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The sharing economy and consumer preferences for environmentally sustainable last mile deliveries

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ABSTRACT

This paper addresses whether consumers' environmental attitudes and behavior are reflected in their stated preferences for last mile delivery options for clothing rentals, and whether preferences are heterogenous across groups of respondents in terms of socioeconomic characteristics, income, and environmental attitudes. The analysis relies on data collected through a discrete choice experiment among Norwegian females between 18 and 70 years of age.

The key results are: i) females have a negative utility from delivery time, delays, local air pollutants (PM) and greenhouse gas emissions (CO_2) from last mile deliveries, and a positive utility from information services and ii) females consumers are likely to accept increased delivery time if it implies reduced emissions. The findings are relevant for both urban planners, online retailers, and transport operators as they show that consumers prefer environmentally sustainable last mile delivery options and that other measures than price can incentivize consumers to choose sustainable deliveries.

1. Introduction

The global sharing economy, where goods or services are rented, swapped or traded through online platforms (Hamari et al., 2016), is expected to rise in future, and predicted to reach USD 335 billion by 2020, up from USD 15 billion in 2014 (Mazareanu, 2019). Only a decade ago, the sharing economy was mainly found within accommodation and transportation, with Couchsurfing, Airbnb and Uber being pioneering companies. Now, it can be found in almost every sector and activity in the world (Rinne, 2019), benefitting the consumer, the environment, and the community, as well as providing new business opportunities for firms that anticipate, welcome and adapt to it (Belk, 2014). One of many sectors adapting to the sharing economy is clothing rentals, covering both specialized online platforms (like Rent The Runway in the US, HURR in the UK and FJONG in Norway) and established fashion retailers (like H&M (Wilen, 2019)), providing consumer access to trendy outfits while benefiting both the wallet and the environment. In terms of sustainability, the entrance of the sharing economy in the fashion industry is welcome; fast fashion, falling prices and diminishing quality of products result in overconsumption and increased clothing waste pushing for new business concepts that combines economic benefit and reduced environmental footprint (Armstrong et al., 2015). Supported by the increased sustainability focus from consumers, circularity is likely to become a key business trend within fashion retail the upcoming decade (i.e. also after the COVID-19 pandemic), including initiatives related to the "Rs" – reducing, recycling, refurbishing, reselling, repairing and renting (Amed et al., 2020). Some researchers even argue that the COVID-19 pandemic may strengthen the industry in long term: with hygiene or contamination

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concerns being a limiting factor for clothing rentals (Armstrong et al., 2015; Baek and Oh, 2021) the pandemic has forced fashion retailers to emphasize and embrace consumers with hygiene concerns, who may still develop favorable attitudes towards such services when reminded about its quality and sustainability aspects (Baek and Oh, 2021), from which clothing rentals might benefit in the future.

In many ways, the sharing economy resembles e-commerce, where goods and services are bought and sold online, with the main difference being how ownership is transferred, and the fact that environmental aspects are a motivating factor for both consumers supporting the sharing economy (Hamari et al., 2016; Standing et al., 2019; Jia et al., 2020) and producers altering their production (Jia et al., 2020). Despite the emphasis on the environmental aspects of the sharing economy, little focus has been put on the freight aspect of it (Lim et al., 2018), although it is expected to alter freight traffic both through opportunities for new innovative transport solutions and changes in transfer of ownership (Carbone et al., 2018). The latter is particularly relevant for large-scale renting of goods between peers or between consumers and online platforms, i.e. clothing rentals, where temporary transfer of ownership generates both a delivery to consumer and a return to sender.

Freight transport has already been altered by e-commerce through online shopping and sharing activities like clothing rentals are assumed to fuel this change. Deliveries directly to consumers increases freight traffic in general and in residential areas in particular (Allen et al., 2018; Visser et al., 2014). However, the impact on total traffic depends on delivery schemes, consumer travel behavior and failed deliveries (Bjørgen et al., 2019; Buldeo Rai et al., 2019; Pernot, 2020), but is also influenced by the competition of market shares pushing for continuously shorter lead times, poor vehicle utilization and duplication of delivery services (Allen et al., 2018). A consequence is increased supply of instant deliveries (deliveries within 2 h of ordering), resulting in higher total distance traveled as trucks are substituted with smaller modes of transport, as well as higher energy consumption and emissions if vans, private cars and motorcycles are used (Dablanc et al., 2017). On the other hand, increased delivery time flexibility is found to reduce vehicle kilometers and environmental impact (Manerba et al., 2018).

Counteracting the continuous reduction in lead time might help reduce emissions from urban freight deliveries of both online shopping and renting. Accepting that parcel deliveries take more than 1 day, or even 5–10 days, might ease the implementation of last-mile collaboration or consolidation, logistics hotels, or crowdshipping (utilizing existing journeys), initiatives suggested by Allen et al. (2018) to improve efficiency in parcel delivery. Local pick-up points have also been found to increase consolidation, optimize delivery rounds, reduce vehicle kilometers and emissions compared to home deliveries (Morganti et al., 2014; de Oliveira et al., 2017; Heshmati et al., 2018). Thus, getting consumers to accept increased delivery time might foster sustainable urban freight transport. This paper contributes to this topic by analyzing consumer last mile delivery preferences when renting an outfit online, and is motivated by the following two main research questions: *i) Are consumers concerned about local air pollution and greenhouse gas emissions from last mile delivery, and if so, can they accept increased delivery time as a measure to reduce these emissions, and ii) do the results vary with consumer type or supplementary information (nudge) about environmental consequences of the fashion industry and last mile deliveries (provided to half the sample)?*

The research questions are answered using an internet panel survey of female respondents between 18 and 70 years of age, inquiring about online shopping and clothing rental habits, preferences and attitudes as well as performing a discrete choice experiment (DCE) to reveal last mile delivery preferences when engaging in clothing rentals. A female-only sample was chosen as Norwegian females on average consume more clothes and are more experienced with reused clothing than men (Laitala and Klepp, 2020). Further, at the time of this study, no Norwegian online clothing rental company targets male consumer, making last mile deliveries services of clothing rentals less applicable for this group. The novelty of this research is how consumers value different last mile delivery services (other than by price), and how the tradeoff between delivery time and emission of local air pollutants (Particulate Matter - PM) and greenhouse gas emissions (CO_2) can be utilized to achieve more sustainable urban freight transport. The authors have not found other papers addressing consumer preference for airborne emissions from last mile delivery nor from the sharing economy.

The rest of the paper is organized as follows: Section 2 provides a literature summary of consumer preferences for the sharing economy and environmentally sustainable deliveries. Section 3 presents the data collection and resulting sample. Section 4 briefly discusses the chosen model specification, followed by estimation results in Section 5. Section 6 provides a discussion of the results including implications for urban freight transport. Section 7 concludes the paper.

2. Sharing economy and environmentally sustainable deliveries

This section summarizes existing literature on the field and helps identify relevant attributes for analysis.

2.1. Consumer behavior and motivation in the sharing economy

Hamari et al. (2016) identified positive attitudes towards the sharing economy, enjoyment of the activity, and potential of economic benefit as key motivations for participating in the sharing economy, with sustainability being an important factor through its impact on attitude. Piscicelli et al. (2015) identified environmental, social and financial motivations for joining an online marketplace to lend and borrow between peers. Baek and Oh (2021) identified functional, economic, emotional and green values as relevant to build positive attitudes towards clothing rentals, although differing with respect to high or low consumer contamination concern. Standing et al. (2019) reviewed transport sharing activities and identified potential for reduced cost, enjoyment, environmental savings and practical aspects as key points for engaging. Hartl et al. (2018) found that a green image is less important than price, easiness of use and flexibility as motivation for carsharing, and that environmental motives work only as a bonus when a consumer chooses P2P (peer-to-peer) over B2C (business-to-consumer) carsharing services. Cerutti et al. (2019) identified health and

environment, social influence and lifestyle as main motivations for bike-sharing. Punel and Stathopoulos (2017) revealed that previous experience impacted preferences for using crowd-shipping services. Separate studies have been done for millennials engaging in the sharing economy, indicating that this is a group of interest within the field. Godelnik (2017) found that economic motives were by far the most important for millennials, followed by social and environmental ones, while Hawlitschek et al. (2018) identified financial-, trust-, lifestyle-, effort- and sustainability-related factors as key points for millennials. Tradition and preserving the "status quo" were found to work against sharing economy participation (Piscicelli et al., 2015), as do time use, less freedom of product use and worry of product damage ("hassle cost") in clothing rentals (Choi and He, 2019).

Demographics seems to play a smaller role in explaining sharing economy motivation. Diamantopoulos et al. (2003) found that socio-demographic variables overall explain a small proportion of the variance, although females hold stronger attitudes towards environmental qualities and green behavior than men, age influences environmental attitudes, high education has a partly positive influence on green behavior, while marriage status and number of kids are insignificant. Diamantopoulos et al. (2003) further argued that the importance of demographic measures is not necessarily transferable and might be outdated if attitudes are changing in society.

2.2. *Consumer preferences for environmentally sustainable last mile deliveries*

Few research papers were found on consumer preferences for last mile deliveries in the sharing economy. The issue was raised by Carbone et al. (2018), who identified four different freight sharing economy solutions: peer-to-peer and business logistics from freight generated by the sharing economy, and crowd or open logistics as part of the sharing economy for logistics (Carbone et al., 2018). Standing et al. (2019) reviewed literature on sharing economy in transport, and identified online platforms supporting increased vehicle utilization and better use of existing capacity as main activities. The impact of freight trips from the sharing economy was not included. Research on crowdshipping, being a freight-sector sharing activity, includes consumer preferences, but these are related to the adaption or supply of the service (Punel and Stathopoulos, 2017; Buldeo Rai et al., 2021; Punel et al., 2018; Gatta et al., 2019; Serafini et al., 2018), not as a solution to reduce freight trips from the sharing economy itself. Hence, an extension beyond the sharing economy was needed to identify consumer preferences for environmentally sustainable last mile deliveries.

Schniederjans and Starkey (2014) investigated intention to buy and willingness to pay (WTP) for a green transportation t-shirt and concluded that a positive attitude towards green freight transport and peer pressure influence purchase intention. Polinori et al. (2018) analyzed students WTP for environmentally labelled last mile delivery when purchasing (also) a green t-shirt, and found that signals or opinions of external parties increased attitudes and WTP for ecofriendly labeling, and that females were more positive than males. Collins (2015) mapped customer preferences for last mile attributes when choosing between home delivery or pick-up point, and the environmental impact through choice of transport to and from the pick-up points. He found that price, quality, location of pick-up points and other delivery alternatives influenced choices and environmental behavior (Collins, 2015). de Oliveira et al. (2017) investigated the potential demand for home delivery and the more environmentally sustainable automated delivery stations (ADS). They found that location, delivery time, information and traceability, and cost of transport had a significant impact on utility. While home delivery was the preferred alternative for most people, ADS had a considerable potential market share if compensated through more flexible delivery time, information services or reduced costs (de Oliveira et al., 2017). Punel et al. (2018) investigated the difference between users and non-users of crowdshipping and revealed that crowdshipping was more prevalent among male, low income respondents who work full-time jobs, are less concerned with safety, trust and privacy issues, but more concerned about the environment, and thus choose crowdshipping to reduce the environmental impact of the delivery, not for monetary gains. Gatta et al. (2019) and Serafini et al. (2018) found that young people where more inclined to both adapt crowdshipping services and act as a crowdshipper and that service levels related to money, time and flexibility influence acceptance probability. Buldeo Rai et al. (2021) investigated consumer preferences towards innovative last mile initiatives, like crowdshipping, and found four consumer segments differing in terms of preference and attitudes, with socio-demographic variations being of less importance. The segment that was most positive to crowdshipping included frequent online shoppers, who preferred parcels delivered at home, were drawn towards innovation and benefitting their local community or the environment, and were willing to wait to avoid additional vehicle kilometers (Buldeo Rai et al., 2021). Valeri et al. (2016) identified environmental awareness and behavior intention to be a key contributor explaining environmental policy preferences.

The role of information in altering consumer preferences for emission reduction was inspired by the work on nudging behavior by Thaler and Sunstein (2009) and is supported in the literature. Godelnik (2017) identified that participants pre-project thought little about their consumption behavior, but post-project had increased their awareness. Polinori et al. (2018) found that information influenced student's WTP for green urban freight transport and should be widely available at low cost. Agatz et al. (2020) found that use of green labels denoting more environmentally sustainable delivery alternatives is an effective tool for steering behavior, with the effect being larger for eco-conscious consumers.

To sum up, positive attitudes towards green consumption or environmentally sustainable behavior influence both participation in the sharing economy and the demand for sustainable last mile delivery. Enjoyment of the activity also motivates sharing, while information or peer pressure motivate environmentally sustainable behavior. Research on demographic factors is inconclusive, but age, income, education, and gender might be relevant.

Table 1
Characteristics of the experimental design: attribute description and levels.

Attribute	Description and levels
1. Delivery time	Number of days the respondent accepts to wait for the parcel:1–5-10–20 days
2. Delays (dummy)	Uncertainty with respect to delivery time:"No", "Yes, 1–2 days"
3. Information (dummy)	Notifications by SMS or e-mail when 1) the good is controlled and approved for shipping and 2) the parcel is shipped to the consumer:"No", "Yes"
4. CO_2 -emission	CO_2-emission resulting from last mile delivery of the parcel. The emission levels differ with respect to transport mode, time, degree of consolidation etc.:0 kg, 0.28 kg, 1.40 kg
5. Particulate matter (PM)	PM resulting from last mile delivery of the parcel. Differs with respect to transport mode, time, degree of consolidation etc.:"Low", "Medium", "High"

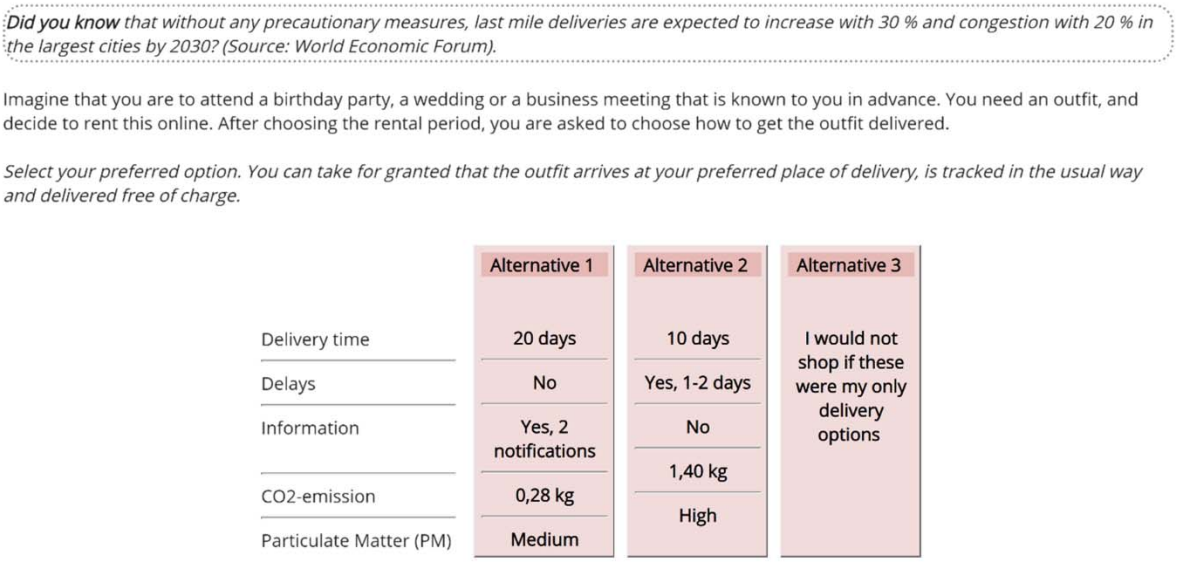

Fig. 1. Example of choice set asked in the survey. Supplementary information in dotted box on top.

3. Survey and data collection

The data was collected through a survey composed of four parts: i) preliminary questions about habits and preferences for online shopping in general and clothing rentals in particular, ii) assertions related to clothing rentals and environment aiming to reveal attitudes, including some repeated questions to test consistency (as suggested by Mathews et al. (2007)), iii) stated choice scenarios (presented in detail in Section 3.1) followed by debriefing questions to reveal untruthful responses and whether the respondents process all attributes equally, or some more than others (inspired by Hensher (2007)), and iv) socio-economic data including age, educational level, occupation, own and household income, and household members. Additionally, supplementary information regarding environmental aspects of the textile industry and last mile deliveries were randomly assigned to half of the respondents (described below).

3.1. Discrete choice experiments

The aim of the survey was to capture consumer preferences for last mile delivery services attributes (including non-market goods like time and emission), for which stated choice methods (SC) with discrete choice experiments (DCE) (as opposed to contingent valuation (CV)) are recommended (Johnston et al., 2017). To capture as realistic experiments as possible, attributes and attribute levels were inspired by consumer surveys from Postnord (2020) and Bring Research (2019), World Economic Forum (2020), as well as existing knowledge of the research team. FJONG, a Norwegian online platform for clothing rental, provided valuable insights and comments to the development of the survey. The resulting design included 5 attributes with 2–4 levels each, as shown in Table 1. The 5 attributes and the implication of their levels were presented in text to the respondents prior to the DCE.

Table 1 shows that delivery time varies between 1 and 20 days. The latter might be unrealistic, potentially violating the assumption about realistic experiments. On the other hand, the probability that consumers consider all attributes increases and more information is obtained when attribute levels widen (Hensher, 2007; Johnson et al., 2007). The 20 days delivery time was included to investigate maximum wait time for consumers. The levels of CO_2-emission are calculated based on average last mile delivery distance (from Statistics Norway) and emission levels (using the Handbook Emission Factors for Road Transport (HBEFA)) for light duty vehicles. The

Table 2
Descriptive statistics for demographic and attitudinal variables for the sample, and corresponding demographics for Norwegian female population 18–70 years old (from Statistics Norway). All variables are binary, taking on the values 1 = "Yes" or 0 = "No". The values presented are the share of "ones" in the sample.

	Sample (N = 513)	**Female population**
Average age and generation [a)]		
Average age (18–70 years); in years	41.9	43.7
1997–2001 (Generation Z)	9%	9%[b)]
1981–1996 (Millennials)	38%	33%
1965–1980 (Generation X)	33%	32%
1949–1964 (Boomers)	20%	25%
Top25pop		
Lived in one of the 25 most populated Norwegian municipalities.	59%	53%[b)]
Education		
Primary school	3%	25%[c)]
High school	34%	36%
College or university	63%	39%
Employment status		
Employed	65%	65%[d)]
Unemployed	4%	3%
Not in work force (incl. students)	27%	32%
Other	4%	
Annual gross personal income in NOK (2019)		
Average income (based on middle value of intervals)	483,000	382,000[e)]
Less than 600,000 NOK	60%	
More than 600,000 NOK	20%	
NA	20%	
Frequent online shopper		
Shopped online at least once a month	33%	
Purchase planning		
Agree that they like to plan their purchases	78%	
Fashion interest		
Agree that they are interested in fashion	40%	
Clothing rentals		
Agree that clothing rentals provide a fashionable wardrobe as well as being more environmentally sustainable than new clothing purchases	45%	
Society should change		
Totally agree that society should pay more attention to the environmental challenges than we do today	52%	
Consumers should change		
Totally agree that consumers must change attitude and behavior to solve the environmental challenges of today	53%	
Information		
Received supplementary information of environmental aspects of clothing purchase and rentals	47%	

Notes: [a)] As defined by Pew Research, [b)] Females 18–70 years, [c)] Females 16 years or older, [d)] Females 15 years or older, [e)] Average annual gross income for females 17 years and older in 2018 (2019 numbers are postponed until January 2021). The average income of employed females only was 506,000 NOK in 2018 (Statistics Norway, Table 12851).

levels for PM are qualitative, which should be avoided in stated preference surveys (Johnston et al., 2017, 2012). However, as PM is an unfamiliar concept for many, the use of qualitative terms was found to be the best way of presenting the levels of this attribute. Price is not included as an attribute in the DCE. Free delivery is a "must-have" to attract customers for many online retailers (Allen et al., 2018), and as many as 31% of Norwegian female customers (and 21% of males) expect free delivery (Bring Research, 2019). Excluding price enables an assessment of how other measures (than price) can incentivize consumers to choose environmentally sustainable deliveries.

To reduce the complexity of the survey, 3 unlabeled alternatives were used. Two alternatives differed in terms of the attributes presented above, while the third was an "opt-out" alternative, to ensure realism for accepting last mile delivery and reliable tradeoffs between the attributes. Each respondent got 9 choice sets, drawn randomly from 16 blocks. The blocks were generated from a full factorial design cleaned from dominant alternatives and grouped into nine groups based on environment and service criteria. One row per group was drawn at random for each block, selecting blocks with low correlation and high balance between attributes (close to orthogonal design), while at the same time avoiding the same row appearing in multiple blocks. A choice set example is given in Fig. 1. The survey was written in QuenchTec.

The supplementary information regarding environmental aspects of the textile industry and last mile deliveries was presented in questions related to habits, attitudes and in the DCE (as shown by the dotted box at the top of Fig. 1). The aim was to test if

supplementary information could work as a nudge to influence attitudes and preferences, as suggested by previous studies presented in Section 2. About half of the respondents, drawn at random, received this supplementary information.

3.2. Survey administration

Originally, the plan was to distribute the survey among receivers of FJONG's newsletter to reach females who were familiar with clothing rentals online, either by first- or secondhand experience. But the Covid-19-pandemic led to a change in plans; a pilot-test among the newsletter receivers indicated respondent fatigue (probably) due to an increase in consumer surveys after the outbreak. To secure an adequate sample size, FJONG's newsletter receivers were abandoned and the survey firm NORSTAT[1] was contacted. The NORSTAT panel consists of 81,000 active panelists, 52% female, evenly spread out on age groups starting from 15 years. Respondents are rewarded for their participation using bonus points. When distributing the survey in question, only females between 18 and 70 years of age were targeted. Survey links were sent out continuously starting June 29th and ending August 3rd 2020. The survey resulted in 595 responses.[2] The frequency of choosing the 3 alternatives presented in the choice sets is provided in Appendix A. The frequency indicates that consumers were able to make tradeoffs between the alternatives, as respondents chose the opt out alternative in only 22% of the choices (i.e. Alternative 3 in Fig. 1).

Prior to distribution both qualitative (general feedback and one-on-one interviews with representatives from both experts and user group) and quantitative (using data from the first 120 responses from the online response panel) pretesting were conducted as recommended (Mansfield and Pattanayak, 2007; Champ and Welsh, 2007; Krupnick and Adamowicz, 2007; Harrison, 2007; Mathews et al., 2007; Johnston et al., 2017). Focus group interviews were not an option due to Covid-19 socializing restrictions. The qualitative pre-testing helped design the attribute levels in the DCE: attribute levels for delays and information services where specified from "Yes" to number of days and notifications respectively. It also revealed that information about attributes and attribute levels prior to the DCE was needed but should be kept short and fine-tuned to increase its probability of being read and understood in full. The first 120 respondents from the online response panel were treated as a pilot and used to verify the survey's functionality and that the DCE design fostered a tradeoff between attributes. This was done prior to full-scale data collection.

3.3. Sample description and summary statistics

After screening for respondents choosing the same alternative in all choice sets, inconsistencies in debriefing questions (i.e. those who after the DCE reported to have answered it both honest and at random), very quick respondents (i.e. speeders) or very slow respondents,[3] 82 respondents were removed from the sample. Hence, the dataset for analysis includes 513 observations. Summary statistics are presented in Table 2. Statistics are presented for the whole sample and the female Norwegian population. The summary statistics for the Norwegian population differs somewhat in terms of the age group included. This is highlighted in the table using notes. Attitude variables are collected asking respondents to disagree with or agree to statements, using a 5-point Likert scale ranging from "totally disagree" to "totally agree". For statements relating to *purchase planning*, *fashion interest* and *clothing rentals* the responses were converted to dummy (binary) variables by merging the "totally agree" and "somewhat agree" responses into the dummy variable "agree" option versus the rest. For the statements relating to change, *Society should change* and *Consumers should change*, a dummy variable was constructed to separate those who "totally agree" from those who don't totally agree to rule out any uncertainty with respect to respondents' willingness to change behavior. A variable (*Top25pop*) denoting whether the respondents live in one of the 25 (out of 356) most populated Norwegian municipalities (ranging from Oslo with 681,000 residents to Lørenskog with 41,000 residents (Statistics Norway, 2018)) was included to capture those who are likely to have attractive shopping opportunities in their proximity and live in municipalities where local air pollution might be an issue. Income was split at 600,000 NOK[4] to capture potential impacts of high income.[5]

The sample seems to resemble the population with respect to demographics, but are more educated than the population as a whole, reflecting also the composition of the NORSTAT internet panel. Approximately 33% of the sample shop online at least once a month. This share is larger than the 12% found by Bjerkan et al. (2020) and lower than the 69% found by Postnord (2020), both surveying online shopping behavior among male and female Norwegian adult respondents. Respondents who are familiar with FJONG (clothing rentals) shows that the latter consists of younger, more urban, more highly educated, and more experienced shoppers with fashion interest and positive attitudes to clothing rentals. Based on information provided by FJONG themselves, their active customers are even younger, more urban, have a higher income and higher participation in the work force.

Fig. 2 presents how some of the expected key attributes, familiarity with FJONG and their concept of clothing rentals, positive

[1] https://norstat.no/

[2] The sample was part of a survey collecting data for two DCEs with respondents being randomly allocated to one of the two DCEs. In total, 4602 links were distributed with a response of 1200 (response rate = 26%), of which 605 respondents answered the other DCE and is not included in this paper. The average time used to complete the survey for all 1200 respondents was 11.5 min.

[3] Inspired by Hensher (2007), Mathews et al. (2007), and as done in an example by Alberini et al (2007, p.214).

[4] The average exchange rate between Euro (€) and NOK (Kr.) at the time of survey (July 2020) was 1€=10.65Kr./1Kr=0.094€ (Norges Bank - Central bank of Norway).

[5] In 2018, only 15% of Norwegian females had an average annual gross personal income of 600,000 NOK or more (Statistics Norway, Table 08411).

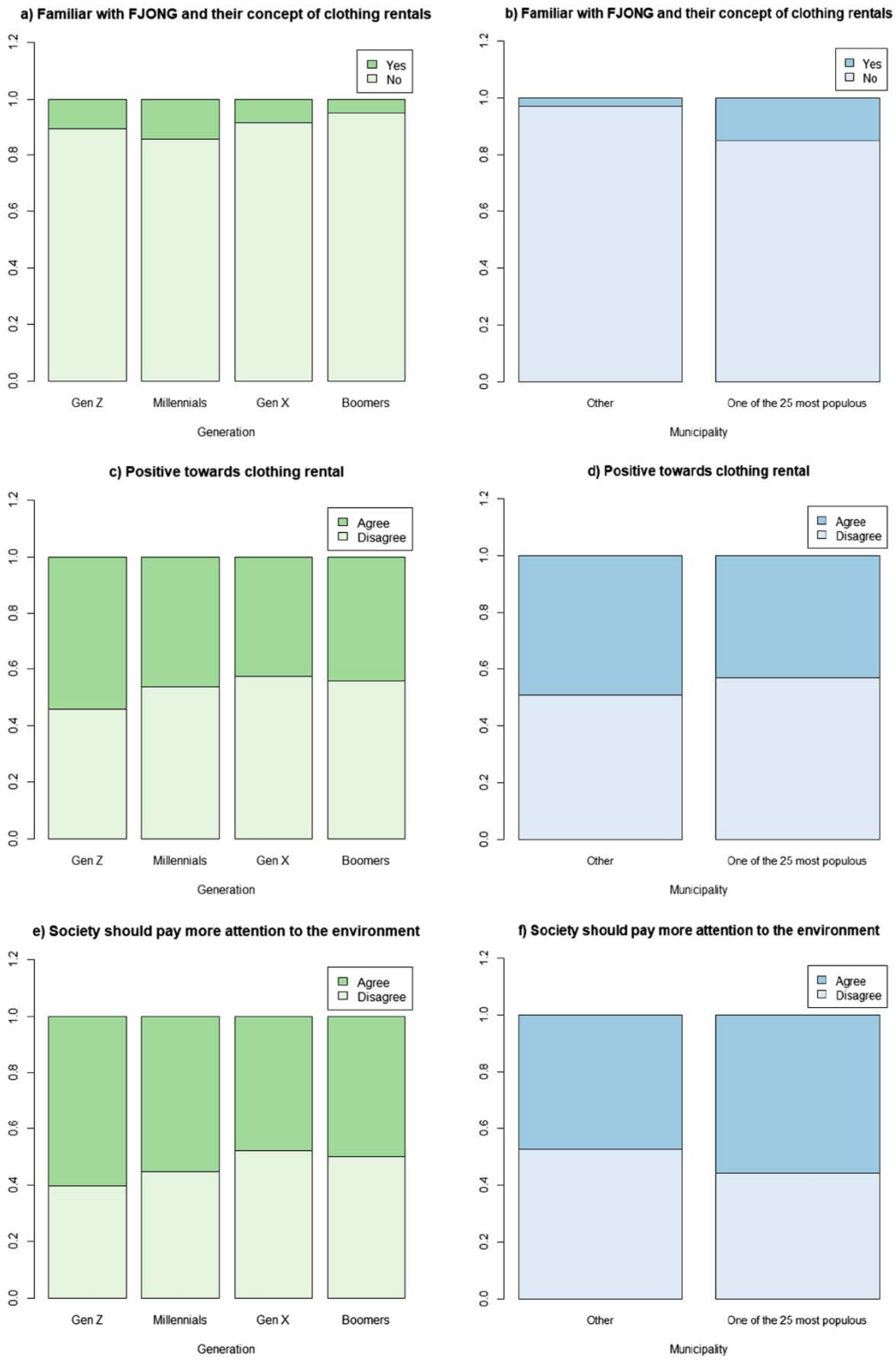

Fig. 2. a)-f): visualizations of how knowledge about clothing rentals and attitudes differ with generation and location.

attitude towards clothing rentals, and environmental concerns, vary with generation and location. In general, young adults and those living in one of the most populous municipalities in Norway are most familiar with FJONG and agree that society should pay more attention to the environment. The share with a positive attitude towards clothing rentals is somewhat lower for people living in the 25 most populous municipalities than for those who do not. Overall, the results are according to expectations, showing that the sharing economy is most popular among the younger generations.

4. Modelling specifications: Revealing consumer preferences

Several methods to reveal consumer preferences are available, each with their strengths and weaknesses. Here, a stated preference approach using a DCE was chosen to capture consumer preferences for last mile delivery attributes, and a discrete choice modeling framework was chosen for estimation. The simple Multinomial Logit Model (MNL) provides a good starting point and a useful benchmark for comparison with more complex models (Marcucci and Gatta, 2012; Valeri et al., 2016; Punel and Stathopoulos, 2017; Swait, 2007). The latent class (LC) model allows for a further exploration of individual heterogeneity by classifying respondents into different classes (groups) using probability (which are based on their characteristics). MNL in combination with LC is used on several occasions, i.e. to model socioeconomic and attitudinal influence on preferences for environmental policy drivers (Valeri et al., 2016) or consumer preferences for last mile deliveries of e-groceries (Gatta et al., 2020).

Assuming that utility consists of a deterministic (observable and estimable) part, $V(X,\beta)$, given by a set of observable variables, X, and their corresponding parameters, β, and a stochastic (unobservable) part, ε, assumed independent and identically (IID) distributed following a standard type I extreme (Gumbel) distribution, the probability of individual n choosing alternative i in choice task t is in the MNL model expressed as $P_{i,t,n} = \frac{e^{\left(\mu V_{i,t,n}\right)}}{\sum_{j=1}^{J} e^{\left(\mu V_{j,t,n}\right)}}$, and in the LC model conditional on class membership (s) as $P_{i,t,n} = \sum_{s=1}^{S} W_{ns} \cdot P_{i,t,n|s} = \sum_{s=1}^{S} W_{ns} \cdot \frac{e^{\left(V_{i,t,n|s}\right)}}{\sum_{j=1}^{J} e^{\left(V_{j,t,n|s}\right)}}$(following the notations by Alberini et al. (2007), Swait (2007), as well as Sarrias and Daziano (2017) for consistency with the gmnl R-package used for estimation). Given the right model choice and realistic parameter values, the estimates from the LC model are known to be asymptotically consistent, unbiased and efficient, and no longer rely on the independence of irrelevant alternatives (IIA) (Swait, 2007). Global optimum for LC is found by running several model versions differing in number of underlying classes. Nested models are compared using the likelihood-ratio (LR) test.

5. Estimation results: Consumer preferences for environmentally sustainable last mile deliveries

Two separate models are estimated to understand consumer preferences for environmentally sustainable last mile deliveries: multinomial logit (MNL) and the latent (LC) class models (see Section 4). Both models are estimated in R (R CORE TEAM, 2020) using the package gmnl (Sarrias and Daziano, 2017; Sarrias, 2017). Standard errors are estimated using the sandwich estimator (White's robust alternative). In both models, ten variables are used to control for heterogeneity based on the literature review in Section 2. The Pearson correlation between them is investigated, revealing acceptable low levels of correlations (see Appendix B).

5.1. Benchmark models

The MNL model is estimated 21 times; for the full sample and 20 different subsamples, two for each of ten explanatory variables. The only variables in the models are the five attributes from the DCE: delivery time, delays, information service, CO_2 and PM. The idea is to investigate if different groups value attributes differently. This approach also reveals any inconsistencies in the subsamples, for instance due to lack of interest in the topic (e.g. in terms of little e-commerce experience, negative to clothing rentals etc.). The delivery time and PM attributes are found to be non-linear and estimated by piecewise linear approximation. This entails the estimation of different values for different ranges of the selected attribute while maintaining the linear utility function. The base categories are delivery time of 20 days and Low PM. As the models are estimated on different subsamples, the model fit is not comparable across models. The most interesting results are presented in Table 3 and discussed below.

The estimation of the full sample provides results according to expectations: utility increases with reduced delivery time and information services and decreases with delays and emission levels. All variables are statistically significant, although the goodness of fit (measured using McFadden pseudo R^2) is low. A higher goodness of fit is achieved for the models estimated on different subsamples, which indicates heterogeneity in the full sample that is not encountered for by the MNL model.

Looking at different subsamples, the overall highest utility gain of reducing delivery time from 20 days to all other alternatives are found for young adults (Gen Z or Millennials). Frequent online shoppers, respondents with an interest in fashion and those who don't plant their purchases also reveal a high utility of reduced delivery time and thus time sensitiveness. The lowest time sensitivity is found for Generation X or Boomers and for respondents who received supplementary information (nudge). Those receiving supplementary information have the lowest disutility of 1–2 days of delay compared to no delay, suggesting that respondents can be nudged towards more time-flexible deliveries.

Increased emission reduces consumer utility in all subsamples indicating that emission reduction is preferred. However, the utility gain of reduced delivery time from 20 days to all other alternatives exceed the utility reduction from an extra kg of CO_2 in all subsamples. Tradeoffs between CO_2-emissions and delivery time shows that respondents who totally agree that consumers or the society should change attitude and behavior to solve the environmental challenges of today are willing to pay the least CO_2-emissions to

Table 3
Parameter estimates and standard errors (in parenthesis) from estimation of MNL-models on different subsamples. Delivery time: Twenty days and PM Low are base categories for their respective variables.

	FullSample	Live in top 25 pop. municipality	Gen Z orMillennials	Gen X orBoomers	Incomegreater than 600 000 NOK	Supplementary information (nudge)	Frequent online shoppers	Society should change	Consumers shouldchange	Do not like purchase planning	Have a fashion interest
Delivery time:	1.843***	2.014***	2.415***	1.410***	1.792***	1.586***	2.222***	1.787***	1.713***	2.128***	2.160***
One day	(0.069)	(0.093)	(0.109)	(0.092)	(0.159)	(0.102)	(0.127)	(0.096)	(0.095)	(0.152)	(0.114)
Delivery time:	1.729***	1.794***	2.134***	1.425***	1.872***	1.588***	2.043***	1.688***	1.680***	1.980***	1.910***
Five days	(0.065)	(0.085)	(0.100)	(0.086)	(0.150)	(0.091)	(0.118)	(0.091)	(0.090)	(0.144)	(0.105)
Delivery time:	1.050***	1.114***	1.334***	0.846***	1.024***	1.069***	1.007***	1.136***	1.100***	1.193***	1.186***
Ten days	(0.061)	(0.080)	(0.092)	(0.082)	(0.136)	(0.091)	(0.110)	(0.085)	(0.084)	(0.133)	(0.099)
Delays	−0.123**	−0.114*	−0.167**	−0.091	−0.208*	−0.038	−0.191**	−0.104	−0.160**	−0.021	−0.162*
	(0.040)	(0.053)	(0.060)	(0.055)	(0.092)	(0.059)	(0.071)	(0.056)	(0.056)	(0.084)	(0.064)
Information	0.218***	0.232***	0.246***	0.208***	0.238**	0.218***	0.201**	0.343***	0.320***	0.131	0.252***
services	(0.037)	(0.048)	(0.055)	(0.050)	(0.083)	(0.051)	(0.065)	(0.051)	(0.050)	(0.078)	(0.059)
CO_2	−0.631***	−0.642***	−0.653***	−0.624***	−0.700***	−0.636***	−0.681***	−0.815***	−0.736***	−0.545***	−0.655***
	(0.037)	(0.048)	(0.055)	(0.051)	(0.085)	(0.059)	(0.066)	(0.054)	(0.053)	(0.077)	(0.059)
PM Medium	−0.338***	−0.329***	−0.283***	−0.395***	−0.395***	−0.306***	−0.454***	−0.326***	−0.345***	−0.304**	−0.325***
	(0.050)	(0.066)	(0.076)	(0.068)	(0.114)	(0.072)	(0.091)	(0.070)	(0.068)	(0.107)	(0.080)
PM High	−1.068***	−1.185***	−1.063***	−1.096***	−1.217***	−1.033***	−1.072***	−1.116***	−1.160***	−1.249***	−1.177***
	(0.057)	(0.076)	(0.085)	(0.077)	(0.129)	(0.084)	(0.100)	(0.080)	(0.080)	(0.127)	(0.092)
Log-likelihood	−4316.17	−2487.627	−1849.56	−2399.866	−861.238	−2107.495	−1377.762	−2240.109	−2304.100	−903.180	−1658.117
N	4617	2727	2178	2439	918	2187	1539	2412	2448	1017	1854
McFadden pseudo R^2	0.123	0.571	0.494	0.629	0.623	0.824	0.719	0.544	0.531	0.815	0.662

Table 4
Coefficients from estimation of latent class model with 4 classes (standard errors in parenthesis). Delivery time: Twenty days and PM Low are base categories for their respective variables.

	Class 1	Class 2	Class 3	Class 4
Group membership				
Intercept		−0.720***	0.295*	−0.879***
		(0.183)	(0.124)	(0.170)
Gen Z or Millennials		0.074	−0.073	0.292**
		(0.117)	(0.085)	(0.104)
Top 25 populated municipalities		0.032	0.012	0.341**
		(0.112)	(0.085)	(0.108)
Income over 600,000 NOK		0.438**	0.030	0.271
		(0.141)	(0.109)	(0.145)
Supplementary information		0.047	0.169*	0.078
		(0.114)	(0.083)	(0.104)
Frequent online shopper		0.356**	−0.122	0.057
		(0.116)	(0.093)	(0.110)
Clothing rentals		−0.299**	−0.004	0.512***
		(0.115)	(0.086)	(0.105)
Consumers should change		0.927***	0.515***	0.260
		(0.141)	(0.106)	(0.140)
Society should change		−0.353**	−0.654***	−0.767***
		(0.136)	(0.106)	(0.131)
Purchase planning		−0.305*	−0.481***	0.063
		(0.135)	(0.101)	(0.134)
Fashion interest		−0.293*	0.042	−0.194
		(0.122)	(0.089)	(0.107)
Group shares	31%	15%	41%	13%
Last mile delivery attributes				
Delivery time:	1.607***	1.310***	5.755***	1.066***
One day	(0.154)	(0.349)	(0.466)	(0.221)
Delivery time:	1.126***	2.177***	4.583***	1.775***
Five days	(0.144)	(0.305)	(0.348)	(0.198)
Delivery time:	0.418**	1.678***	2.633***	1.553***
Ten days	(0.135)	(0.254)	(0.229)	(0.165)
Delays	−0.515***	0.049	−0.315*	0.107
	(0.100)	(0.171)	(0.129)	(0.112)
Information services	−0.026	1.211***	−0.140	0.665***
	(0.091)	(0.255)	(0.116)	(0.117)
CO_2	−1.022***	−2.109***	−0.836***	0.122
	(0.101)	(0.451)	(0.142)	(0.150)
PM Medium	−1.111***	0.482	−0.588**	0.096
	(0.116)	(0.262)	(0.186)	(0.137)
PM High	−2.086***	−0.737**	−1.237***	−0.917***
	(0.157)	(0.271)	(0.187)	(0.191)
Log-likelihood	−3679.68			
AIC	7489.36			
BIC	7907.80			
McFadden pseudo R^2	0.232			
N	4617			

Significance: *** = $p < 0.001$; ** = $p < 0.01$; * = $p < 0.05$

reduce delivery time followed by the subsample of Generation X and Boomers. The subsamples that are willing to emit the most CO_2 to reduce delivery time are respondents who do not totally agree that society should pay more attention to the environmental challenges than we do today, respondents who do not like purchase planning and respondents belonging to Generation Z or Millennials. The tradeoffs are influenced both by a high disutility of emission as well as consumers' level of time sensitiveness. The strongest disutility of moving from low to medium or high PM-levels are found in the subsamples for respondents who do not like to plan their purchase, respondent with an income above 600,000 NOK and respondents who live in one of the top 25 populated municipalities. Interestingly, for all subgroups a 1 kg increase in CO_2-emissions reduces utility more than a change from low to medium PM-levels but less than a change from low to high PM-levels.

Debriefing questions inquiring about the importance of the different attributes revealed a somewhat even distribution across the attributes, although delivery time was voted the most important attribute and PM the least (see Appendix D). The Pearson correlation showed, as expected, a positive correlation between the importance of delivery time and delays (0.43), delays and information services (0.40), and CO_2-emission and particulate matter (0.84), confirming the findings from model estimation.

Table 5
Consumer type, preferences and acceptance of increased delivery time when little information on consumer segment is available or individual consumers can be targeted directly.

Consumer type	Preferences	Measures
Essentially younger than 40 years	Time sensitive, prefer both quick delivery, avoidance of delay and information about the shipment	Unlikely to accept increased delivery time to reduce emissions. Zero-emission vehicles (electric vans, bicycles, drones/droids) with little change in the delivery solution might be an option.
Essentially older than 40 years	Time is of less importance, although utility increases with reduced delivery time	This is probably the least time sensitive group of consumers who are likely to accept increased delivery time to reduce emissions.
Has income above average	Time is of average importance, with 5 days' delivery being preferred to one day. Emission, particularly PM, should be highlighted.	Likely to accept increased delivery time to reduce emissions. Potential measures might be consolidation or crowdshipping, which might take more time but have the potential to reduce emissions from last mile transport.
Shop at least once a month	Consumers are both time sensitive and negative to emissions	Less likely to accept increased delivery time to reduce emissions. Investments in technology that increases efficiency and reduced emissions might pay off if consumers return to website.
Consumers believe in change for the environment	Less time sensitive, accept longer delivery time for reduced emissions. Prefer information services	Very likely to accept increased delivery time if the environmental aspect is highlighted. Expected to be flexible towards the delivery solutions: zero-emission vehicles like bicycles, crowdshipping, pick-up points etc.

5.2. Heterogenous preference

The latent class (LC) model is estimated using the same attributes and explanatory variables as the MNL models. A model with 4 classes was chosen based on test criteria and an assessment of the plausibility of the results (see Appendix C). The results are shown in Table 4. The top part explains group membership, while the lower part shows their preferences for last mile delivery attributes. The LC model can be compared with the full sample model in Table 3. A likelihood ratio-test reveals that the LC model is preferred over the MNL model ($\lambda_{LR} = 1272.98$), advocating the inclusion of observed and unobserved heterogeneity across groups. In general, the estimation results show that attitudes (*clothing rentals*, *consumer should change* for the environment, *society should change* for the environment, and interest in *purchase planning*) are important and reveal more about the different classes than demographic variables. This is consistent with the literature review presented in Section 2.

The four classes are found to differ. Class 1 (31% of the sample) consists of individuals that do not stand out with respect to demographics or online shopping habits. Instead, they tend to totally agree that society, not consumers, should pay more attention to the environmental challenges. They also seem to plan their purchases more than class 2 and 3. Looking at the last mile delivery service attributes, this class prefers shorter delivery time to longer (although the difference in parameter estimates for five- and one-day delivery time is significant only at the 10% level ($\alpha = 0.087$)), and has a negative utility of delays. This group has the overall largest disutility of increased PM-levels and are, together with class 2, willing to trade off the least CO_2 for reduced delivery time. Thus, this class of consumers requests both a high level of delivery services and environmentally sustainable solutions.

Class 2 (15% of the sample) consists of respondents with higher income and more frequent online shoppers than the other three groups. They are negative to clothing rentals and strongly believe in change for the environment, with consumers being the most important agent. They do not plan their purchases and are not fashion-interested. These respondents prefer five days' delivery time to one day; and insignificant parameter difference between ten and five days and ten and one day indicates indifference of delivery time at or below 10 days. This curious result might indicate that some consumers have lower time sensitivity of online shopping than what is communicated by online retailers and transport operators, of which 1-day delivery time is unnecessary. This group wants information services and has a strong disutility of CO_2-emission. PM is less important.

Class 3 (41% of the sample) is the largest class and resembles class 1 in terms of consumer characteristics, with the exception that respondents tend to agree that consumers should change for the environment rather than society, does not plan their purchases and received supplementary information in the survey. This group is time sensitive and thus willing to emit relatively large amounts of CO_2 to reduce delivery time compared to the other groups (although having a significant disutility of CO_2). The difference in parameter size for PM Medium and PM High is significant only at $\alpha = 0.081$. The lack of purchase planning might explain the time sensitivity, and supplementary information might have influenced the importance of emission reduction.

The last class, class 4 (13% of the sample), is the smallest class including younger and more urban respondents who are positive to clothing rentals but not to change for the environment. Five-day delivery time provides the highest utility of delivery time, although the difference between ten and five days is insignificant (the difference between ten and one day is significant at $\alpha = 0.085$). As for class 2, the importance of rapid deliveries is questioned. This group prefers information services to no information services, does not care about CO_2-emission or medium PM-levels, which are both insignificant, but has a negative disutility of high PM-levels compared to low. Overall there seems to be a lack of clear preferences in this class which might indicate that the respondents care less about last mile delivery attributes than what was found in the other classes.

Table 6
Consumer type, preferences and potential measures when more information on consumer segment is available, or group characteristics are of interest.

Consumer type	Preference	Measure?
The average consumer (72% of the sample)	Prefer both reduced delivery time and low emission levels …	
Believe society, not consumers, should act on behalf of the environment (31%)	… with little room for change from the consumer	Are willing to emit only 1.6 kg CO_2 to reduce delivery time from 20 days to 1 day and a have large disutility of moving from low to high PM-levels (-2.086). Zero-emission technology (electric vans, bikes) might provide both rapid delivery and reduced emissions.
Believe consumers should change for the environment, do not plan purchases (41%)	… with potential to be inspired or engaged in more environmentally sustainable behavior	This group is willing to emit as much as 6.9 kg CO_2 to reduce delivery time from 20 days to 1 day but have a medium-large disutility of moving from low to high PM-levels (-1.237). Emission mitigating measures may require consumer participation as long as it does not imply large increases in time use, like crowdshipping or use of pick-up points.
High income, frequent online shoppers who believe consumers must bear the largest burden of changing for the environment. Less interested in fashion, clothing rentals or planning (15%)	Prefer 5 or even 10 days delivery time to 1 day, have a negative utility of emissions of both CO_2 and PM	Consumers are willing to emit only 0.6 kg CO_2 to reduce delivery time from 20 days to 1 day, buts the disutility of moving from low to high PM-levels is low (-0.737). This group is expected to choose the more environmentally sustainable service if the reduced emissions (in CO_2) and expected day of arrival are clearly communicated. Expected to be flexible in terms of measures.
Young, urban, positive to clothing rentals (13%)	Seem to care less about the last mile delivery solutions than the other groups, accept longer delivery time if information service is provided. Emissions are of less concem.	Uncertain. CO_2-emission levels are insignificant, and the disutility of moving from low to high PM-levels is moderate (-0.917). Potential indifference with respect to delivery alternatives can be tested.

Supplementary information regarding environmental aspects of the textile industry and last mile deliveries was included in the survey to nudge attitudes and preferences. However, it was found to have an influence in one of four classes (class 3) only. Thus, to investigate the importance of the supplementary information, the LC model was estimated again without this variable. A likelihood-ratio test showed that this restricted model (without supplementary information) could not be rejected in favor of the full model ($\lambda_{LR} = 0.478$). This indicates that the supplementary information included in the survey failed in influencing (nudge) preferences. When using nudging, it is important to properly design it to foster the expected behavior change (Marcucci et al., 2018). The information provided in our survey might not have been sufficiently tailored or strong enough to succeeded in altering consumers environmental consciousness. Further research on the role of information as nudge should investigate the design of such information, who it might alter and how.

Although the modelling efforts clearly show that there is unobserved heterogeneity in the data, the McFadden pseudo R^2 is small. This might be explained by behavioral intentions. One of the main findings from Hamari et al. (2016) is the discrepancy between reported attitude and actual behavior indicating that consumers tend to overreport their interest in sharing economy and environment. Godelnik (2017) discloses that students are claiming that environmental motivation is more important than social motivation, but their behavior reveals the opposite. One reason might be that consumers are not ready to prioritize the environment over their personal wellbeing and pleasure, and that society is still encouraging non-sustainable lifestyles (ElHaffar et al., 2020). Although efforts have been made in this work to reveal unmotivated consumers and non-rational answers in the DCE, specific questions about behavior intention could have increased the models' explanatory power. Price is also excluded from the DCE and thus the modelling effort, which might contribute to the small McFadden pseudo R^2.

6. Discussion

Based on the estimation results above, what can be said about *consumers' concern with airborne emissions from last mile delivery, increased delivery time as an emission mitigating tool, and the role of supplementary information in explaining preferences*, as asked in the research question? Such knowledge might allow online retailers and transport operators to design last mile delivery alternatives that best fit their customers, thus achieving environmentally sustainable deliveries at low cost.

When little consumer information is available the MNL might provide enough information about last mile delivery preferences although not capturing unobserved heterogeneity in the deterministic part of the utility function. Some examples are highlighted in Table 5 together with an assessment of potential measures to reduce emissions from last mile deliveries.

The LC model provides a broader picture, considers the heterogeneity between consumer preferences and should be preferred when possible, for instance when more information is available about the consumers or when group characteristics are of interest. The main findings and their implications are presented in Table 6, along with the tradeoff between reducing delivery time from 20 days to 1 day and CO_2-emission.

The overall result is that (some) consumers are likely to accept increased delivery time if compensated in terms of reduced airborne emissions from transport. The most likely acceptance range lies between 5 and 10 days with compensation levels and measures depending on consumer group. Although no one seemed to prefer 20 days of delivery time, it might be accepted if well compensated. Another finding is that one consumer group seems to care less about last mile delivery attributes than the others. Buldeo Rai et al. (2021) also identified a group with neutral positions towards environmental sustainability and last mile innovations. This result is interesting and might indicate that last mile delivery services are of less importance to some consumers than perceived by retailers and freight operators.

The findings above clearly show that consumers prefer reduction in airborne emissions from last mile deliveries. Thus, online retailers and freight operators should offer consumers environmentally sustainable last mile delivery solutions when they shop online. Sustainable urban freight transport should also be on the agenda for governmental authorities and public planners. Governmental authorities might suggest that emissions from last mile deliveries are communicated to online retailers and consumers, either by stating the emissions explicitly or through eco-labels or their like. The latter are found to have the potential to reduce both emissions and costs from last mile deliveries (Agatz et al., 2020), thus bringing positive effects to both consumers and freight operators. Some consumers accept longer delivery times and might even be willing to contribute through changed behavior, and as such increase freight carriers' flexibility to find low cost environmentally sustainable delivery solutions, like consolidation, use of pick-up points or crowdshipping. As both public and private parties might benefit from targeting consumers, public-private partnerships could be created, having the potential to maximize the benefits from initiatives related to a seamless mobility and goods delivery ecosystems as well as support development and testing of emerging solutions (Shaheen et al., 2020, 2019)

By tailoring solutions to different consumer preferences, more accurate measures can be provided. However, the bundle of alternatives should be carefully considered and communicated, as people tend to choose short delivery time when this is offered (Allen et al., 2018). Although not significant in the overall model, supplementary information (nudge) is significant for one of the classes, indicating that information might work as a nudge to increase environmental behavior for some consumers.

To get an idea of the transferability of the results, debriefing DCE questions included evaluation of the attributes for subscription rentals in addition to the one-time rentals presented in the DCE. The answers are presented in Appendix D, and reveal a similar distribution as for the one-time rentals, also found in Appendix D. However, delays, information services, and air emissions are rated somewhat more important for subscriptions. The extension from clothing rentals to other parts of the sharing economy is not investigated. Based on the findings by Diamantopoulos et al. (2003), an all-female sample with high education might overestimate the importance of air emissions in last mile delivery if transferred to the overall population, but the effect of demographics is inconclusive. It would be interesting to compare the results with an all-male sample or a mixed-gender sample to test potential differences.

7. Conclusion

"Anticipating new technologies is one of the critical components to improve performance and decrease negative impacts of goods deliveries" (Punel and Stathopoulos (2017) paraphrasing from Macharis and Kin (2017)). The sharing economy is one of many consequences of emerging technologies, bringing us towards new consumption and freight patterns. For the part of the sharing economy where renting of goods is the key concept, freight traffic is highly influenced as both deliveries and returns are generated. This paper has analyzed consumer preferences for environmentally sustainable last mile deliveries from online clothing rentals. A particular focus was put on increased delivery time as an emission mitigating tool. The influence of supplementary information was also investigated to see if consumers can be nudged towards desirable actions. To answer these questions, discrete choice modeling was conducted on data from a discrete choice experiment on an all-female sample in a survey inquiring about online shopping and clothing rental habits, preferences and attitudes.

The estimation results showed that respondents have a negative utility of delivery time, delays, PM- and CO_2-emissions, and a positive utility from information services. Although varying in size and significance between different respondent types, some were found likely to wait 5–10 days to reduce levels of PM and CO_2. Thus, presenting consumers with environmentally sustainable delivery options might contribute to more sustainable urban freight transport. One of the respondent groups responded to supplementary information (nudge), but the variable was irrelevant in the overall model.

This paper provides new evidence on the preferences for last mile delivery attributes in the sharing economy as well as for last mile delivery attributes when free delivery is assumed. Free delivery is expected by many customers and offered by many online retailers, and is thus a relevant aspect of online shopping. Suggested future research relates to expanding the sample to cover males, other parts of the sharing economy as well as modeling efforts to understand even more of the consumer preferences.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

Frequency of choices from the discrete choice experiment. Each of the 513 respondents received 9 choice sets, resulting in 4,617 observations.

The table reveals a good mix of choice alternative 1 and 2, and 22% of the choice sets resulting in choice of alternative 3 as shown in Table A1.

Table A1
Frequency of choices.

Alternative	1	2	3
Frequency	1723	1873	1021

Appendix B

The ten variables used in estimations were checked for correlation together with a variable for time use on the discrete choice experiments and propensity to swap between the answers agree-disagree-do not know on a repeated question. The last two variables were added to rule out that some consumer group answered more at random than others. The correlations are presented in Table B1. In general, there are low correlations between variables. The exception is the high, positive correlation between *society should change* and *consumers should change* for the environment, as well as the negative correlation between the aforementioned variables and *Swap*. This

Table B1
Correlation between variables explaining heterogeneity in the model, plus a variable for time use.

	Frequent online shopper	Clothing rentals	Society should change	Consumers should change	Purchase planning	Fashion interest	Top 25 pop	Gen Z or Millennials	Income over 600,000 NOK	Time use DCE	Swap
Information	−0.01	0.00	0.06	0.11	0.02	0.04	0.00	−0.04	0.04	0.08	−0.01
Frequent online shopper		−0.01	−0.08	−0.07	−0.06	0.24	0.14	0.14	0.10	0.05	0.03
Clothing rentals			0.15	0.17	0.09	0.15	−0.06	0.05	−0.02	0.00	−0.12
Society should change				0.60	0.09	0.00	0.08	0.07	0.02	−0.01	−0.30
Consumers should change					0.15	−0.04	−0.01	0.01	−0.02	−0.02	−0.23
Purchase planning						0.08	0.05	0.10	−0.11	−0.14	−0.08
Fashion interest							0.16	0.16	0.02	0.07	−0.05
Top 25 pop								0.12	−0.01	−0.09	−0.03
Gen Z or Millennials									−0.10	0.00	−0.08
Income over 600,000 NOK										0.05	−0.03
Time use DCE											0.03

correlation is not surprising and indicates that a fair share of the respondents think all should contribute (both consumers and society) to solve the environmental issues of today, and that respondents who strongly agree change is necessary for the environment are more consistent in their answers.

Appendix C

Models with 4, 5 and 8 classes (highlighted in grey in Table C1) were investigated for inclusion in the paper using test criteria based on the suggestions by Swait (2007) and Sarrias and Daziano (2017 – gmnl). All inclusion criteria balance the reduction in the log-likelihood function with the increase in the number of parameters. In addition, the models were evaluated in terms of class characteristics, class shares and plausibility of results. Compared to the model with 4 classes, both the models with 5 and 8 classes resulted in difficulties distinguishing between classes as well as some classes that made little sense. With 8 classes, three of five groups had a share below 8%. One class even had a share below 1%.

Table C1
Measures for Selecting Number of Classes in Latent Class Models, based on Swait (2007).

Number of classes	K	Estimation ended in	LogL	AIC−2 (LogL-K)	AIC3−2logL + 3 K	BIC LogL+ (K*LogN)/2	BIC(from R gmnl)	McFadden pseudo $\rho^2$1-((Log(full)-K)/LogL
2	27	Successful convergence	−3906.70	7867.41	7894.41	3956.17	8041.22	0.202
3	46	Successful convergence	−3739.85	7571.70	7617.70	3824.13	7867.83	0.232
4	65	Successful convergence	−3679.68	7489.36	7554.36	3798.77	7907.80	0.240
5	84	Successful convergence	−3636.98	7441.97	7525.97	3790.89	7982.72	0.245
6	103	Iteration limits exceeded	−3612.14	7430.28	7533.28	3800.85	8093.34	0.246
7	122	Iteration limits exceeded	−3552.46	7348.93	7470.93	3775.99	8134.30	0.254
8	141	Successful convergence	−3518.34	7318.67	7459.67	3776.67	8226.36	0.258
9	160	Nas produced						
10	179	System is computationally singular						
N	4617							

Appendix D

After the DCE, all respondents were asked to rate the importance of the presented attributes, from very unimportant to very important. The overall frequency distribution for the sample is shown in Figs. D1 (one-time rentals) and D2 (subscription). The latter includes an alternative for "don't know".

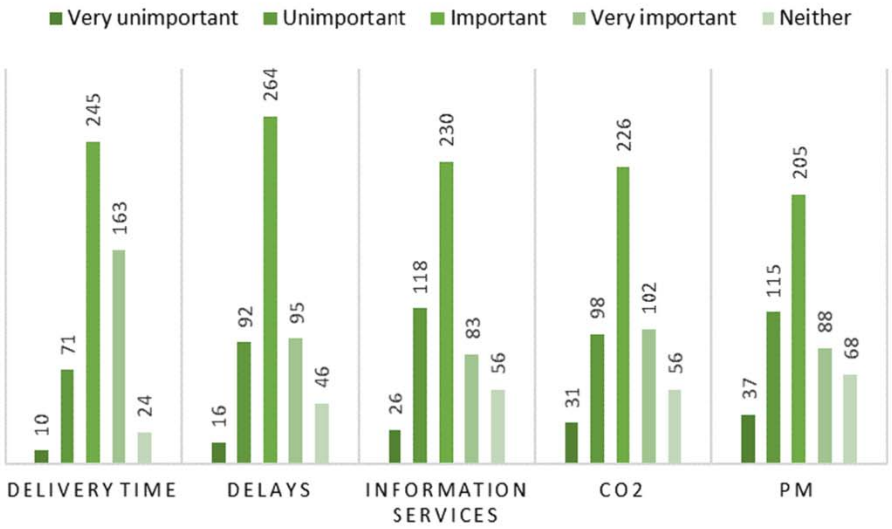

Fig. D1. Importance of attributes in debriefing question.

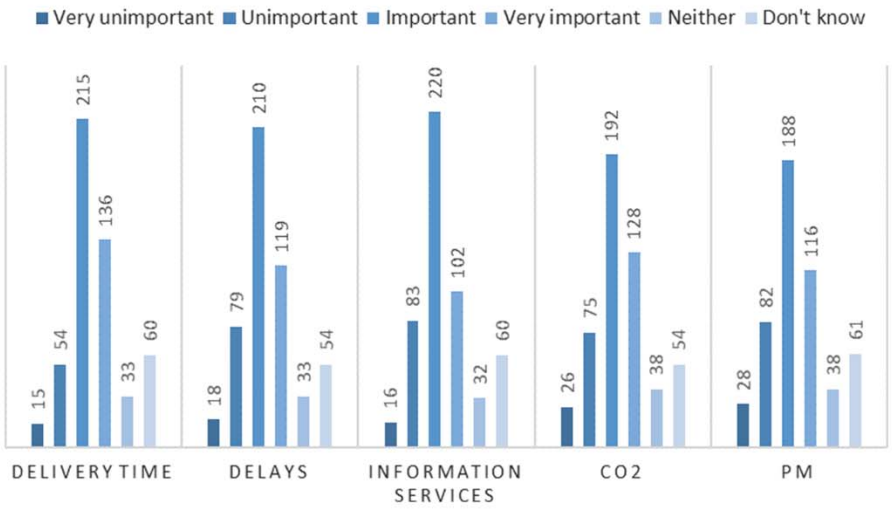

Fig. D2. Importance of attributes in debriefing question for a clothing rental subscription.

References

Agatz, N., Fan, Y., Stam, D. 2020. Going green: the effect of green labels on delivery time slot choices. Available at SSRN 3656982.

Alberini, A., Longo, A., Veronesi, M., 2007. Basic Statistical Models For Stated Choice Studies. Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Approach to Theory and Practice. Springer, Arlington, Virginia, USA.

Allen, J., Piecyk, M., Piotrowska, M., McLeod, F., Cherrett, T., Ghali, K., Nguyen, T., Bektas, T., Bates, O., Friday, A., Wise, S., Austwick, M., 2018. Understanding the impact of e-commerce on last-mile light goods vehicle activity in urban areas: The case of London. Transp. Res. Part D: Transport Environ. 61, 325–338.

Amed, I., Berg, A., Balchandani, A., Hedrich, S., Rölkens, F., Young, R., Jensen, J.E., Peng, A., 2020. The State of Fashion 2021: In search of promise in perilous times. McKinsey & Company, The Business of Fashion.

Armstrong, C.M., Niinimäki, K., Kujala, S., Karell, E., Lang, C., 2015. Sustainable product-service systems for clothing: exploring consumer perceptions of consumption alternatives in Finland. J. Cleaner Prod. 97, 30–39.

Baek, E., Oh, G.-E., 2021. Diverse values of fashion rental service and contamination concern of consumers. J. Business Res. 123, 165–175.

Belk, R., 2014. You are what you can access: Sharing and collaborative consumption online. J. Business Res. 67, 1595–1600.

Bjerkan, K.Y., Bjørgen, A., Hjelkrem, O.A., 2020. E-commerce and prevalence of last mile practices. Transp. Res. Procedia 46, 293–300.

Bjørgen, A., Bjerkan, K.Y., Hjelkrem, O.A., 2019. E-groceries: Sustainable last mile distribution in city planning. Res. Transp. Econ. 100805.

Bring Research, 2019. Slik velger kundene deg. In: Norge, P. (ed.).

Buldeo Rai, H., Verlinde, S., Macharis, C., 2019. Unlocking the failed delivery problem? Opportunities and challenges for smart locks from a consumer perspective. Res. Transp. Econ. 100753.

Buldeo Rai, H., Verlinde, S., Macharis, C., 2021. Who is interested in a crowdsourced last mile? A segmentation of attitudinal profiles. Travel Behav. Soc. 22, 22–31.

Carbone, V., Rouquet, A., Roussat, C., 2018. A typology of logistics at work in collaborative consumption. Int. J. Phys. Distrib. Log. Manage. 48, 570–585.

Cerutti, P.S., Martins, R.D., Macke, J., Sarate, J.A.R., 2019. "Green, but not as green as that": An analysis of a Brazilian bike-sharing system. J. Cleaner Prod. 217, 185–193.

Champ, P., Welsh, M., 2007. Survey Methodologies for Stated-Choice Studies. *Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Approach to Theory and Practice*. Springer, Arlington, Virgina, USA.

Choi, T.-M., He, Y., 2019. Peer-to-peer collaborative consumption for fashion products in the sharing economy: Platform operations. Transp. Res. Part E: Log. Transp. Rev. 126, 49–65.

Collins, A., 2015. Behavioural Influences on the Environmental Impact of Collection/Delivery Points. In: Fahimnia, B., Bell, M., Hensher, D. (Eds.), Green Logistics and Transportation. Springer, Cham.

Dablanc, L., Morganti, E., Arvidsson, N., Woxenius, J., Browne, M., Saidi, N., 2017. The rise of on-demand 'Instant Deliveries' in European cities. Supply Chain Forum: Int. J. 18, 203–217.

de Oliveira, L.K., Morganti, E., Dablanc, L., de Oliveira, R.L.M., 2017. Analysis of the potential demand of automated delivery stations for e-commerce deliveries in Belo Horizonte, Brazil. Res. Transp. Econ. 65, 34–43.

Diamantopoulos, A., Schlegelmilch, B.B., Sinkovics, R.R., Bohlen, G.M., 2003. Can socio-demographics still play a role in profiling green consumers? A review of the evidence and an empirical investigation. J. Business Res. 56, 465–480.

Elhaffar, G., Durif, F., Dubé, L., 2020. Towards closing the attitude-intention-behavior gap in green consumption: A narrative review of the literature and an overview of future research directions. J. Cleaner Prod. 275, 122556.

Gatta, V., Marcucci, E., Nigro, M., Serafini, S., 2019. Sustainable urban freight transport adopting public transport-based crowdshipping for B2C deliveries. Eur. Transport Res. Rev. 11, 13.

Gatta, V., Marcucci, E., Pira, M.L., Inturri, G., Ignaccolo, M., Pluchino, A., 2020. E-groceries and urban freight: Investigating purchasing habits, peer influence and behaviour change via a discrete choice/agent-based modelling approach. Transp. Res. Procedia 46, 133–140.

Godelnik, R., 2017. Millennials and the sharing economy: Lessons from a 'buy nothing new, share everything month' project. Environ. Innovat. Soc. Trans. 23, 40–52.

Hamari, J., Sjöklint, M., Ukkonen, A., 2016. The sharing economy: Why people participate in collaborative consumption. J. Assoc. Inform. Sci. Technol. 67, 2047–2059.

Harrison, G., 2007. Making Choice Studies Incentive Compatible. *Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Approach to Theory and Practice*. Springer, Arlington, Virginia, USA.

Hartl, B., Sabitzer, T., Hofmann, E., Penz, E., 2018. "Sustainability is a nice bonus" the role of sustainability in carsharing from a consumer perspective. J. Cleaner Prod. 202, 88–100.

Hawlitschek, F., Teubner, T., Gimpel, H., 2018. Consumer motives for peer-to-peer sharing. J. Cleaner Prod. 204, 144–157.

Hensher, D., 2007. Attribute Processing in Choice Experiments and Implications on Willingness to Pay. *Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Approach to Theory and Practice*. Springer, Arlington, Virginia, USA.

Heshmati, S., Verstichel, J., Esprit, E., Vanden Berghe, G., 2018. Alternative e-commerce delivery policies. EURO J. Transp Log.

Jia, F., Yin, S., Chen, L., Chen, X., 2020. The circular economy in the textile and apparel industry: A systematic literature review. J. Cleaner Prod. 259, 120728.

Johnson, F., Kanninen, B., Bingham, M., 2007. Experimental Design For Stated-Choice Studies. Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Approach to Theory and Practice. Springer, Arlington, Virginia, USA.
Johnston, R.J., Boyle, K.J., Adamowicz, W.V., Bennett, J., Brouwer, R., Cameron, T.A., Hanemann, W.M., Hanley, N., Ryan, M., Scarpa, R., Tourangeau, R., Vossler, C. A., 2017. Contemporary Guidance for Stated Preference Studies. J. Assoc. Environ. Resour. Econ. 4, 319–405.
Johnston, R.J., Schultz, E.T., Segerson, K., Besedin, E.Y., Ramachandran, M., 2012. Enhancing the Content Validity of Stated Preference Valuation: The Structure and Function of Ecological Indicators. Land Econ. 88, 102–120.
Krupnick, A., Adamowicz, W., 2007. Supporting Questions in Stated Choice Studies. *Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Approach to Theory and Practice*. Springer, Arlington, Virginia, USA.
Laitala, K., Klepp, I.G., 2020. Klær og miljø: Innkjøp, gjenbruk og vask.
Lim, S.F.W.T., Jin, X., Srai, J.S., 2018. Consumer-driven e-commerce: A literature review, design framework, and research agenda on last-mile logistics models. Int. J. Phys. Distrib. Log. Manage. 48, 308–332.
Macharis, C., Kin, B., 2017. The 4 A's of Sustainable City Distribution: Innovative Solutions and Challenges ahead. Int. J. Sustain. Transp. 11, 59–71.
Manerba, D., Mansini, R., Zanotti, R., 2018. Attended Home Delivery: reducing last-mile environmental impact by changing customer habits. IFAC-PapersOnLine 51, 55–60.
Mansfield, C., Pattanayak, S., 2007. Getting Started. In: Kanninen, B. (Ed.), Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Approach to Theory and Practice. Springer, Arlington, Virginia, USA.
Marcucci, E., Gatta, V., 2012. Dissecting preference heterogeneity in consumer stated choices. Transp. Res. Part E: Log. Transp. Rev. 48, 331–339.
Marcucci, E., Gatta, V., le Pira, M., 2018. Gamification design to foster stakeholder engagement and behavior change: An application to urban freight transport. Transp. Res. Part A: Policy Pract. 118, 119–132.
Mathews, K., Freeman, M., Desvousges, W., 2007. How and How Much? Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Approach to Theory and Practice. Springer, Arlington, Virginia, USA.
Mazareanu, E., 2019. Value of the global sharing economy 2014-2025. In: Statista (ed.). Statista https://www.statista.com/statistics/830986/value-of-the-global-sharing-economy/#statisticContainer.
Morganti, E., Seidel, S., Blanquart, C., Dablanc, L., Lenz, B., 2014. The Impact of E-commerce on Final Deliveries: Alternative Parcel Delivery Services in France and Germany. Transp. Res. Procedia 4, 178–190.
Pernot, D., 2020. Internet shopping for Everyday Consumer Goods: An examination of the purchasing and travel practices of click and pickup outlet customers. Res. Transp. Econ. 100817.
Piscicelli, L., Cooper, T., Fisher, T., 2015. The role of values in collaborative consumption: insights from a product-service system for lending and borrowing in the UK. J. Cleaner Prod. 97, 21–29.
Polinori, P., Marcucci, E., Gatta, V., Bigerna, S., Bollino, C.A., Micheli, S., 2018. Eco-labeling and sustainable urban freight transport: How much are people willing to pay for green logistics? *Rivista Internazionale di Economia dei Transporti /*. Int. J. Transport Econ. XLV, 631–658.
Postnord 2020. Netthandel i Norden - Oppsummering 2019. In: Postnord (ed.) Netthandel i Norden. PostNord.
Punel, A., Ermagun, A., Stathopoulos, A., 2018. Studying determinants of crowd-shipping use. Travel Behav. Soc. 12, 30–40.
Punel, A., Stathopoulos, A., 2017. Modeling the acceptability of crowdsourced goods deliveries: Role of context and experience effects. Transp. Res. Part E: Log. Transp. Rev. 105, 18–38.
Rinne, A., 2019. 4 big trends for the sharing economy in 2019. *World Economic Forum Digital Economy and New Value Creation*. World Economic Forum.
R CORE TEAM, 2020. R A Language and Environment for Statistical Computing and Graphics. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.
Sarrias, M., Daziano, R., 2017. Multinomial Logit Models with Continuous and Discrete Individual Heterogeneity in R: The gmnl Package. J. Stat. Softw. 72, 1–46.
Schniederjans, D.G., Starkey, C.M., 2014. Intention and willingness to pay for green freight transportation: An empirical examination. Transp. Res. Part D: Transport Environ. 31, 116–125.
Serafini, S., Nigro, M., Gatta, V., Marcucci, E., 2018. Sustainable crowdshipping using public transport: a case study evaluation in Rome. Transp. Res. Procedia 30, 101–110.
Sarrias, M., 2017. FAQ: Latent Class Multinomial Logit Model using gmnl Package [Online]. RStudio. https://rpubs.com/msarrias1986/335556 [Accessed 03.09 2020].
Shaheen, S., Cohen, A., Randolph, M., Farrar, E., Davis, R., Nichols, A., 2019. Shared Mobility Policy Playbook.
Shaheen, S.A., Cohen, A.P., Broader, J., Davis, R., Brown, L., Neelakantan, R., Gopalakrishna, D., 2020. Mobility on Demand Planning and Implementation: Current Practices, Innovations, and Emerging Mobility Futures.
Standing, C., Standing, S., Biermann, S., 2019. The implications of the sharing economy for transport. Transport Rev. 39, 226–242.
Statistics Norway, 2018. Norges 100 mest folkerike kommuner [Online]. Statistics Norway. https://www.ssb.no/befolkning/artikler-og-publikasjoner/norges-100-mest-folkerike-kommuner [Accessed 12.10 2020].
Swait, J., 2007. Advanced Choice Models. *Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Approach to Theory and Practice*. Springer, Arlington, Virginia, USA.
Thaler, R.H., Sunstein, C.R., 2009. Nudge: Improving decisions about health, wealth and happiness. Penguin Books, London.
Valeri, E., Gatta, V., Teobaldelli, D., Polidori, P., Barratt, B., Fuzzi, S., Kazepov, Y., Sergi, V., Williams, M., Maione, M., 2016. Modelling individual preferences for environmental policy drivers: Empirical evidence of Italian lifestyle changes using a latent class approach. Environ. Sci. Policy 65, 65–74.
Visser, J., Nemoto, T., Browne, M., 2014. Home Delivery and the Impacts on Urban Freight Transport: A Review. Proc. – Soc. Behav. Sci. 125, 15–27.
WILEN, A., 2019. H&M Tests Renting Clothes to Address Environment Concern. Bloomberg. Bloomberg https://www.bloomberg.com/news/articles/2019-11-29/h-m-tests-renting-clothes-as-fashion-faces-environment-concern.
World Economic Forum, 2020. The Future of the Last-Mile Ecosystem. In: Forum, W.E. (ed.) Transition Roadmaps for Public- and Private-Sector Players. www.weforum.org.