can simultaneously contribute to the circular economy and sustainable consumption. Recently, several systematic literature reviews have been conducted to capture the state-of the art of circular business models (Centobelli et al., 2020; Rosa et al., 2019). Centobelli et al. (2020) suggested that further

research into the role of digital technologies in the development of circular business models is needed.

In the context of circular business models, access-based product-service systems (AB-PSS) have been studied (e.g., Roy, 2000; Tukker, 2015). Through AB-PSS consumers can use products for a fee without purchasing the products. AB-PSS could improve sustainability by transferring responsibilities for repair and maintenance to the provider, thereby potentially extending product lifetimes. In addition, granting consumers access to products for a fee might reduce the overall number of products needed. So far, many consumers are not enthusiastic about consuming AB-PSS and still value owning products (Mashhadi et al., 2019; Mont, 2002; Poppelaars et al., 2018).

Roy (2000, p. 297) suggested that "the rapid advance of information and communication technologies, from smart cards to mobile communications, are likely to make many types of sustainable product-service system more economic and practical." Two decades later, digitalisation has changed many business models and penetrated consumers' everyday lives (e.g., Bouwman et al., 2018; Vor dem Esche and Hennig-

Thurau, 2014). Digitalisation could enable the circular economy (e.g., Antikainen et al., 2018; Centobelli et al., 2020; Ingemarsdotter et al., 2019) if efforts in both directions were consciously aligned (Hedberg and Šipka, 2020). However, the effects of digitalised AB-PSS on consumers have received little attention. To better understand this phenomenon, we aim to answer the following question in this research: How does digitalisation of AB-PSS and consumers' digital confidence influence consumer attitudes and experiences? We thus explore when and how digitalisation influences consumer attitudes and use experiences in mobility AB-PSS.

2. Background

2.1. Digitalisation of products and services

Digitalisation has led to innovative, digitally-connected products that have opened pathways for new services and business models (Rijsdijk et al., 2007; Wünderlich et al., 2013). The seamless information exchange in the digital age has been used by entrepreneurs to develop personalised services, interact directly with consumers, and optimise AB-PSS offerings to make them attractive for consumers and viable for companies (Bocken et al., 2019; Rachinger et al., 2018). A few studies have explored the impact of digitalisation on business models (e.g., Bouwman et al., 2018; Rachinger et al., 2018). Bouwman et al. (2018) outlined the role of social media and big data in business model innovation; they concluded that these have a positive impact on business performance.

The recent rise of the 'sharing economy' and therewith the peer to peer sharing of resources has been frequently attributed to the wide diffusion of the internet (Belk, 2014a; Belk 2014b; Curtis and Lehner, 2019; Pouri and Hilty, 2020). Online platforms and social media are points where supply and demand can meet (Belk, 2014b). Similarly, digitalisation has facilitated the emergence of novel, potentially circular AB-PSS; business models that manage and allocate resources through online platforms and often involve Internet of Things connected products (e.g., Valencia Cardona et al., 2015). For example, pay-per-use appliance services have been enabled by digital infrastructure that facilitates continuous data exchange between the AB-PSS provider and the devices in users' homes (Bocken et al., 2019).

A few recent studies explored the role of digitalisation in the shift towards a circular economy and circular business models. Okorie et al. (2018) reviewed literature linking the circular economy, digital technologies, and Industry 4.0. They found that publications within these areas are growing but that there are few publications connecting them. Some studies investigated how businesses are utilising digital technologies to support circular strategies. For example, Ingemarsdotter et al. (2019) outlined how the Internet of Things could theoretically support circular strategies and showed to what extent this is happening in practice so far. They conclude that some companies apply the Internet of Things to extend product lifetimes but only few companies use it to help close product and material loops.

In addition, several single case studies were conducted to explore this topic; Alcayaga and Hansen (2019) researched textile washing services in the business to business context and found that the implementation of smart textiles enabled the AB-PSS provider to track the textiles' location and condition, thus enabling the firm to better analyse the cycles and lifetimes of their textiles. Bressanelli et al. (2018) showcased through a case study of a company that provides household appliances through AB-PSS, how the Internet of Things and big data analytics could enable and support circular strategies. Bocken et al. (2018) found that Internet of Things connected washing machines placed in an AB-PSS operated on a pay-per-use model, can be used to stimulate more sustainable washing practices. While these studies provide interesting insights into digitalisation of circular business models, more research is needed to understand the influence and role of digitalisation in the shift towards circular business models, especially in consumer markets.

2.2. Digitalisation of consumer experiences

Consumers have become increasingly digitally active over the last decade and are progressively adopting digitalised services. Digitalisation has infused everyday life and shifted power from marketeers to consumers (Labrecque et al., 2013). Consumers can now easily access other consumers' reviews to assess providers and to compare offerings (Sparks et al., 2013). Further, consumers can customise products, track their orders, envision potential purchases in their homes with augmented reality, and influence public opinion of offerings – anytime and anywhere as long as they have access to the world wide web (Vor dem Esche and Hennig-Thurau, 2014). Digitalisation has influenced consumers and Young et al. (2017) demonstrated that social media and e-newsletters can, for example, be used to change consumer behaviour to reduce food waste.

The diffusion of smartphones has further accelerated digitalisation; nowadays, smartphones are indispensable for most consumers. Many consumers obtain decision-relevant information online (Vor dem Esche and Hennig-Thurau, 2014), shop online, and increasingly also conduct online shopping on their smartphones (Pantone and Priporas, 2016). In western Europe, smartphones reached a market diffusion of 67% in 2018 (Statista, 2019a) and 91% in The Netherlands (Statista, 2019b), the location of our study. Scholars developed an interest in determining people's digital confidence, which describes "users' digital literacy and confidence to use digital products" (Benson, 2019, p. 1). Sussan et al. (2016) suggested that digital confidence comprises two pillars, namely digital privacy and security, and digital adoption. Despite the wide spread of smartphones and digitalisation of consumers, the impact of digitalisation has not yet been fully grasped and the role of consumers' digital confidence on their attitude towards digitalised offerings has not yet been studied.

2.3. Research focus: digitalisation of AB-PSS

We study the effects digitalised mobility AB-PSS in consumers as mobility AB-PSS are examples of widely adopted, digitalised AB-PSS. The recent increase in mobility AB-PSS might have been enabled by digitalisation. For example, bicycle sharing systems have considerably grown in number within a decade, from 13 bicycle sharing schemes globally in 2004 (before smartphones were widely adopted) to 855 in 2014 (Fishman, 2016). Bicycle sharing systems have evolved since they were first implemented five decades ago; they started as a localised phenomenon, of free or coin-deposit shared bicycles, evolved into digitally enabled systems integrated with other modes of transport that could be accessed with smartcards (Shaheen et al., 2010), and further evolved into systems that users access through smartphone applications. We refer to these developments as the *digital evolution* of mobility AB-PSS.

Many mobility AB-PSS are digitalised today but it is unclear how this affects consumer attitudes and use experiences. Recent studies analysing digitalised AB-PSS, did not explicitly address the consumer side (e.g., Alcayaga and Hansen, 2019; Bressanelli et al., 2018; Ingemarsdotter et al., 2019). We aim to increase the understanding of the effects of digitalised AB-PSS on consumers by exploring how digitalisation of AB-PSS and consumers' digital confidence influence consumerattitudes and use experiences? Based on the previously introduced literature we developed a framework of consumer attitudes and use experiences in digitalised AB-PSS (Fig. 1).

Leasing and sharing services are AB-PSS that differ in the temporality of access (Bardhi and Eckhardt, 2012). For example, consumers repeatedly obtain access to products for a short time through bicycle sharing while consumers access one product for an extended period in car leasing. This difference in temporality influences the importance of product and service aspects; in long-term AB-PSS product aspects are more important as a consumer extensively uses that product while in short-term AB-PSS the service aspects are crucial as products are
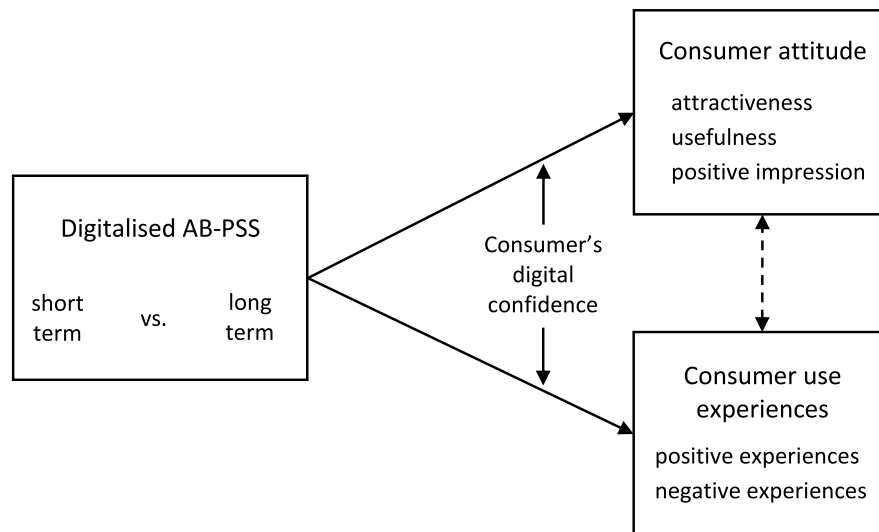
Figure 1. Framework of effects of digitalised AB-PSS on consumer attitudes and experiences.

frequently accessed and released. Digital aspects of AB-PSS generally support service aspects. Belk (2014b) suggested that digital aspects are more important for AB-PSS providing short-term access than for those providing long-term access. Consumers' digital confidence is thus likely to only affect their attitude towards short-term AB-PSS.

More specifically, building on Belk's (2014b) and Bardhi and Eckhardt's (2012) work, our framework suggests that consumer's digital confidence influences consumers' attitude towards digitalised short-term AB-PSS but not their attitude towards digitalised long-term AB-PSS. In other words, consumers who are confident using smartphones are likely to have a more positive attitude towards digitalised short-term AB-PSS, while this confidence does not influence their attitude towards digitalised long-term AB-PSS. We hypothesise the following:
H1. : Consumers' digital confidence positively influences consumers' attitude towards digitalised short-term AB-PSS but not consumers' attitude towards digitalised long-term AB-PSS.

Beyond attitude, our framework suggests that digitalised AB-PSS also influence consumers' use experiences. As outlined above, we expect high digital confidence to lead to positive attitudes towards short-term AB-PSS, thus increasing the likelihood of adoption and consequently use of digitalised AB-PSS. So far, consumers' use experiences in digitalised AB-PSS did not receive much attention in the literature. A thorough understanding of positive experiences and negative experiences is needed, given that the sustainability potential of short-term AB-PSS lies in substituting the purchase of a product. Understanding use experiences is thus crucial to sustain consumers' positive attitudes and foster the continued use of the AB-PSS.

In this paper, we present the findings of a survey and user interviews that provide evidence that digital confidence plays an important role for consumers in digitalised short-term AB-PSS. This study contributes deeper insights into how digitalised AB-PSS affect consumer attitudes and consumer use experiences.

3. Method

We applied a mixed-methods approach (Schoonenboom and Johnson, 2017). Mixed-methods approaches can be applied for different purposes, for example, a quantitative research can be followed by a qualitative one in order to elaborate on the initial findings (Brannen, 2005). Collecting both qualitative and quantitative data allowed us to gain nuanced insights into the effects of digitalised AB-PSS on consumers' attitudes and use experiences.

First, we surveyed the impact of consumers' digital confidence on

their attitude towards digitalised AB-PSS, using a sample from the general Dutch population (n = 47). Building on the survey findings, semi-structured interviews were conducted with key informants who use mobility AB-PSS (n = 10). Consumers' experiences during the use of digitalised AB-PSS received little attention so far, and thus, necessitated a qualitative approach.

3.1. Survey

With the survey, we aim to determine when consumers' digital confidence influences their attitude towards digitalised AB-PSS. Participants were sampled from a consumer panel of Delft University of Technology. The sample comprises participants living in or near Delft in the Netherlands (n = 47). Participants were aged between 26 and 75 (M_{age} = 44) and 62% of the sample are female. Smartphones were used by 98% of participants.

About half of the participants (n = 23) evaluated hypothetical bicycle leasing services and the other half (n = 24) evaluated hypothetical bicycle sharing services. The hypothetical AB-PSS were designed to resemble AB-PSS that are available in the Netherlands to improve the validity of participants' responses. The questionnaires were part of a larger task that took participants 30-40 minutes, hence every participant only completed one of the two questionnaires. Both services can be considered digitalised AB-PSS as digital aspects were built-in; for example, websites and smartphone applications, online reviews, and GPS location of bicycles and service points.

After reading an explanation of the digitalised AB-PSS, participants completed the survey that assessed their attitude towards the digitalised services and their digital confidence. The attitude towards the AB-PSS was measured with three items on 7-point semantic differential scales (e.g., attractive - unattractive); namely the perceived attractiveness, usefulness, and positive impression of the AB-PSS (adapted from Van den Hende and Schoormans, 2012; Hassenzahl, 2001). Sussan et al. (2016, p. 326) suggested that digital confidence can be understood through an adoption lens and in this context "measures whether consumers recognize the opportunities of digitalization, as reflected in adoption rates of Internet, fixed and mobile broadband, various digital devices, and digital services". In this study, we applied this adoption perspective to digital confidence which is reflected in the three items through which we assessed it, namely the perceived ease of use of smartphone applications, the frequency of use of smartphone applications for services, and whether participants perceived that smartphone applications increased the ease of use of services (assessed on a 7-point Likert scale, strongly agree - strongly disagree).

3.2. Interviews with key informants

Building on the findings of the survey, we conducted semi-structured interviews with ten users of mobility AB-PSS. Through these interviews we explored consumers' use experiences in digitalised mobility AB-PSS. We selected key informants (n = 10) for the interviews, who all have used at least one mobility AB-PSS and live in the Netherlands (see Table 1). Their experience with mobility AB-PSS ranged from having used one a few times to having regularly used one or several AB-PSS for up to 20 years.

Table 1
List of interviewed AB-PSS users and the mobility AB-PSS they use (*names changed).

Name*	Age	Occupation	AB-PSS experience
Peter	19	Bachelor student	Swapfiets
Anna	25	Junior Service Designer	Swapfiets & OV-bike
Tom	19	Bachelor student	Swapfiets & OV-bike
Julia	25	Master student	Mobike & OV-bike
Ben	27	Researcher	Mobike & Felyx
Fenna	29	Researcher	ShareNow & OV-bike
Steve	45	Teacher	Greenwheels
John	33	Researcher	Greenwheels & OV-bike
Sophie	37	Researcher	Greenwheels
Martin	54	Project Manager Innovation	Greenwheels

During the interviews, the key informants outlined their experience with mobility AB-PSS and the role of digital aspects within these services. The interviews lasted 20-40 minutes. The interviews were conducted in person, recorded, transcribed, and coded to discover themes (Ryan and Bernard, 2003) related to users' experiences using digitalised AB-PSS. Initially, the interviews were coded according to three main themes, namely the evolution of digital aspects, the positive experiences, and the negative experiences resulting from the digital aspects of the AB-PSS. Subsequently, quotes related to these three themes were placed in thematic clusters. To ensure the validity of our findings, the information obtained through the interviews was triangulated with secondary sources, such as the companies' websites, to retrace the development of the digital aspects. Further, most of the AB-PSS explored through user interviews were used by several interviewees, two AB-PSS were only used by one interviewee each. This ensured that insights are not AB-PSS provider specific but likely to apply to mobility AB-PSS in general.

All mobility AB-PSS used by interviewees incorporate some digital aspects. For example, Mobike (www.mobike.com) offers sharing bicycles without docking stations, this is enabled by a smartphone app that allows consumers to locate, reserve, and unlock bicycles, as well as pay. The bicycles are equipped with Internet of Things connected smart locks. OV-fiets (www.ns.nl/en/door-to-door/ov-fiets) offers shared bicycles at Dutch railway stations. These bicycles can be accessed with a smartcard of the Dutch railway service. This service is connected to the website and app of the Dutch railway service, where the availability of bicycles at the railway stations is displayed in real time.

4. Results

4.1. Survey: digital confidence and attitude towards digitalised AB-PSS

We hypothesised that consumers' digital confidence has a positive influence on their attitude towards digitalised short-term AB-PSS but not on their attitude towards digitalised long-term AB-PSS. The reliability of the digital confidence scale (Cronbach's alpha = .72) and the AB-PSS attitude scale (Cronbach's alpha = .90) were above the .70 threshold and can thus be used in the analysis. A preliminary analysis of the attitude scale and the digital confidence scale for the two AB-PSS indicates that attitudes are more positive towards short-term AB-PSS

Table 2
Mean and standard deviation for consumers' digital confidence and AB-PSS attitude for both services.

	Short-term AB-PSS	Long-term AB-PSS	Total
	(n = 24)	(n = 23)	(n = 47)
	M_{age} = 43	M_{age} = 45	M_{age} = 44
	63% female	61% female	62% female
Digital confidence	M = 6.43	M = 6.20	M = 6.32
	SD = .88	SD = .76	SD = .82
AB-PSS attitude	M = 5.82	M = 4.20	M = 5.03
	SD = 1.16	SD = 1.32	SD = 1.47

($M_{short-term}$ = 5.82; $M_{long-term}$ = 4.2) and that digital confidence in our sample is high ($M_{digital\ confidence}$ = 6.32; see Table 2 for details).

We regressed AB-PSS attitude on digital confidence for each AB-PSS to test hypothesis 1. The regression analysis showed that consumers' digital confidence significantly influences their attitude towards short-term AB-PSS ($F(1, 22)$ = 8.463, $p < .01$) with R^2 = .28. The higher consumers' digital confidence the more positive their attitude towards short-term AB-PSS. We analysed long-term AB-PSS in the same way and found that digital confidence has no influence on consumers' attitudes in this case ($F(1, 21)$ = .016, $p = .9$) with R^2 = .001. These findings thus support our hypothesis; the digital confidence of consumers indeed only has an effect on consumers' attitude towards short-term AB-PSS but not on their attitude towards long-term AB-PSS. Consumers' attitude towards short-term AB-PSS depends on their level of digital confidence. Having lower digital confidence results in lower attitudes towards short-term AB-PSS, and thus, makes adoption and repeated use of the service less likely.

4.2. Interviews: user experiences in digitalised AB-PSS

Building on the results of the survey, interviews were conducted with digitally confident users of mobility AB-PSS. The focus of the interviews was on short-term AB-PSS as the survey and previous literature established that digital aspects are more important in short-term AB-PSS than in long-term AB-PSS (Belk, 2014b). Three main themes emerged from the interviews, namely the digital evolution of AB-PSS, negative use experiences, and positive use experiences in digitalised mobility AB-PSS. In this study, digital evolution refers to the changes of digital aspects of AB-PSS that interviewees noticed and experienced.

The interviewees described more digital aspects in the scooter and car sharing AB-PSS than in the bicycle AB-PSS. The complexity of the products could explain this; bicycles are relatively simple mechanical products whereas modern scooters and cars are more complex and contain electronics. These more complex products offer many possibilities for digitalisation, for example, by making use of built-in sensors, screens, and data (e.g., on usage, battery levels, and damages). In bicycle sharing, digitalisation is important to consumers but its role is mostly limited to locating and accessing the bicycles via smartphones.

As for digitalisation in long-term AB-PSS, some interviewees used leased bicycles from Swapfiets. As expected, for this long-term AB-PSS digital aspects were not of high importance and only mentioned in connection to service encounters such as the initial receiving and eventual repairs of the bicycle. Interviewees valued getting in touch with the long-term AB-PSS provider Swapfiets via the messaging application WhatsApp (Anna; Tom). The following sections present negative and positive use experiences related to of digital aspects of short-term AB-PSS and their evolution.

Effort required to use digital aspects

Greenwheels has provided shared cars in the Netherlands since 1995. Steve has been using their cars since 1999 and described how the service evolved. Initially, bookings had to be made via telephone, later a website, and subsequently an app were launched through which consumers could book cars. Martin remembered that he had to go

through several steps when he used to book cars on his computer through the Greenwheels website, this required more effort than booking through the app requires now: *"I used to have to start my laptop, enter the online environment, having to reserve via the online environment"*. The way users can unlock cars has also changed; initially cars were accessed using a Greenwheels card, soon users could unlock the cars with their Dutch public transport card as a result of a collaboration between Greenwheels and the Dutch railway service. Now users can open the cars using the Greenwheels app on their smartphones. Steve explained why he still unlocks Greenwheels cars with his public transport card rather than with his smartphone:

> "Since a couple of years, you can also unlock it with your phone but I don't really use it that much. I generally switch the GPS off on my phone because it saves battery so I'd have to actively switch on the GPS and then swipe it over. I always have my public transport card with my driver's license on me so for me it is a no-brainer." (Steve)

Flaws in the design and performance of digital aspects

Several interviewees described why they perceived certain digital aspects of the AB-PSS as unattractive or even useless. Fenna mentioned that she does not use the onboard system of ShareNow cars because *"it is so slow and it gives the wrong route or the slowest route […] and the interface isn't pretty."* John used to avoid opening the Greenwheels website on his smartphone because *"when you do it on a small smartphone screen things become, for my taste, a bit unhandy"*. For a while Greenwheels has been providing an app, Martin described how the Greenwheels app evolved: *"The app has become more sophisticated so that it has a little film inside and it has better visual quality but I liked the app as it was in the beginning, it was very straight forward."*

Furthermore, some interviewees found a mismatch between the digital information and physical artefacts. For example, Fenna recollected an incident when several cars were displayed as available in the ShareNow app; however, the cars were not accessible because they had been towed into a closed-off yard by the municipality. Similarly, Ben was irritated by the information provided when checking Felyx scooters for damages:

> "You can see which damages there are to check whether it matches with the actual thing. It never matches, it is really weird. Even things like the mirror, it would say like there is no mirror and there are mirrors and vice versa. It'll say there are big damages but there are no damages and it is just really weird." (Ben)

Dependence on digital aspects

Some interviewees voiced negative emotions and concerns they had experienced because of the high degree of dependence on digitalisation in some AB-PSS. Several of the AB-PSS introduced in this section, rely on users' smartphones. Fenna revealed that she usually does not use the car sharing service if her phone battery charge level is below 50% and Julia described her worries about the smartphone running out of battery while using the service:

> "What I just remembered about Mobike and what I found to be a big disadvantage is that on one occasion my mobile phone battery was nearly empty, and I thought 'What will happen if it's empty?' and that made me stressed out even more." (Julia)

In addition, some users depend on AB-PSS in their daily routines, a malfunctioning of digital aspects can disrupt these routines and cause emotional reactions:

> "When it [the app] blocks or there is a big bug you're locked out of the car and you can't get home. […] So, we were doing the groceries and we had all the groceries in our hands and we were getting back to the car and we couldn't get back into the car. The car was in the parking lot, so you also have to pay for being in the parking lot and we couldn't access the car again and both of our mobile phones were

not connecting. We just thought that it was a national issue and we just were like 'Nooooo, we just want to get home, please!'" (Fenna)

> "I remember that one time that I had reserved via the app and that the app hadn't been rolled out for such a long time and that my reservation had not been processed so that when I put my card on the windscreen of the car it wouldn't open and then I had to call and then it took a long time because there was a glitch in the system meaning that there were a lot of people waiting to be given access and that made me quite angry because that was when I was travelling from home and I had to bring my daughter to one of her swimming lessons and then timing is essential and I can't lose 10 minutes on such a thing. (Martin)

Further, Julia raised concerns that digitalised AB-PSS might exclude less digitally confident consumers, for example, in her parents' neighbourhood:

> "I think that my neighbours would not use it at all because they'd think: 'Oh, what is an app and what should I do with it?' So, the app would be a negative aspect there." (Julia)

Increased use efficiency because of stored data and privacy concerns

Most interviewees of this study outlined initial registration procedures before the first use of the AB-PSS. The AB-PSS providers store the data and create user profiles to which subsequent service interactions are linked. Hence, AB-PSS users do not have to sign a contract before each use thereby speeding up the service interaction compared to traditional rental services. John compared the OV-bike sharing systems with traditional bicycle renting:

> "I think it is mostly the administrative part that is now streamlined which makes it more convenient for the companies as well as for me the user to have this service. Of course, I could have gone to the bicycle place before and rented a bike but then you have to go to the office, ask the guy there to let me rent a bicycle, then he would need a copy of my passport or driver's license, he would sign me into the register, I would pay the rental fee and probably a deposit beforehand, then he would have shown me the bicycle. Well, this whole thing would have cost more time and would have been more bothersome than just take the bike, scan and go." (John)

While interviewees perceived the time savings and convenience achieved through stored data and built-in sensors positively, some interviewees were concerned with data privacy especially when envisioning how these services might develop in the future (Steve; Martin).

Benefits of digital interaction with AB-PSS providers

The introduction of digital channels has simplified booking processes and made AB-PSS more convenient to use. Several interviewees preferred digital interaction with the AB-PSS provider over calling the customer service which they felt cost more time and hassle. Tom, Sophie, and Steve liked being able to contact the customer service or extend bookings through apps because they could do this swiftly during other commitments, such as lectures, meetings or family gatherings, if necessary. Anna found digitally interacting with the AB-PSS provider more relaxed than calling. Other interviewees emphasised time savings resulting from digital interaction, Martin explained how selecting and booking vehicles himself via the app saved time compared to talking to a customer service agent trying to find an available vehicle in his vicinity: *"It [relieves me from] having to think before starting [the journey to work] so I can do it very quickly so it saves thinking time."* Both Fenna and Ben mentioned that they were less likely to report damages caused by previous users if they had to call the customer service rather than being able to quickly enter the damages in the app. A few interviewees outlined how the channels through which they interact with the AB-PSS providers have evolved. For example, the introduction of apps sped up

the reservation process of vehicles and shortened users' planning horizon:

> "They introduced the app which made it easier because you didn't have to start the computer and login or call, you could just open the app because you were automatically logged in and it knew location wise already that you were in Delft. I remember it became easier with the app. […] The booking time, I think, also shortened [with the app]. While before you did it the day beforehand for sure or maybe even a couple of days in advance because it takes more time and effort to do it while now it is just on the go." (Sophie)

Systems integration

Interviewees experienced the integration of different digital aspects within the AB-PSS and the integration of AB-PSS into existing services and infrastructures as beneficial. Several interviewees emphasised that this integration made OV-bike and Greenwheels more convenient and accessible. While Peter is currently not using OV-bike he felt that the service would be more appealing if it were even more embedded in the app of the Dutch railway service: *"It would be nice if you could go to the [future] app directly from the Dutch railway service's online journey planner."* Martin has been using Greenwheels car sharing since 2011 and explained that the integration of digital aspects made him experience the service as reliable and helped him build trust in the service:

> *"It works well because I reserve on my app and now it always pops open when I put my card on the windscreen and that is what I would like. […] So, it feels like the car is in connection with the rest and that is more now than it used to be. Because I used to feel like there is this system but then whether the car is connected to the system I was not so sure, most of the times it opened up but now it feels more like 'Of course it will open up'. […] You do feel that it is one big thing, it is a reassuring system."* (Martin)

Direct feedback

Digitalisation can give AB-PSS users a sense of control by giving them access to relevant information. For example, by clearly displaying the availability and location of the vehicles. Further, some of the AB-PSS provide electric vehicles and Steve, Ben and Fenna mentioned that they check vehicles' battery levels in the apps before selecting a vehicle to ensure it is sufficient to reach their destination or to also cover the return journey. Fenna explained that ShareNow cars have onboard computers that display the driver's current sustainability score thus providing direct feedback on the driving. One interviewee explained how the app gives him a feeling control and peace of mind:

> "Through the app you get a lot more sense of control; you know where they [the scooters] are, you know whether they are locked or not, you can look at it and it gives you feedback. It shows you that you have locked it, unlocked it and you have used it for this many hours. I sometimes look at the overview of the rides that you have taken. It gives you information on costs, I think that is really important. So, it shows you directly how minutes you did go, how many euros did that cost." (Ben)

Advanced digital aspects

The interviews revealed how AB-PSS providers used advanced digital aspects to create more positive use experiences. A few interviews recalled incidents when the vehicles did not lock because one of the digital aspects did either not work or did not connect to the other digital aspects. For example, Ben and Fenna described that this caused them stress because it meant that costs kept rising despite them no longer using the vehicles. The car sharing system ShareNow evolved further and now use the built-in sensors to automatically lock the cars:

> "I think with the new system you don't have to log out on the app anymore because now it locks automatically. I remember sometimes the app takes a long time because your phone doesn't always want to cooperate; so the app shuts down or your phone shuts down or it takes a shitload of time to get stuff going and I noticed lately that it's been locking the car automatically without me even having to push

on a button and before that I was like: 'Oh no, ahhh, the time is going on, leave me alone!' So that was a good one." (Fenna)

5. Discussion and recommendations

5.1. Discussion

Digital aspects of AB-PSS influence consumers' attitudes and use experiences. We demonstrated that digitally confident consumers have a more positive attitude towards short-term digitalised AB-PSS than less digitally confident consumers. Users of these services seem to be generally digitally confident. Furthermore, digital aspects of AB-PSS had a lesser influence on consumer attitudes and use experiences in long-term AB-PSS, because digital AB-PSS aspects often facilitate consumers' interactions with the service provider (e.g., the accessing and releasing of products). Such interactions occur frequently in short-term AB-PSS whereas they occur infrequently in long-term AB-PSS. Thereby, this study substantiates Belk's (2014b) conjecture that digital aspects are more important in short-term AB-PSS and limited to locating and comparing choices in long-term AB-PSS. Digitalisation contributed to the recent success and spread of short-term mobility AB-PSS in the consumer market. By now, digital aspects are 'must-haves' in many short-term mobility AB-PSS and 'nice-to-have' in long-term mobility AB-PSS. Digitalised AB-PSS are thus more likely to be adopted by digitally confident consumers than by less digitally confident consumers.

Digitalised AB-PSS can affect consumers in several ways. AB-PSS are generally complex (Tunn et al., 2020) and digital aspects add another layer of complexity. Digitalised AB-PSS rely on several digital aspects and are thus susceptible to disruptions. For example, the service delivery of AB-PSS can be compromised if a consumer's smartphone runs out of battery, the providers' app has a bug, or a sensor built into the product fails. Consumers' resulting negative use experiences can trigger negative emotions. This is interesting as consumers usually do not have strong emotional connections with products accessed through AB-PSS (Tunn et al., 2019b). Positive and negative use experiences can be closely related; for example, users felt that stored data and digital aspects made AB-PSS efficient and convenient, while they also voiced privacy concerns. While it is hoped that AB-PSS providers "collect rich data about consumers and translate these into meaningful, highly individualized services" (Valencia Cardona et al., 2015, p. 25), the digital aspects of AB-PSS also enable unwanted surveillance (Ziegeldorf et al., 2014). It is therefore crucial to design stable, reliable systems, and build consumers' trust in the digitalised short-term AB-PSS.

With this study, we build on and extend previous research (Bardhi and Eckhardt, 2012; Belk, 2014b; Bressanelli et al., 2018; Tukker, 2015) by providing a consumer perspective on digitalised AB-PSS. We contribute insights into the effects of digitalised AB-PSS on consumer attitudes and use experiences and demonstrate the role of consumers' digital confidence. Our findings can be directly attributed to digitalisation as interviewees described their experiences in the context of the digital evolution of AB-PSS.

While the presented research investigated mobility AB-PSS, some findings are likely to apply to other digitalised offerings. For example, it is likely that consumers' digital confidence also influences their attitude towards digitalised services and products in other application areas. In addition, digitalised AB-PSS from outside the mobility sector are likely to create similar use experiences for consumers. For instance, direct feedback about the availability of rental clothes via a smartphone app would probably contribute to a positive use experience. However, consumers are likely to interact less with, for example, a rented electric drill.

Digital technologies are still developing at a fast pace and in the coming years 5G mobile networks will be rolled out. This development is likely to have some implications for short-term mobility AB-PSS. We consulted an expert on this topic who suggested that 5G is most

beneficial in densely populated areas as it allows more devices to connect and process higher data volumes, it also promises to increase the reliability of the network, and it will allow to connect many smaller devices and sensors. Therefore, digital aspects of AB-PSS such as built-in sensors and scanners could be directly connected to the mobile network and for instance, inform the AB-PSS provider about the status of the products to trigger maintenance and repair before users notice and report component issues or failures. Overall, the implementation of a 5G mobile network could increase the reliability of these services and could enable new, data-heavy applications and services that require data exchange in real-time.

AB-PSS need to be purposefully designed to enable the transition towards a sustainable, circular economy (Kjaer et al., 2019). When assessing the sustainability of digitalised AB-PSS, the impacts of the required digital infrastructure need to be considered in addition to impacts created by operating the service (Kjaer et al., 2019), and impacts caused by adverse consumer behaviour (Schaefers et al., 2016). The question is whether the digitalisation of an AB-PSS helps to make the service so much more attractive that the AB-PSS substitutes unsustainable consumption alternatives and whether these potential sustainability gains outweigh the additional impacts created by operating the AB-PSS including the required server infrastructure and other digital aspects (Pouri and Hilty, 2020).

5.2. Recommendations

Based on the findings of this study, a few key recommendations for AB-PSS designers and app developers have been formulated. Services such as AB-PSS should provide digital communication channels as phoning is seen as somewhat outdated and less convenient by consumers. Digitalised short-term AB-PSS should target digitally confident consumers. When designing short-term AB-PSS, digital aspects are essential and it should be ensured that digital aspects such as smartphone applications are user-friendly and highly reliable. This can help consumers build trust in the AB-PSS and experience benefits such as convenience and time savings.

In addition, AB-PSS designers should keep in mind that more complex products (e.g., cars) offer more opportunities for digitalisation than less complex products (e.g., bicycles). However, designers should deliberate whether digital aspects are needed and beneficial or merely creating additional environmental impacts. Finally, the sustainability potential of digitalised AB-PSS should be analysed when designing them as required sensors and server infrastructure cause environmental impacts that might outweigh their benefits.

The applied methodology and set-up of the study entail some limitations that provide avenues for future research. Future research could test the effect of digital confidence on consumers' attitude and behavioural intention with a larger sample also taking participants' values into account. In addition, digital aspects should generally be considered more in AB-PSS research and consumers' digital confidence should be taken into account when AB-PSS targeting consumer markets are studied. For the interviews, we deliberately selected key informants who were users of mobility AB-PSS; however, non-users might perceive the digital aspects differently. The digital aspects might even be the reason why some consumers are not using mobility AB-PSS. In addition, it stands out that the digital confidence of consumers in our survey sample is very high. This seems to be representative of the Dutch population of whom 91% had already adopted smartphones in 2018 (Statista, 2019b). We suggest using larger samples and including non-users and users with lower digital confidence in future research. Finally, we would like to encourage more research assessing the environmental impacts of digitalisation to understand when and how digitalisation can support the transition towards a sustainable, circular economy (Hedberg and Šipka, 2020; Rahmana et al., 2020).

6. Conclusions

Many circular business models such as AB-PSS have been enabled by digitalisation. However, the effect of digitalised business models has received little attention so far. Recently, an increasing number mobility AB-PSS such as bicycle sharing systems have been implemented and subsequently adopted by consumers (e.g., Fishman, 2016). We thus studied the effects of digitalised mobility AB-PSS on consumer attitudes and use experiences using a mixed-methods approach. With the presented research, we illustrated how digitalisation has enabled the recent spread of mobility AB-PSS. We contributed insights into the effects of digital aspects on consumers' use experiences of AB-PSS and presented when and how consumers' digital confidence influences consumers' attitudes towards these services.

We found that consumers' digital confidence has a significant effect on consumers' attitudes towards short-term AB-PSS. The effect of digital aspects and consumers' digital confidence is limited in long-term AB-PSS such as bicycle leasing. Well designed and integrated digital aspects can enhance consumers' use experiences in short-term AB-PSS. Digital aspects can increase convenience, lead to time savings, create perceived control, and help users build trust in the service.

Yet, digitalised short-term AB-PSS depend on the functioning of several digital aspects including consumers' smartphones and are thus prone to technical issues that can render the service unusable and upset consumers. In addition, digitalisation of short-term AB-PSS excludes less digitally confident consumers. However, considering the wide diffusion of smartphones among the Dutch population and the planned introduction of the 5G network, digitalised AB-PSS and other digitalised services have a large and growing target group.

Declaration of Competing Interest

None

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