Last-mile delivery preferences:

exploring the potential of Parcel Lockers at online checkout and for failed delivery

Willem de Vette
4588681

TU Delft

Delft University of Technology

EPA Master Thesis

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Willem de Vette (4588681)
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TU Delft Delft University of Technology

Preface

This master's thesis serves as the conclusion to the master of Engineering and Policy Analysis at the University of Technology in Delft. Over the last 8 months, I have researched the topic of consumer preferences in last-mile delivery with growing interest. It has been a really helpful journey for me, both academically and personally. This has been made possible by a number of people, to whom I am very grateful.

First of all, I would like to thank my supervisor for their feedback, support and guidance in this process. Foremost, I would like to thank my first supervisor Eric Molin. I am very grateful for your supervision, and the structured way of the feedback and supervision process. This really helped me to think about the next steps of my research and to embrace the feedback. You were always available and quick to reply to any of my questions. I would also like to express my gratitude to Ron van Duin, who served as my second supervisor. Even though our contact was less frequent, it was very to nice be able to discuss the topic of last-mile delivery in more depth, especially as my interest in the topic grew over time. Both of you have been helpful, understanding, and kind in the whole process, for which I again would like to express my gratitude.

Lastly, I would like to say special thanks to my family, my friends, and my girlfriend. All of you have supported me greatly throughout what was sometimes a difficult process. To be able to discuss things, whether academic struggles or just to blow off some steam, has been really valuable. After seven years my time as a student in Delft has come to an end. The many friends I made along the way will always remind me of the nice time I spent here.

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Abstract

The growth of e-commerce has increased the demand for last-mile delivery. This increased demand poses the sector of last-mile delivery with challenges such as traffic congestion, route optimization and environmental concerns. Delivery to a Service Point or a Parcel Locker, self-collection alternatives, have to potential to address these challenges. This research employs a discrete choice experiment to gather insights into consumer preference for regular parcel delivery and to uncover previously unexplored consumer preference for alternative delivery preference in the case of delivery failure. This second aim constitutes the main addition of this study. An online survey was conducted which resulted in 210 valid responses. The results show that in the case of anticipated failed delivery, most consumers prefer delivery to their neighbours or have the parcel left at an agreed place around the house. The distance to a Service Point or Parcel Locker is the most important delivery attribute guiding this decision. However, both now and in the future, demand for the PL as an alternative delivery option in case of delivery failure seems low, with few policy options to increase this demand. Regarding parcel delivery preference at checkout, the price of Home Delivery is most dominant in the trade-off consumers make. In contrast to other studies, the opening hours or the delivery moment do not contribute significantly. To best increase the demand for self-collection alternatives, parcel delivery companies should focus on: shortening the distance to the Parcel Lockers or Service Points, locating Parcel Lockers in commercial buildings as opposed to public spaces, and increasing the awareness of Parcel Lockers and increasing the awareness of the benefits of self-collection in general. However, the results of this study indicate that in order for the PL to become dominant 'at online checkout', both a price incentive and a shortening of the distance from consumer to PL are necessary, but at significant cost. Further research should aim to investigate the demand for changing delivery options through notifications and the viability of the last-mile delivery market agreeing on lower prices for self-collection as proposed in scientific literature.

Executive summary

The e-commerce sector has witnessed remarkable growth over the past decade, with its share in total purchases tripling from 2014 to 2019. The COVID-19 pandemic further accelerated this trend, as lockdown measures led to a surge in e-commerce sales. Consumers, compelled to shop online during the pandemic, have continued to do so even after restrictions eased. The convenience of online shopping, a widening product range, and faster delivery options have contributed to this shift. The demand for last-mile delivery is projected to increase by 78% in 2023. Last-mile delivery, the final step in the delivery process, is crucial for e-commerce companies to differentiate themselves. This final leg involves transporting parcels from nearby warehouses of the parcel couriers to the consumer. However, this growth in last-mile delivery brings challenges like traffic congestion, route optimization, and environmental concerns. Efforts to enhance last-mile delivery align with sustainability goals. Negative impacts, such as pollution and congestion caused by delivery vehicles, affect liveability and generate complaints. Sustainability initiatives, like the Dutch Climate Agreement and Green Deal ZES, aim to mitigate these effects. Various stakeholders play roles in B2C parcel delivery, including governments, logistic service providers (e.g., DHL), parcel locker companies, and e-retailers. Home delivery, manned/unmanned pick-up points, and parcel lockers offer different delivery methods. Failed home deliveries contribute to inefficiencies and increased costs, affecting both consumers and delivery companies.

Current research focuses on improving last-mile delivery efficiency and exploring alternative methods. While traditional home delivery remains popular, it comes with negative external effects and operational costs. The use of self-collection alternatives such as a Parcel Locker is a last-mile delivery innovation that could seriously contribute positively to the challenges the last-mile delivery sector faces. Parcel lockers show potential to mitigate the issues but face challenges like limited awareness of the alternative and its perceived advantages. This study can help last-mile delivery companies determine whether it is necessary to try and steer consumers towards self-collection alternatives in case of delivery failure, and what delivery factors they can employ to do so. Besides that, this study delivers discrete choice data on consumer preferences in case of delivery failure, which has not been done yet. Besides that, this study also provides last-mile delivery companies with consumer preferences for a regular delivery scenario 'at online checkout'.

Therefore, the following research question is formulated:

What are Dutch consumers' preferences when choosing the delivery reception method for online ordered products, what are their preferences when home delivery is anticipated to fail, and what factors influence their preferences?

Methodology

To answer this research question, this study employs a stated preference survey that includes a discrete choice experiment with two distinct choice questions. These choice questions aim to uncover consumers' preferences for last-mile delivery alternatives in two distinct choice scenarios. The first choice question depicts a regular scenario 'at online checkout', where the consumer is asked to choose between three delivery options at the check-out when online shopping. This first choice question is aimed at providing insights into consumer preference for either Home Delivery, Service Point, or Parcel Locker, and what factors influence this preference. The second choice question describes a situation of anticipated failed home delivery, where the consumer receives a message stating that they can choose between five delivery options in the case that they cannot attend their preferred delivery. As the Parcel Locker can also be used in case of delivery failure, this second choice question aims to provide information on to what extent the Parcel Locker is a preferred alternative in this case and what factors influence this. Discrete choice data is gathered through an online survey. Discrete choice modelling is then used to analyse this discrete choice data. A Mixed Multinomial Logit (ML) model is estimated on the choice data for both the choice experiments.

Results

The survey was administered online, and a total of 210 respondents completed the survey, resulting in a total of 2100 observations on the choice question 'at online checkout'. Figure 1 below shows the distribution of choices between Home Delivery (HD), Service Point (SP) and the Parcel Locker (PL) in the first choice question 'at online checkout'.

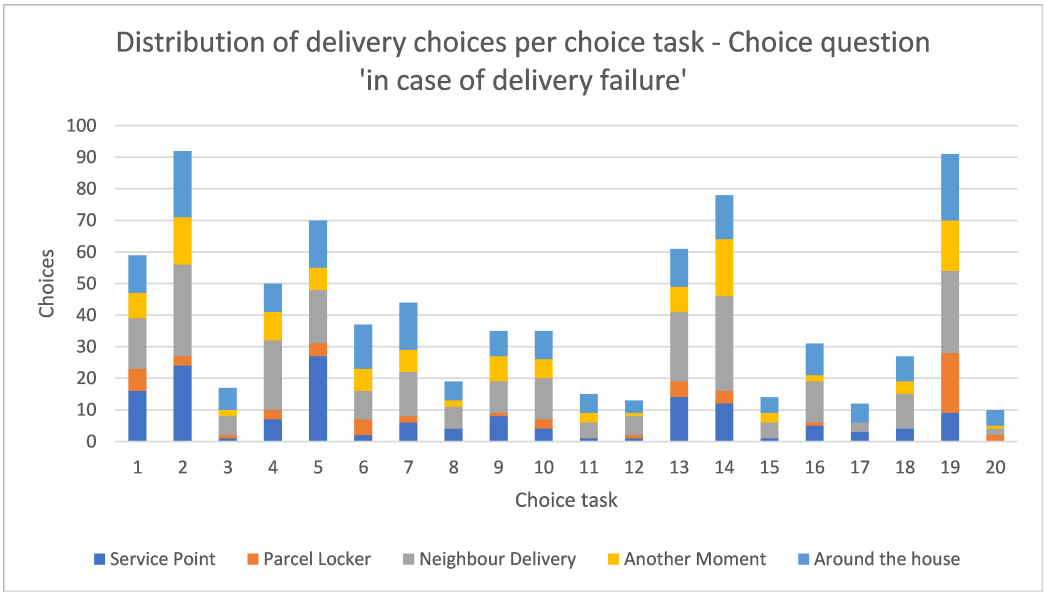

Figure 1: Distribution of choices per choice task - Choice question 'at online checkout'

In the first choice question of the experiment, Home Delivery emerged as the most preferred option, followed by the Service Point, and then the Parcel Locker. The results of this first experiment show that consumers are influenced in their preference by the price of the delivery method, the distance to a Service Point or Parcel Locker, and by the number of days a parcel is kept in a Parcel Locker. Consumers are less sensitive to price increases for SP and PL than they are for HD. Surprisingly, in contrast to other studies, this research finds that neither opening hours nor delivery time significantly impact consumer preferences. Despite using similar attributes as prior studies, this research's findings differ, highlighting the complex nature of delivery preferences. The distance attribute for Service Point and Parcel Locker is similar to other studies, while the number of days before returning to sender has relatively low importance, consistent with previous research. The RTS is an attribute that received less attention in other consumer behaviour studies. For the PL, the distance and price are more important factors. The results indicate that a shorter RTS has a small influence on the preference for the PL.

Working consumers, whether part-time or full-time, find self-collection alternatives more appealing than non-working ones. Frequent online shoppers tend to favour Home Delivery over self-collection. Additionally, consumers with prior experience using Service Points tend to find both Service Point and, to a lesser extent, Parcel Locker alternatives more attractive than Home Delivery.

On the second choice question 'in case of delivery failure', 810 responses were gathered from 188 individuals. Figure 2 below shows the distribution of choices between SP, PL, Neighbour delivery (NEIGH), Choose another moment (MOMENT), and Leave at an agreed place around the house (AHOUSE) in the second choice question 'in case of delivery failure'.

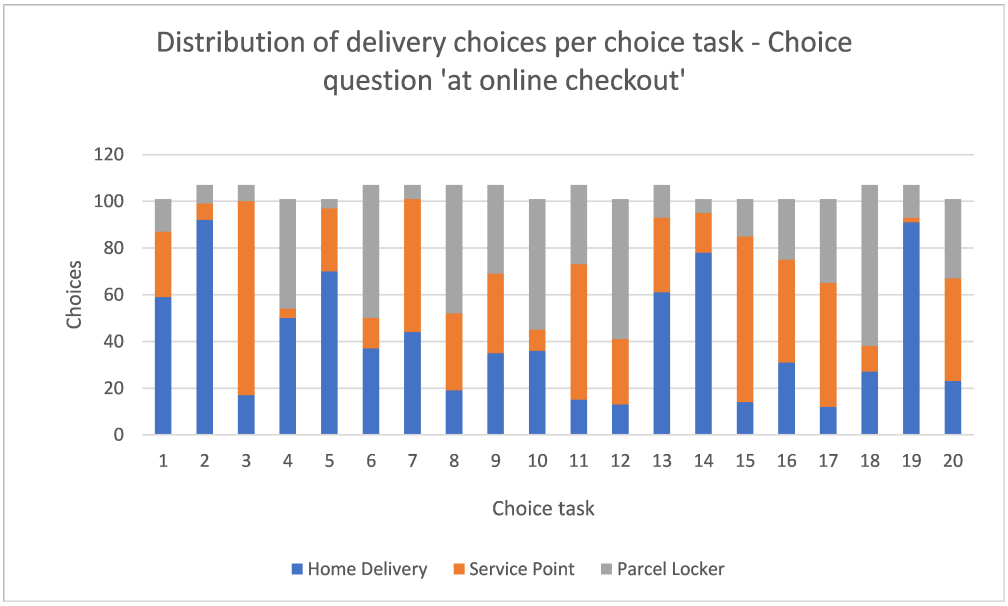

Figure 2: Distribution of choices per choice task - Choice question 'in case of delivery failure'

In the second choice question 'in case of delivery failure', which simulates a situation where home delivery is expected to fail, consumer preferences were examined. The majority of consumers indicated a preference for either having the parcel delivered to their neighbours or leaving it at an agreed place around their house. The next preferred option was delivery to a Service Point (SP), and then rescheduling the delivery for another moment. The least chosen alternative was delivery to a Parcel Locker (PL) in the event of a delivery failure. It's important to note that this scenario was presented after Home Delivery was chosen in the previous question. Based on the findings of this study, it appears that there isn't much demand for the Parcel Locker when a delivery fails, even if the PL is located very close to the consumer.

Consumer choices for alternative delivery methods were influenced by the opening hours of the Service Point, as well as the distances to both the Service Point and Parcel Locker. The inclusion of Saturdays as open days for Service Points positively impacted their attractiveness. When computing the relative importance of delivery attributes, only three parameters were significant. Among these, distance to the Service Point held the greatest significance, followed by distance to the Parcel Locker. In the absence of a price attribute, the trade-off between attributes is dominated by distance to the Service Point or Parcel Locker. Contrary to the expectation of the author, the absence of a price attribute didn't result in more pronounced trade-offs between other attributes besides the distance. This could be due to the overall preference for non-self-collection alternatives when anticipating failed home delivery, which resulted in less information on the SP and PL alternatives that included the delivery attributes. In terms of socio-demographics, older consumers and female consumers were more likely to choose another moment or the option to leave the parcel around the house. Those who work part-time or full-time were less inclined to choose this option. More frequent shoppers showed a greater inclination towards Neighbour delivery and leaving the parcel around the house alternatives.

Respondents of the survey on average indicate experiencing little restrictions when it comes to the delivery and collection of their parcels from their neighbours. There is however also a group of people that perceives neighbour delivery as a burden and is concerned with the privacy of their online shopping. In the second choice scenario on anticipated delivery failure, the increasing degree of burden experienced by neighbour delivery positively impacts the attractiveness of all other available alternative delivery options especially that of the self-collection alternatives SP and PL. The degree to which respondents see parcel lockers as advantageous over home delivery contributes to a great extent to how likely respondents are to choose a self-collection alternative. Most respondents see the possibility of collecting parcels at their own convenience as an advantage, while fewer people agree that it improves their overall reception experience.

Policy Recommendations and implications

The addition of the second choice question 'in case of a failed delivery' is what constitutes the main addition of this study relative to others. The results of this study indicate that the PL is not considered by consumers as a good delivery option in case of a failed delivery. It is actually the least preferred option. The largest share of consumers prefer that the parcel is either delivered to their neighbours or is left at an agreed place around their house. That the parcel is to be delivered to a SP is the next most preferred. To reschedule the delivery to another moment comes next, while delivery to a PL in case of a delivery failure is the least chosen alternative. When picking an alternative delivery method, consumers are influenced by the opening hours of the Service Point, the distance to the Service Point and the distance to the Parcel Locker. Service Points also being open on Saturdays positively impacts the attractiveness of the Service Point. In the absence of price as a delivery attribute, distance to the SP or PL is dominant in the trade-off between the attributes. It was expected that the absence of price would spur more trade-offs between the other attributes and that some of these would become significant. However, this was not the case and could be attributed to the overall preference towards the non-self-collection alternatives in the case of failed home delivery.

The market share analysis in case of failed delivery, seen in Figure 3 below, showed that in the current last-mile market, PL only has a share of 4%. Based on the findings of this study, it appears that there isn't much demand for the Parcel Locker when a delivery fails, even if the PL is located very close to the consumer. It's clear that policymakers and parcel delivery companies are limited in their ability to influence demand for parcel lockers solely based on distance. Without a price incentive, the PL cannot compete with neighbour delivery or leave the parcel around the house in the event of a failed delivery.

Scenario	Reference scenario 1	Scenario 2 - PL Closer	Scenario 3 - PL Extremely close	Scenario 4 - PL and SP at same distance	Scenario 5 - Fewer SPs, PL closer
SP Opening hours	Weekdays: only daytime	Weekdays: only daytime	Weekdays: only daytime	Weekdays: only daytime	Weekdays: only daytime
SP Distance	1 km	1 km	1 km	1 km	1.5 km
PL Distance	2 km	0.5 km	0.2 km	1 km	0.5 km
PL Opening hours	Weekdays and Saturday: day + evening, Sunday: day	Weekdays and Saturday: day + evening, Sunday: day	Weekdays and Saturday: day + evening, Sunday: day	Weekdays and Saturday: day + evening, Sunday: day	Weekdays and Saturday: day + evening, Sunday: day
PL RTS - Days before returned to sender	7 days	7 days	7 days	7 days	7 days
SP	24%	17%	16%	20%	12%
PL	4%	15%	18%	10%	18%
MOMENT	12%	11%	11%	11%	12%
AHOUSE	26%	24%	23%	25%	25%
NEIGH	35%	33%	32%	34%	34%

Figure 3: Predicted market shares for the delivery options - Choice question 'in case of delivery failure'

Concerning the consumers' choice for a delivery option 'at online check out', it is evident that price and distance significantly influence the choice for parcel lockers and service points. Consumers are less inclined to choose for a parcel locker when it's farther away. Research conducted by the Autoriteit Consument & Markt (2020) in 2020 revealed that the parcel locker network in the Netherlands had a 5% coverage, implying that only 5% of households had a parcel locker within walking distance. Notably, frequent users of parcel lockers are less sensitive to distance, suggesting that familiarity with their benefits reduces this concern. A key policy recommendation is therefore to expand and enhance the parcel locker networks' coverage. The placement of additional parcel lockers closer to residences increases visibility and accessibility. The responsibility for installing more parcel lockers lies with parcel delivery companies, while regulatory matters mostly fall within the purview of public stakeholders. Some parcel lockers are limited to specific delivery companies, which limits the coverage of the network. White-label lockers, like those offered by DeBuren and Budbee, are open to all couriers and expand

the network's coverage. It is recommended to parcel delivery companies to make their lockers white label, to increase the coverage of the PL network. For full accessibility, companies need to collaborate and deliver to their competitor's lockers, but competition considerations hinder this.

As situating parcel lockers in public spaces involves regulatory complexities, that are governed by local authorities, as not everyone might welcome Parcel Lockers due to concerns for increased traffic and noise, but also because of aesthetic concerns. Public space-based lockers typically operate 24/7, whereas those within commercial buildings align with their opening hours. Interestingly, this study demonstrates that consumers are indifferent to 24/7 availability compared to commercial building hours. Consequently, the second policy recommendation underscores a focus on placing parcel lockers in commercial buildings, considering their relative ease of implementation.

Consumers are also influenced by the price of a delivery method, and to increase PL demand the introduction of a price incentive is recommended. When policymakers or parcel delivery companies introduce a price incentive in order to stimulate self-collection, similar to a price increase of just HD, the demand for self-collection alternatives would significantly increase and overtake HD as the dominant delivery alternative when ordering a product online. One recommendation is thus for parcel delivery companies and e-retailers to start offering differentiating prices for HD, SP and PL. E-retailers might be hesitant to introduce this and to ask for an extra delivery fee for home delivery in fear of dissatisfaction from their customers. So, future research could look into the acceptance of increased prices for home delivery.

However, placing a Parcel Locker is accompanied by significant costs and these costs should be taken into consideration. For example, the province of South-Holland estimated the cost of a single parcel locker at 20.000 euros (M. van der Steeg, 2022). These investment costs would have to be earned back through parcel that are being delivered and returned through the PL. The results of this study raise concerns regarding the demand for demand, and thus the profitability of the PL. In the current situation depicted in the market share analysis, for both 'at online checkout' and 'in case of delivery failure' the demand for the PL is low. This indicates that first, the option has to be made more attractive before consumers start to use it. But to compete with HD 'at online checkout' shortening the distance is not enough, and a price incentive for the PL has to be agreed on to. Substantial costs have to be made before consumers will opt for the PL 'at online checkout'. The demand for the PL 'in case of delivery' shows that even when distances are shortened, the PL is unable to compete with delivery to a neighbour or to have the parcel be left at an agreed place around the house. The limited impact of RTS on choice for the PL leaves the opportunity for companies that own PL lockers to limit this period and by such increase the (economic) efficiency of the locker. However, a too short RTS period could drive consumers towards choosing the SP instead of the PL. Last-mile delivery companies can therefore limit the number of days the parcel is available in the locker, increasing the economic efficiency of the locker, but should be cautious that this period does not become too short if they do not want consumers to switch to a SP.

As previously discussed, consumer awareness and perceived benefits play a pivotal role in influencing the preference for parcel lockers. Particularly, working individuals exhibit a greater inclination toward self-collection options. Hence, policymakers can strategically target this demographic to educate them about the advantages of parcel lockers. Furthermore, if parcel delivery companies can provide conclusive evidence that delivery to a parcel locker results in lower emissions compared to home delivery, highlighting this fact to consumers positively impacts their likelihood of choosing parcel lockers as a delivery option.

Parcel delivery companies adopt strategies like early notification of delivery windows and offering alternative delivery methods if the customer can't be present for home delivery. This approach, simulated in the experiment, aims to reduce failed deliveries. Moreover, when consumers opt for Service Point (SP) or Parcel Locker deliveries, parcel delivery companies can optimize parcel consolidation for efficiency gains. Conversely, if consumers opt for deliveries near their homes, like to neighbours or around their house, it necessitates a dedicated trip for the delivery company. In the absence of price incentives, the research reveals limited interest in Parcel Lockers as a failed home delivery alternative. The early notification and alternative choice approaches show potential, as some respondents indicated they find them highly beneficial. This might be because Home Delivery is often the sole option available, even if it's inconvenient due to home availability constraints, effectively confining recipients. Conversely, initial delivery information is sometimes incorrect, with 13-22% of parcels delivered on the wrong day, as found by (Multiscope, 2023).

Future research should utilize more advanced choice modelling techniques to estimate the data, such as Hybrid

Choice Modelling or a Latent Class choice model. Hybrid Choice Modelling is a more advanced modelling technique that allows for more advanced modelling of latent psychological explanatory variables and segmentation based on these variables. Latent Class modelling can be used to more accurately find distinct groups in the population based on socio-demographic or background characteristics, and can therefore be used to more clearly research heterogeneity in the sample.

As several respondents indicated that it was a favourable option they would like to use in real life, research should be done into the effectiveness of sending messages that notify consumers on when the delivery is scheduled and allow them to choose an alternative location. Are consumers interested in such a system, and will they actually use it? Parcel delivery companies should look into the best design for such a notification system.

Lastly, with respect to research on parcel lockers, it is advised to perform research that focuses not on consumers but on businesses in the Dutch e-commerce market. One aspect that is mentioned in this paper as well as many times in other scientific papers is the need, at this moment, for a price incentive to steer consumers towards parcel lockers or service points. These price incentives, or any difference in price that is related to the delivery method and not delivery speed, are not occurring in the Dutch delivery market. Research should therefore focus on whether parcel delivery companies, e-commerce companies and consumers are willing to adopt such an incentive that would steer away from home delivery, and what drives them in this belief. This would provide a meaningful bridge between what scientific literature proposes and what the market is willing to do with the propositions.

Contents

1 Introduction

The e-commerce sector has been constantly growing over the past decade, tripling its share in total purchases between 2014 and 2019 (World Economic Forum, 2020). On top of this constant growth came a COVID-19 induced boom in e-commerce sales, since it forced the majority of the world population to stay at home. A lot of consumers were forced to shop online and have their parcels and groceries at home, and are not moving away from it after measures were relieved. Online shopping is becoming easier and more and more convenient. The range of products that are available is growing. Customers are also getting used to faster delivery, with a majority of the parcel carriers offering customers options for next day. The growth of the e-commerce sector is expected to cause demand for last-mile delivery to increase by 78% in 2023 (World Economic Forum, 2020). Most of these online ordered products are sent to a parcel carrier company (such as DHL or PostNL), whom are then responsible for the delivery of these products to the sender. These companies carry out the 'last mile' of the delivery process.

The last mile is crucial for the delivery company to get right, as it is the part of the supply chain that is most exposed to the customer and is seen as the key aspect to differentiate from competing companies (Joers et al., 2016). Last-mile delivery is the process of performing the last step in the logistical supply chain, which usually consists of transporting the parcel from the nearest warehouse or hub to the customer's doorstep. (Gevaers et al., 2009, p.2) provide the following definition of the last mile: *"The last mile is the last stretch of a business-to-consumer (B2C) parcel delivery to the final consignee, who has to take reception of the goods at home or at a cluster/collection point."*. The increase in demand for last-mile delivery causes an increase in delivery vehicles, which is posing several challenges that parcel couriers have to deal with to provide a satisfactory 'last mile': traffic and congestion issues, route optimization, and environmental issues due to an increase in distance travelled by delivery vehicles.

Further, the Dutch Authority for Consumers and Markets (ACM) indicates that while the share in traffic volume by delivery vehicles is relatively low per municipality, there is still the necessity to engage in sustainability initiatives (Autoriteit Consument & Markt, 2020). Factors such as pollution, congestion, and road safety all impact the liveability in residential areas, leading to an increasing number of complaints on delivery carriers. Examples of such complaints are: reckless driving and wrongly parked vehicles that create unsafe situations, or running engines that create noise and air pollution. In the Netherlands, 1250 complaints about delivery drivers were recorded in 2019 alone by a Dutch traffic safety organization (van Joolen, 2019). Aiming to improve last-mile delivery in the light of these limitations is in line with the Dutch Climate Agreement (Ministerie van Algemene Zaken, 2022), and with Green Deal ZES, which is the initiative by several municipalities to achieve more silent, efficient and sustainable city logistics, setting the goal of emission-free urban zones in cities in 2025 (Green Deal, 2014).

Several groups of actors are involved in B2C parcel delivery, who can play different roles in the process of ensuring that the growth of e-commerce and parcel delivery sector conforms to sustainability targets. National and local governments can set rules or guidelines for parcel carriers, such as a minimal load capacity. Local governments can additionally incorporate parcel locker stations in their urban planning when designing new neighbourhoods, or assign locations in the public space for these stations. Furthermore, there are logistic service providers, such as PostNL or DHL, that carry out the last mile deliveries and who dominate the last mile delivery market. Similarly, there are also parcel locker companies that are independent. They do not deliver parcels themselves but collaborate with the other (larger) logistic service providers. Lastly, there are e-retailers who sell their products and collaborate with a logistic service provider to cover the last mile part of the delivery.

The e-retailers have access to a number of last mile delivery methods that are offered by parcel carrier companies. These last-mile delivery methods, either differ on where the parcel is delivered or how the parcel delivery is performed, or on both. In the Netherlands, the most dominant delivery method is home delivery (HD). Which can be performed by a standard delivery van, (smaller) electrical vehicles, or delivery bikes. Another form of last-mile delivery is the use of a manned pickup point, often referred to as a service point (SP). Here, the parcel is not delivered to the home address, but to a location usually in the neighbourhood where it can be picked up by the customer. Similarly, the use of a unmanned pickup point, a parcel locker station (PL), is another option. When using this method, the parcel is delivered to the parcel locker station and put in a locker by the carrier, where the customer can later pick up the parcel by opening the locker with a personal code.

For the parcel delivery companies, the last mile in delivery is often the least efficient part of the supply chain,

this is due to a number of reasons. First, compared to other parts of the supply chain, the last-mile delivery to the customer often involves much fewer packages per stop. Fewer packages per stop means that the parcel courier has to make more stops to deliver the same amount of packages, making it less efficient and resulting in more travelled kilometres Second, the 'Not-at-Home Problem', when a delivery is unsuccessful because of the recipient not being home, causes a higher failure rate and consequently higher costs and emissions (Gevaers et al., 2011). On this topic, Edwards et al. (2009) found that making an extra trip due to a failed first delivery attempt would result in 15% extra CO2 emission, in the case of van delivery with a 10% failure rate. Delivery failure percentages differ per country and per carrier, and ranges anywhere from 3% to 60% (Buldeo Rai et al., 2021). Furthermore, of the total cost made by the parcel carrier the costs associated with the last mile delivery process contribute significantly, making up 30 to 50 percent of the total cost, depending on the calculation method (Autoriteit Consument & Markt, 2020). Additionally, research shows that in the UK urban and municipal delivery make up 50 percent of the sector's total green-house gas emissions (Department for Transport, 2017). Each case of a failed delivery that results in an extra delivery attempt adds to the operational cost and emission for the parcel courier. The parcel courier does not want to come back for another attempt, wanting to complete the delivery on the same day, either to deliver the parcel to neighbours, to a service point or a parcel locker. From the consumers' perspective, failed deliveries are unwanted too. Research shows that delivery failure is the main reason for reaching out to the parcel courier (Filiopoulou et al., 2022), as consumers often perceive the times their delivery fails as high. Delivery cost and delivery failure are the most important problems concerning the delivery process (Filiopoulou et al., 2022). In the case of a failed delivery, parcel couriers can do several things. Either deliver the parcel to neighbours, to a service point or a parcel locker, or they make another attempt the next day. It is common to deliver the parcel to someone's neighbour in the Netherlands, but some consumers may not like this due to privacy or security concerns, or because this limits their independence (Asdecker, 2021).

Improving last-mile delivery would benefit society as a whole since this could reduce the negative impact last-mile delivery has. That is, besides the obvious benefit of a smoother delivery process and reception process for the customer, increased last-mile delivery demand also causes negative external effects, e.g. pollution and congestion due to increased travelled distance by delivery vehicles, in residential areas and to society as a whole (Carotenuto et al., 2018; Weiss & Onnen-Weber, 2019). The first important negative effect of last mile delivery is that it's the most polluting part of the supply chain, accounting to half of the total emissions (Department for Transport, 2017). Failed first-time home deliveries only add to this problem (Song et al., 2013; Edwards et al., 2009). Delivery by cargo bike reduces the negative impact of emission but does not reduce the number of delivery vehicles, as more feeder trips to micro depots have to be made (Llorca & Moeckel, 2021). From the viewpoint of the parcel delivery company, it also slightly increases total operational time. Second, extra demand for last mile delivery causes congestion in urban areas in, which is best seen in the increase in Light Good Vehicles (LGV), or delivery vans, being registered every year. This increase is 12% over 2015-2020 in the UK (Department for Transport, 2020) and in the Netherlands, a 13% increase was registered from 2020 to 2021 (Stichting BOVAG-RAI Mobiliteit, 2022). Third, more delivery vehicles on the road, together with the pressure to deliver packages as fast as possible also leads to curbside parking and unsafe situations in traffic (Butrina et al., 2017; Autoriteit Consument & Markt, 2020), mainly due to a lack of parking spaces to unload (Holguín-Veras & Patil, 2005).

Taken together, the increasing demand for last mile delivery and the costs associated presents the field of last mile logistics with new challenges. This also becomes apparent from reviewing current academic literature on last-mile delivery, since alternative delivery methods and new technologies are increasingly getting attention. While traditional home delivery is still the preferred delivery method in the Netherlands, this brings along a lot of negative external effects for consumers and society and a lot of operational costs for parcel couriers. Aiming to reduce failed home deliveries positively impacts parcel delivery for all. Parcel lockers can provide a solution for failed deliveries for both the consumer and the delivery company, as it has the potential to decrease operational cost and amount of delivery vehicles (Duin et al., 2020), and can limit greenhouse gas emissions (Edwards et al., 2010). However, parcel locker use is still limited, due to a wide variety of reasons such as limited knowledge, low perceived advantage of using a parcel locker due to the price or because the locker is too far away. By investigating how consumers perceive this innovation, it is possible to determine how parcel couriers could shape a parcel locker network.

Literature overview and aim

Parcel delivery for business-to-consumer (B2C) has been researched extensively, resulting in a wide range of research topics. One branch that has received a lot of attention is improving the efficiency of the delivery vehicles,

namely the vehicle routing problem. Other branches of research have focused on exploring new ways of parcel delivery through the use of autonomous vehicles (AVs) or airborne delivery by drones. The different branches of research typically focus on one of two areas, either they study mathematically the impact of new routing strategies or transport alternatives, or they study consumer behaviour or consumer acceptance regarding parcel delivery options. Studies in this second area researched what factors influence consumer preference when the consumer shops online and has to choose a certain delivery option. This area has received attention in Australia (Collins, 2015), Belgium (Verlinde et al., 2018; Rai et al., 2021), Poland (Iwan et al., 2016)and the Netherlands (Molin et al., 2022), among others, often trying to capture willingness of consumers to adopt alternative delivery options like parcel lockers or delivery by AVs. Knowledge of consumers' perceptions of physical delivery features such as the price of delivery or distance to a collection point is crucial for parcel couriers. Knowing what latent perceptions, such as perceived effort or perceived advantage, drive the acceptance and intention to use delivery last-mile delivery innovations can help parcel couriers and local governments to nudge groups of consumers towards these innovations. Additionally, knowing different consumer segments based on their perception of sustainability, perceived value, or perceived effort of last-mile delivery methods or based on socio-demographic context can be very valuable. This is so that parcel delivery providers may better understand the context in which customers choose their last-mile delivery options, which can then be utilized to influence policy. For policymakers to know if preferences for a delivery method differ between for example rural or urban areas can be very important for the implementation of this delivery method. Similarly, if policymakers have information on how consumers perceive the value of a certain delivery method, they can then use this information to try and increase consumers' knowledge of such delivery alternatives to make them aware of its advantages. Ma, Wong, & Teo (2022) identifies the assumption of homogeneity as a shortcoming in existing studies. Ma, Wong, & Teo (2022) argue for exploring heterogeneity more, and this can be done by including socio-demographic factors and/or by measuring latent perspectives regarding delivery methods. Segmentation on latent perspectives towards self-collection alternatives has received little attention in the Dutch context. The most important knowledge gap that was identified within this area of research is the lack of attention given to what consumers' preferences are when they are not home for home delivery, i.e. a delivery fails the first time, and what factors influence their preferences.

This study aims to extend current academic literature on parcel delivery preferences for online-ordered products and also add a new dimension to current knowledge on consumer preferences by investigating what their preferences are when the consumer is faced with a failed delivery attempt. Preferences for generic delivery attributes such as price, and delivery method specific attributes such as distance to a collection point or moment of delivery. By investigating the factors that influence consumer preference for the different delivery options, this study is an extension of the earlier research by Molin et al. (2022), aiming to investigate how the potential of parcel lockers can be unlocked. Further, as parcel lockers also serve as one of the alternative locations of delivery for when a home delivery fails, knowing when and if consumers prefer parcel lockers over other alternatives uncovers consumer preferences previously unexplored. These preferences can then be used as input for more realistic simulation and optimisation studies that examine the effectiveness of last-mile delivery innovations on the whole delivery process. In light of this context, it would be interesting to look further into consumers' preferences for alternative delivery options when they are not able to attend their (preferred) home delivery. Therefore, the following research question is formulated:

What are Dutch consumers their preferences when choosing the delivery reception method for online ordered products, what are their preferences when home delivery is anticipated to fail, and what factors influence their preferences?

Sub-questions

In order to address the main research question, it will be divided into sub-questions. These sub-questions will each cover a distinct part of the main research question. The proposed sub-questions are:

1. What delivery factors influence consumer choice for a delivery method at checkout, and what is their relative importance?
2. What delivery factors influence consumer choice for delivery option in case of anticipated delivery failure, and what is their relative importance?
3. What effect do socio-demographic characteristics have on consumer choice for a delivery method?
4. What effect do attitudes towards last-mile delivery methods have on consumer choice for a delivery method?

The goal of this study is to provide the last mile logistics sector with a clear indication of consumer preferences for alternative delivery methods when home delivery fails, and specifically, whether the PL has a place in this and what factors related to the PL influence this. With this information, last-mile delivery companies can determine whether it is necessary to try and steer consumers towards self-collection alternatives in case of delivery failure, and what delivery factors they can employ to do so. Besides that, this study delivers discrete choice data on consumer preferences in case of delivery failure, which has not been done yet. This choice data is complementary to 'regular' delivery preference choice data and can be used by last-mile delivery companies to extend their models on route optimization. Besides that, this study also provides last-mile delivery companies with consumer preferences for a 'regular' delivery scenario. These actors can use the information on the factors that underlay consumers' preferences to see what is necessary to steer consumers towards using PLs more often. By including the attribute Days before Return to sender (RTS), the study also includes an attribute that has a significant impact on the efficiency of a PL. Information on this factor should further help to shape policy around the PL.

Method

To answer the research question and its sub-questions, this study uses a specific type of stated preference method, the discrete choice experiment, in order to elicit consumers' preferences for last-mile parcel delivery alternatives and attributes. To this aim, the DCE stated preference method is preferred over discrete choice contingent valuation (CV) (Johnston et al., 2017). A discrete choice experiment (DCE) allows respondents to evaluate hypothetical scenarios, therefore being able to provide valuable information on consumer preference. The Revealed preference method asks respondents for their actual behaviour and is therefore unable to ask respondents for scenarios that are hypothetical and less suitable for the goal of this study. A standard survey would be unable to capture how consumers actually make trade-offs when presented with a specific choice scenario. The use of DCE to capture consumer preferences in last-mile delivery of online ordered products is already established in this field of academic literature (Rai et al., 2019; Kiba-Janiak et al., 2022; Molin et al., 2022). To construct the survey, existing literature on consumer preferences for last-mile delivery options will be reviewed. Based on the factors that are found in this literature review, a pilot survey will be designed. This pilot is tested among a small group of respondents to identify errors and validate the research process. The final survey will be distributed among Dutch consumers. The data gathered by distributing this survey will be analysed using statistical data analytic methods.

Structure Thesis

The thesis will be structured as follows. The second chapter performs a literature review in aid of constructing a survey with a discrete choice experiment. The Third chapter discusses the design process and construction of the survey. The fourth chapter presents the results of the survey and the interpretation of these results. The fifth chapter will use the results from the survey to compute different policy scenarios. Last, the sixth chapter concludes the survey by answering the research question, discussing the thesis's contribution to literature, policy implication and areas of interest for future research.

2 Methodology

This section will delve into the methodological framework underpinning our research, which revolves around the application of Discrete Choice Experiment (DCE) and Discrete Choice Modeling (DCM). These methodologies play a crucial role in understanding and analyzing the decision-making processes that individuals undertake in various choice contexts. Whether it's identifying consumer preferences, assessing policy impacts, or evaluating market dynamics, DCE and DCM provide powerful tools for investigating discrete choices and modelling them with precision.

2.1 Discrete choice experiment

This study uses a specific type of stated preference method, the discrete choice experiment (DCE), in order to elicit consumers' preferences for last-mile parcel delivery alternatives and their characteristics. The use of DCE to capture consumer preferences in last-mile delivery of online ordered products is already established in this field of academic literature (Rai et al., 2019; Kiba-Janiak et al., 2022; Molin et al., 2022), these studies are already discussed in the literature review and an overview can be seen in Table 1. In a discrete choice experiment, respondents are presented with a set of alternative options and are asked to make a choice between them. This set of alternative options is called a choice task. The choice alternatives can be described by their attributes, and the respondents' valuation of an alternative depends on the attributes' levels (Ryan & Gerard, 2003). The discrete choice experiment will take a labelled form and, as opposed to an unlabelled form, this form takes alternative-specific names for the alternatives (Louviere et al., 2000). This allows for specifying alternative specific attributes. The selection of the attributes and their levels is critical, as these describe the alternatives and respondents are asked to make their choice based on the information provided by them (Rohr et al., 2011). A DCE can however not include all the important attributes that are proposed in the literature, as this would result in choice sets that would impose too large of a cognitive burden on the respondent. Selecting these attributes and their values can be guided by a literature review, expert opinions, interviews, or group discussions Coast & Horrocks (2007). In this study, a literature review will guide the selection of attributes and their respective values.

2.2 Discrete choice modelling

The data obtained by a DCE can be analysed through discrete choice modelling. Discrete choice modelling aims to help the researcher observe trade-offs based on the choice data. There are several models that can be estimated on discrete choice data. The models that are estimated in this study will be discussed in this section. Model estimation in this study is based on the Random Utility Model (RUM) framework. This model aims to describe and predict choices by individuals among several alternatives. The framework assumes that individuals derive utility from choosing an alternative, and choose the alternative that the one gets the highest utility from. The utility U for decision maker n for choice alternative i can be written as:

$$U_{in} = V(X_{in}; \beta) + \varepsilon_{in} \tag{1}$$

In this equation, X is a vector that contains all explanatory variables for alternative i and decision maker n, β is a vector containing all parameters that are to be estimated, V is the systemic utility and is the function of vectors X and β, ε_{in} is the random error term for individual i and alternative n and is also called the unobserved utility. The multinomial logit (MNL) model (McFadden, 1974) assumes that the error term ε_{in} is independently and identically (IID) distributed across all individuals. This MNL model gives the following function for the probability P for alternative i and individual n:

$$P_{in} = \frac{e^{V_{in}}}{\sum_{k=1}^{j} e^{V_{ik}}} \tag{2}$$

Where V again is the systemic utility of alternative i for individual n, k is the number of the alternative, and j is the number of alternatives in the choice set. There are however some assumptions underlying the MNL model that, if violated, can have a significant impact on the validity of the estimated parameters. To simplify the analysis of choice behaviour, the MNL assumes independence of irrelevant alternatives (IIA), which is the source of the IID assumption for the error term. This means that in the MNL model, the choice for one alternative over another alternative is only affected by these two alternatives and does not depend on the presence of other alternatives in the choice set. The MNL model would fail to capture correlations between unobserved utility

for two similar alternatives in a choice set. As the error term of the utility function captures unobserved utility, incorrectly assuming that the error term is IID can lead to flawed results.

The MNL model is able to capture taste heterogeneity for (delivery) attributes among different individuals. By including interactions between socio-demographic variables and delivery attributes, a MNL model is able to capture heterogeneity for delivery attributes. Finally, as the MNL model assumes that error terms are IID, this means that the model is unable to capture utility correlation among repetitive choices made by the same individual, this effect is also called the panel effect. This study will perform two choice experiments for two different choice scenarios. Both choice sets feature two alternatives, 'Service Point' and 'Parcel Locker', among other alternatives. Both are self-collection services that depend on the consumer to make the final leg of the delivery process by their selves. It is very likely that an individual does not prefer to make this effort of picking up the parcel from a Service Point, and this would then also be the case for the Parcel Locker as it requires this effort too. But for a Home Delivery alternative, this is not the case. Intuitively, the Service Point and the Parcel Locker alternatives have more in common than they do with the Home Delivery. This would mean that the IIA property is violated. Besides that, the choice experiments also ask respondents repetitive questions, resulting in panel data. To overcome these issues, the Mixed Multinomial Logit model is introduced.

The Mixed Multinomial Logit model (ML) relaxes the assumption of the IID error term and introduces a shared error component υ and lets both the parameters β and the shared error component vary randomly along a certain distribution. The randomness of a parameter can be tested for by introducing and adding a random component sigma, that follows a certain distribution, to the parameter estimate. This sigma, dependent on the distribution and its value, can be added or subtracted from the parameter estimate. In this way, it captures taste heterogeneity for a certain attribute such as price. A shared error component captures something else. A shared error component says something about the correlation between utility for alternatives. A shared error component can be added to the utility function of two (or more) similar alternatives, to capture whether there is a correlation between the unobserved utility of these alternatives. If this is significant, it tells us that there are some unobserved features in both error terms that the alternatives share. In this study, both the error term and the parameters follow a normal distribution. It is assumed that $\beta_{xin} \sim \mathcal{N}(\mu_x i, \sigma_x i)$, implying a mean parameter μ is estimated for all parameters, as well as a standard deviation σ. For the shared error component, $\eta(j,k) \sim \mathcal{N}(0,\sigma)$ is assumed, following a normal distribution with a zero mean and standard deviation σ. The likelihood of the model is then estimated by the following equations (adapted from (Train, 2003):

$$P_{i*nt}(\beta_j) = \frac{e^{V_{in}(\beta_j)}}{\sum_{i'} e^{V_{i'n}(\beta_j)}} \tag{3}$$

$$L_n = \int \left[\prod_t P_{i*nt}(\beta_j) \right] f(\beta_j) d\beta_j \tag{4}$$

3 Literature Review

In this section, the current literature on B2C parcel delivery preferences is reviewed. The literature review will provide a comprehensive overview of what has been researched in the field of parcel delivery preferences. The review in this section is driven by multiple research goals:

1. To underpin and further expand the identified research gap
2. To identify the delivery options that are offered in the current parcel delivery market. The delivery options in the current delivery market are used to inform the choice of alternatives in the construction of the DCEs. Besides that, some delivery options have certain features or characteristics that others do not. This influences the next goal.
3. To identify the factors relating to delivery options that have been researched in other studies on consumer parcel delivery preferences. The step aims to inform the decision of which factors to include in the conceptual model and is crucial in the DCE as the factors serve as attributes defining the different delivery options.
4. To identify socio-demographic factors, or other (directly measurable) factors such as online shopping frequency that are included in studies on parcel delivery preferences. First and foremost, socio-demographic information helps to determine the representativeness of the sample of the survey. Second, by including socio-demographic variables and shopping characteristics, the study aims to research heterogeneity in taste for delivery options and delivery attributes.
5. To identify what latent perceptions towards delivery options have been researched in other studies and to determine how these were included. By measuring latent perceptions on things like neighbour delivery and environmental sustainability, the study tries to gather knowledge on the context from which consumers make their choice.

By answering these questions, this section further aims to construct a list of factors that are found in the existing literature. From this list, a set of factors is selected from which a conceptual model is constructed.

3.1 Review Method

A search strategy was applied to find academic literature that is similar to the research topic and goal of this thesis. The search strategy consisted of a combination of terms that each represent a core feature of the research. First, to find literature that used the same research method, the following boolean term is used: (“stated choice” OR "stated choice experiment" OR "stated preference" OR "choice model" OR "consumer preference"). Next, the following boolean term is used to find literature that studies parcel delivery: ("parcel delivery" OR "package delivery" OR "packet delivery" OR "last mile delivery" OR "home delivery"). This boolean search strategy was applied in the Scopus database and ScienceDirect databases and resulted in 42 results and 293 results. This difference stems from the fact that Scopus automatically searches for these terms in the title, abstract or keywords, and ScienceDirect does not. Limiting ScienceDirect to only search within title, abstract, and keywords results in 21 results. The focus of this research is on B2C delivery of parcels and on consumers, therefore studies on online grocery shopping are excluded as well as studies focusing on routing of vehicles. Snowballing is used to find other interesting articles that researched the broader topic of last-mile delivery or were not found in the initial search.

3.2 Understanding current literature on last-mile delivery

In this section, the current literature on last-mile delivery, and specifically on delivery methods and consumers' preferences for them, will be analysed. To this end, this section aims to provide an overview of what has already been researched, in order to provide a more extensive underpinning for the research gap.

From reviewing the literature it becomes evident that researchers have investigated many different delivery methods that have the potential to reduce the costs and externalities caused by last-mile delivery, such as collection-and-delivery points (Song et al., 2012; Edwards et al., 2009), parcel lockers (Schnieder et al., 2021), or other forms of delivery transportation such as porters and cycle couriers (McLeod et al., 2020) or autonomous vehicles (Polydoropoulou et al., 2022). The literature that is found can roughly be divided into two different sections based on what the research focuses on. First, there is research on the preference of consumers for alternative ways of transportation for last-mile delivery, e.g. by drones, autonomous vehicles, or via crowdsourcing

initiatives. Second, there is research that studies the preference of consumers for alternative delivery reception methods, e.g. home delivery, parcel lockers, and reception boxes. Further, since the use of collection-delivery points and parcel lockers, research within this strand has also been occupied with optimization of CDP or parcel locker location based on consumer preferences and on estimating the sustainable potential of this delivery alternative.
Recently, there has been a lot of attention within sustainable urban logistics to collection-delivery points and parcel lockers; what drives consumers to choose these delivery options; what are the optimal locations for parcel lockers or CDPs; what is the (environmental) impact of using parcel lockers or CDPs compared to conventional home delivery. Collins (2015) consider the use of collection-delivery points (CDP) to greatly reduce the number of failed deliveries. Besides this, Collins (2015) states that the CDP approach to last-mile delivery also positively impacts the environmental footprint.

Research on parcel lockers has looked into finding the optimal location for parcel lockers. Lin et al. (2020) and Lyu & Teo (2022) researched this optimization problem in case studies in Singapore. Both incorporate consumers' choices into designing the network, highlighting how important knowledge of consumers' preferences for locker location is. Others, like Peppel & Spinler (2022) have used optimal locker location to calculate potential savings on operational and environmental costs. Some parcels may be fit to be delivered to the mailbox, however, for most deliveries someone will have to be home to collect the parcel from the carrier. As was mentioned earlier, a significant share of parcels ordered for home delivery fail at the first delivery attempt. While research by (Boyer et al., 2009) showed that shortening the delivery window length increases the delivery success rate, it negatively impacts routing efficiency, i.e. the number of miles driven per customer, and parcel consolidation. Manerba et al. (2018) find similar results, where reducing the delivery time window by 2 hours when adopting a fast delivery service resulted in almost four times more travelled kilometres. For this reason, this research will not consider researching the impact of predefined delivery windows and lengths in reducing first-time delivery failure rates.
Another branch of research has investigated what influences consumer preferences for (sustainable) delivery methods. First, Collins (2015) conducted a stated choice experiment to map what factors influence customers when choosing between home delivery and collection-delivery point options. He found the price, location, and quality of the CDP and delivery option to have the potential to influence more environmentally friendly behaviour when collecting the parcel from the CDP. In the context of the Netherlands, Molin et al. (2022) researched consumer preferences for parcel delivery methods. Specifically, a stated choice experiment was conducted where respondents could choose between home delivery, delivery to a service point, or delivery to a parcel locker.

Lastly, research has focused on exploring underlying factors that might influence consumer preferences. These factors might be latent constructs such as value perception, effort expectancy or environmental consciousness (Ma, Teo, & Wong, 2022). Others have studied whether socio-demographic factors influence consumer preferences, and if certain consumer segments can be identified based on such factors (Nguyen et al., 2019) or on their preferences (Kiba-Janiak et al., 2022).
There has been a growing academic body of research into alternative ways to deliver parcels by the use of autonomous vehicles (AVs). For example, two Greek studies have explored consumer preferences for alternative last-mile delivery methods.Filiopoulou et al. (2022) found that Greek consumers are hesitant to adopt delivery by drone as an alternative and still prefer traditional home delivery. Similar results are found by Polydoropoulou et al. (2022) came to the same conclusion, stating that home delivery is the preferred option and that Greek respondents were unwilling to pay extra for more advanced delivery, delivery by automated vehicles or drones in this context. An Australian study showed that "postie" delivery, i.e. traditional home delivery by a person, is still preferred over delivery by drone or autonomous vehicle (Merkert et al., 2022). Merkert et al. (2022) did find that drone delivery could become competitive if the alternative was faster and cheaper.

Another emergent concept is crowdsourced last-mile delivery. This concept entails the delivery of a parcel to the end-consumer on an ad-hoc basis by an individual who is uncertified in logistics, using applications or online platforms (Carbone et al., 2017). A study among Belgium consumers by (Rai et al., 2021) showed that although general interest is low, a segment of frequent online shoppers and active home delivery users are interested in a crowdsourced last-mile.

These are all promising fields of research within sustainable city logistics that should be acknowledged within this literature review to provide the full picture of the scientific body of research. However, this study will not focus on how the parcel gets from the depot to the place of delivery. Instead, this research will focus on

preferences for different types of reception methods of parcels by the consumer. Alternatives to home delivery can also be called place-of-delivery innovations. Allen et al. (2007) identify five last-mile delivery systems next to home delivery: reception boxes, delivery boxes, controlled access systems (smart lock system (Buldeo Rai et al., 2021)), collection points, parcel lockers. Figure 4 provides an overview of the different last-mile delivery aspects that have been discussed.

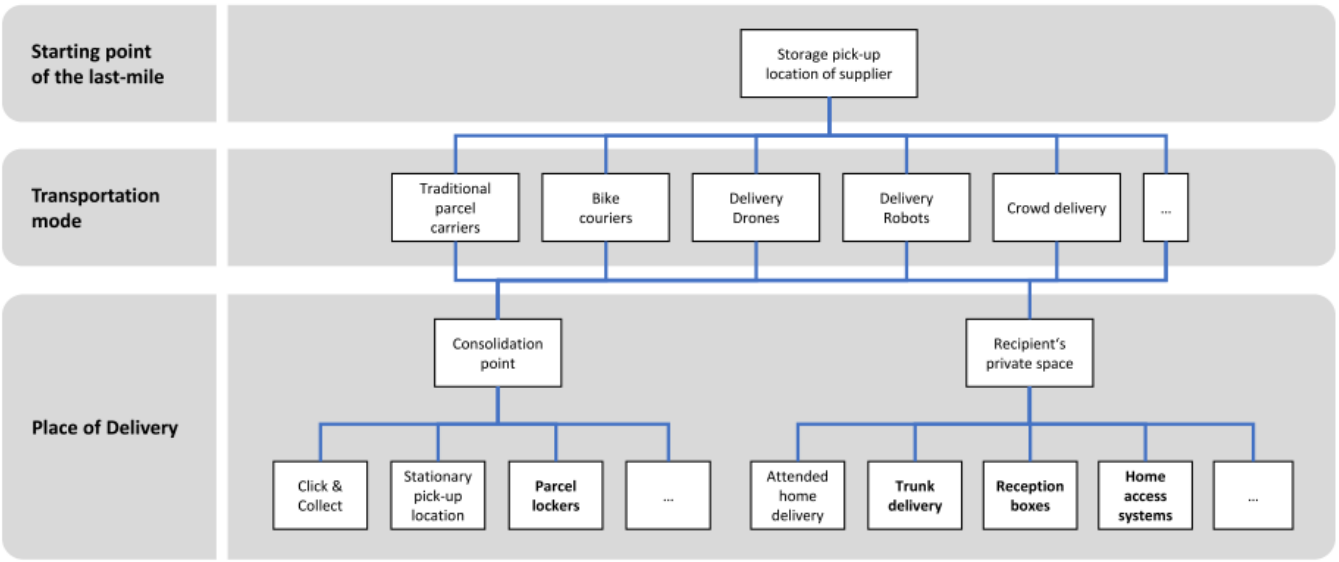

Figure 4: Last-mile delivery typology, work from Asdecker (2021) based on Gevaers et al. (2011)

3.3 Factors influencing parcel delivery preferences

This section aims to find which factors that relate to delivery options in the context of last-mile delivery have been researched in other consumer behaviour-centred studies. This group of factors that will be identified are ones that serve as a characteristic of a certain delivery option. These are factors that are relevant to what Rohr et al. (2011) call the output side of parcel delivery, the side that affects how the consumer perceives the service quality. These can be gathered from qualitative data, e.g. when a study asked respondents open-ended questions about what they think is important when choosing a certain delivery method. It can also be gathered from quantitative data, e.g. when a study performed a choice experiment through a survey. Similar studies were identified using the search strategy described at the beginning of this chapter. From the initial list of papers, a further selection is made by reading the abstract of the paper. Other studies are considered similar to this study when a discrete choice experiment questionnaire was used to explore consumer preferences for certain attributes in the delivery process of an online purchase.

The first study to use a discrete choice experiment or a stated choice experiment to look into, among other things, what drives consumers to choose between home delivery and a collection-delivery point (CDP) was conducted by Collins (2015) in Australia. Collins (2015) makes a distinction between traditional delivery, and three pick-up alternatives (from home, from work, from a regular shopping location). These pickups were from either a service point or a parcel locker. If a pickup alternative was chosen, the respondent was asked some follow-up questions regarding how and when the pick-up would be made. The ability to choose a delivery time window and the width of this window, as well as the provision of early notice of the delivery date, all majorly contribute to choosing home delivery. Whereas for the pick-up alternatives, distance, parking availability and the days before the parcel is returned to the sender (RTS) are the key utility-generating features. Collins (2015) eventually uses the behavioural implications from the discrete choice survey data to develop a framework on how consumer behaviour can be incorporated in simulating the environmental footprint of last-mile delivery.
Research by Iannaccone et al. (2021) to assess consumer preferences for the use of a PL compared to home delivery for e-commerce related deliveries specifically targeted a young audience, under the age of 30. They find that Incentive, Green certification, and Accessibility in terms of opening hours of the locker all have a significant positive impact on utility for choosing the PL alternative, while Distance has a significant negative impact on this utility. Whether the PL was assisted or automated, and the Location of the PL were found insignificant.Iannaccone et al. (2021) chose to include the attribute 'Incentive', instead of providing a cost of

delivery, which gives an indication of a discount on the sale price when a PL alternative is chosen.

de Oliveira et al. (2017) analysed potential demand for parcel lockers in Brazil via a SP survey, asking respondents to choose a delivery option. These options varied on the delivery time (time window of the parcel being delivered), information and traceability, price and location, either at home or at a parcel locker. All parameters for the attributes were found to be significant. Information and traceability were the most important attributes in the experiment, followed by delivery time, price, and location being the least important. Delivery price being only the third most important attribute is somewhat contradictory to the findings of other studies, such as (Silva et al., 2019; Rai et al., 2019). Price however was only indicated by either 'reference price' or 'reduced price' and had no numeric value. While the study can conclude whether offering a discount positively impacts utility, it limits the study in two ways. First, there is no indication as to how much this discount should be. Second, by not incorporating a numeric value for price, the study is unable to compute consumers' WTP for improved services (Rohr et al., 2011). So, including a numeric value for price is essential. Another study from Brazil, by Silva et al. (2019), concluded that if shipping costs and shipping time would decrease, and the pickup site was en route to daily travel, a pick-up alternative to home delivery would be much favoured. Waiting Time was found not to be significant, from which it was concluded that this was due to both levels of the attribute (waiting for a portion of the day, or the whole day) being unwanted by the respondents. Again, the cost of delivery was put into relative terms, with the cost of delivery to a pick-up site being 25% or 50% cheaper than home delivery. This poses the same problems as were identified when discussing de Oliveira et al. (2017).

Rai et al. (2019) study consumer preferences for alternative last-mile delivery options. Four attributes are considered, namely: delivery price, delivery speed, delivery reception and return possibility. Four alternative delivery options are considered within the experiment by varying the attribute 'delivery reception'. These are 'delivery at the address of choice', retail groups store, pick-up point, and parcel locker. The levels for the delivery price attribute are a realistic representation of the current market, meaning that both numeric prices and delivery prices framed as 'free from X amount' are selected. Delivery price is found to be the most important attribute in consumer preference in this experiment. Delivery speed and delivery reception are deemed less important in this experiment. Within their experiment, Rai et al. (2019) find that consumers are fairly indifferent to delivery reception or speed when delivery and return are free. Interestingly, Rai et al. (2019) shows that consumers indicate to be willing to walk further if their parcels are delivered together. Kiba-Janiak et al. (2022) took a more holistic approach, aimed at finding consumer segments with similar preferences for sustainable last-mile delivery options. In their conjoint analysis, they considered four delivery attributes: delivery price, delivery method, delivery time and mode of transport. In line with the findings by Rai et al. (2019), Kiba-Janiak et al. (2022) also find the delivery price to be the most important factor in determining what delivery options the respondents choose. Both Rai et al. (2019) and Kiba-Janiak et al. (2022) conclude that in order for respondents to choose the more sustainable option the delivery cost has to be free, and that the majority is unwilling to pay more for sustainable delivery. Ignat & Chankov (2020) finds that after showing the respondents in their study information on the environmental impact of the delivery option, respondents are more willing to wait longer, pay more and choose a less convenient location for a more environmental delivery. Kiba-Janiak et al. (2022) mention that a lack of awareness of the impact the different delivery methods can have on the environment could be the reason consumers choose less environmentally friendly delivery options, which is underlined by the findings of Ignat & Chankov (2020). When provided with a cost-benefit, respondents are willing to choose a less convenient location for delivery if this means it's more environmentally friendly. Similarly, respondents are willing to pay more for an environmental delivery when the delivery is made at a more convenient location (called location-benefits) (Ignat & Chankov, 2020). Other research regarding consumers' willingness to adopt more environmental delivery options comes from (Caspersen & Navrud, 2021; Caspersen et al., 2022). In the studies, besides other attributes like speed and cost, information about emissions was also provided. Both studies analysed a group of female shoppers for online clothing rentals. They found that this consumer group is willing to pay for CO2 mitigation ranging between 12-80 NOK for different consumer types, and they are willing to accept slower deliveries if this implies reduced emissions from the delivery process. Delivery time, delays, local air pollutants and CO2 emissions all contribute negatively to the utility for last-mile deliveries for this consumer group.

Thomas et al. (2022) also experimented with the impact that showing environmental impact information of last-mile delivery options has on consumer behaviour. They experimented with showing four different green nudges: personal impact statement, absolute measure, social comparison, and relative measure. After being shown these nudges, the respondents most respondents altered their choice to the more environmentally friendly delivery option. To provide additional evidence to this claim, Thomas et al. (2022) perform a post hoc experiment where a price discount is compared to the 'nudges'. The personal impact nudge has a similar effect on delivery

option choice as the price discount. Considering the studies by Thomas et al. (2022); Ignat & Chankov (2020); Caspersen & Navrud (2021); Caspersen et al. (2022) it should be noted that it is possible that respondents feel some kind of social pressure to choose the more sustainable alternative, also called a taboo trade-off.

In a small stated preference study conducted in Brazil, de Souza et al. (2022) looked at several less-researched delivery features: the possibility of scheduling, the possibility of rescheduling, presence of an app to manage these processes. They also included delivery costs in order to calculate the willingness-to-pay of the consumers for the addition of such features to the delivery system. The presence of the features 'app technology' and 'scheduling possibility' contributed positively to the respondent's utility for the delivery system.

Gawor & Hoberg (2019) studied three aspects of the last-mile delivery process, delivery speed, delivery method and the total price including shipping. The aim of the research was to compute the monetary value of consumers for delivery speed and delivery method. Respondents had to choose between the delivery options provided by different retailers for a certain product. Further, Gawor & Hoberg (2019) identify four segments based on their attribute segments: money-led shoppers (budgeters), lead-times shoppers, convenience shoppers, and balanced buyers. The budgeters segment is the largest, accounting for nearly half of the respondents. Following a similar approach based on conjoint analysis, Nguyen et al. (2019) investigate consumers' valuations of the delivery attributes: speed, time slot, daytime/evening delivery, delivery date, and delivery price. They follow the Mental Accounting Theory for money, time, and convenience in the delivery process for online retailing. Three segments are identified, a 'price-oriented', a 'time- and convenience-oriented', and a 'value-for-money-oriented' segment. Both Gawor & Hoberg (2019) and Nguyen et al. (2019) found the delivery fee to be the most important feature for consumers in selecting a delivery option. Ma, Wong, & Teo (2022) conclude that compared to home delivery, self-collection should offer lower prices, faster delivery and more favourable delivery schedules.

Two studies have undertaken a stated preference experiment with the aim of analysing consumer preferences for delivery by automated vehicles. (Kim, 2020) compared drone delivery to traditional delivery in the Korean context. Kim (2020) show that drone delivery has the potential to compete with motor delivery for urgent deliveries (delivery time of max. 2h) and that younger consumers are more likely to adopt drone delivery. Lastly, because truck delivery is so cheap compared to drone delivery, drone delivery does not challenge it. Polydoropoulou et al. (2022) have taken a wider approach, comparing traditional delivery in Greece to both delivery by Ground Automated Vehicles and by drones. They found that the traditional delivery service is still preferred to the emerging new delivery services provided by drones and automated vehicles. Delivery time and delivery cost are found to have a significant negative effect on utility.

In the context of the Netherlands, Molin et al. (2022) researched consumer preferences for parcel delivery methods. Specifically, a stated choice experiment was conducted where respondents could choose between home delivery, delivery to a service point, or delivery to a parcel locker. Molin et al. (2022) find that home delivery is still the preferred method for Dutch respondents, however a small increase in the price of home delivery combined with a smaller distance to a parcel locker could severely increase the choice for parcel lockers. The increase in price for home delivery can also be seen as an indirect discount for choosing the pick-up point or parcel locker alternatives. It can be concluded that there is a broad consensus in the literature that a price incentive is necessary in order to move consumers towards using parcel lockers. The foregoing part of this review focuses on studies that contained discrete choice or stated preference experiments in order to identify delivery attributes that are important to consumers when selecting a delivery method. However, some important research has been done that did not specifically contain a DCE or SPE, but do investigate the perception of different last-mile delivery systems from a consumers' perspective.

3.4 Non-DCE studies on delivery attributes and consumer attitudes

This section will first briefly discuss several academic non-DCE studies that have done important research on last-mile delivery attributes, and parcel lockers in particular. After that, this section delves into consumer behavioural studies that examine the relationship between consumer perceptions of last-mile delivery methods and their choice behaviour through theoretical mechanisms. This aims to identify whether previous how previous DCE and non-DCE studies have incorporated consumer perceptions for different aspects of delivery methods, and what these perceptions are.
Iwan et al. (2016) performed a pilot study investigating the efficiency of parcel lockers in Poland. They find that location is the most important factor in accomplishing efficient use of parcel lockers, efficiency based on the average number of parcels delivered monthly by each locker. Additionally, a pilot study looked into the

Table 1: List of stated preference studies and delivery attributes for place-of-delivery innovations

Study	**Method**	**Delivery alternatives considered**	**Delivery attributes considered**
Collins (2015)	DCE / SPE	HD, CDP	Delivery cost, delivery day (HD), time slot (HD), RTS (CDP), opening hours (CDP), distance (CDP), parking availability (CDP), type of CDP
Iannacone et al. (2021)	DCE / SPE	HD, PL	Monetary incentive, distance, opening hours, type of PL, environmental certification, location
Molin et al. (2022)	DCE / SPE	HD, SP, PL	Delivery cost, delivery moment, distance, opening hours
Nguyen et al. (2019)	CBCA	HD	Delivery speed, time slot, delivery moment (time), delivery date, delivery cost
Ignat & Chankov (2020)	DCE / SPE	HD, pick-up	Delivery cost, delivery speed, location of delivery, CO2 emission, carrier driver benefits
Caspersen et al. (2021)	DCE / SPE	Assumes preferred place of delivery	Delivery speed, possibility of delay, information, CO2-emission, particulate matter
Caspersen et al. (2022)	DCE / SPE	Assumes preferred place of delivery	Delivery cost ,delivery speed, possibility of delay, information, CO2-emission
Gawor & Hoberg (2019)	CBCA	HD, pick-up	Delivery speed, delivery location, total price incl. delivery
Ma et al. (2022)	DCE / SPE	HD, PL	Delivery cost, delivery speed, attended delivery (HD), time slot (HD), distance (PL), pick-up time window (PL), work from home restriction
de Souza et al. (2022)	DCE / SPE	HD	Possibility of scheduling, cost of scheduling, app technology, reschedule available
Oliveira et al. (2017)	DCE / SPE	HD, pick-up station	Delivery cost (relative, discount), delivery location, delivery moment, information and traceability
da Silva et al. (2019)	DCE / SPE	HD, pick-up	Delivery cost (relative, discount), delivery speed, need to wait for delivery, distance (pick-up)
Buldeo Rai et al. (2019)	CBCA	HD, pick-up, PL	Delivery cost, delivery speed, delivery reception, return possibility
Kiba-Janiak et al. (2022)	CBCA	HD, SP, PL	Delivery cost, delivery method/location, delivery date, ecological transport mode

consumers' perspective on parcel locker usage. Iwan et al. (2016) find that price, location and 24-hour availability are the three most stated reasons by the respondents to use a parcel locker. Further, respondents expect the location to be close to home. Lemke et al. (2016) presents the results of the same study in Poland as Iwan et al. (2016) but for a much larger group of customers. 24 24-hour availability of the locker, as well as the price of the service and location of the locker, are still the three most important criteria for choosing a parcel locker. To investigate the last-mile delivery situation in Sweden from a business perspective, Patowary et al. (2021) conducted a qualitative analysis of 51 webshops as well as a survey among consumers. Consumers indicate that home delivery is the most preferred delivery method, with delivery to a pick-up station second. It is important to note that Patowary et al. (2021) state that the actual situation is that about three-quarters of the respondents pick up their parcel. Consumers are also willing to pay extra for home delivery. But, the biggest barrier consumers face is inconvenient delivery times for home delivery. The most offered time slot is during the workday, but evening delivery is preferred.

Instead of focusing on physical delivery attributes such as price or delivery time and examining consumer trade-offs, there is another branch of research that focuses on theoretical consumer behaviour mechanisms. These studies are conducted to examine consumer perceptions and acceptance of self-collection alternatives based on behavioural theories. Including consumers' latent perspectives on time, convenience, environmental consciousness, and perceived value of PL, among others, as well as including socio-demographic factors such as gender, age, and online shopping frequency, contributes to filling a knowledge gap identified in the literature. Ma, Teo, & Wong (2022) wrote a literature review, which identifies the assumption of homogeneity as a shortcoming in existing studies. Ma, Teo, & Wong (2022) argue for exploring heterogeneity more, and this can be done by including socio-economic and measuring consumer behavioural factors. The majority studies the causal relationship between consumers' latent perceptions and their intention to use self-collection alternatives. Table 2 provides an overview of behavioural studies that are discussed in this literature review.

Asdecker (2021) researched four alternative place-of-delivery innovations through literature and through interviews to gain insights into how consumers perceive these innovations. Parcel lockers, reception boxes, trunk delivery and home access systems are included in the research. They find that factors of influence are 'convenience', 'security', 'privacy' and 'perceived relative advantage'. Where 'security' is mentioned mostly in relation to trunk delivery and home access systems, and not in the context of parcel lockers. For parcel lockers, respondents mostly mention perceived additional effort and spatial impediments as circumstances limiting utilization. One particular finding is that only one person mentions environmental issues in the interviews. According to Asdecker (2021) this indicates an unwillingness of consumers to adopt innovations that support greener last-mile delivery.

Yuen et al. (2018) are the first to investigate the relationship between characteristics of innovation, anchored in Innovation Diffusion Theory (IDT), and the intention of consumers to use self-collection alternatives. Of the five factors they considered, relative advantage, compatibility and trialability positively influence the intention of consumers to use self-collection alternatives. In order to improve consumer's intention to use self-collection, the advantages of self-collection over home delivery should be clear to consumers. In another study by Yuen et al. (2019), they find convenience, security and reliability, to have a mediated effect through perceived value and transaction cost on consumer intention to use. This again shows that if the value of self-collection is known or perceived positively, the intention to use increases. Here the construct of convenience can be influenced by physical delivery attributes of parcel lockers such as distance to the locker, opening hours, and days before the parcel is returned to the sender. The additional effort the consumer has to make in order to collect their parcel negatively impacts the perceived value of self-collection services (Yuen et al., 2019; Ma, Teo, & Wong, 2022). Asdecker (2021) find the perceived additional effort to be associated with the use of a parcel locker.

Some studies also aim to find consumer segments for self-collection services. (Wang et al., 2020) finds consumer segments based on how respondents relate to the four factors, innovativeness, self-enhancement, green knowledge and service value, that were identified through Value Co-Creation Theory. The largest segment 'Patrons' was driven by all four factors, while the second-largest segment 'Traditionalists' consisted of less innovative users. Wang et al. (2020) found in this second-largest segment that scoring high in self-enhancement and green knowledge was not enough to motivate the use of self-collection alternatives, as this segment also perceives the value of self-collection to be low.

Ma, Teo, & Wong (2022) stands out in combining both branches of research. A recent study by Ma, Teo, & Wong (2022) studies the preference of consumers for last-mile delivery through a stated preference experiment and also incorporates a latent variable framework to study how latent perceptions such as value-perception, environmental consciousness and effort expectancy influence utility for last-mile delivery methods. Value perception of self-collection and effort expectancy are significant in their effect on self-collection. Interestingly, environmental consciousness was found to have an insignificant, even negative relationship with self-collection utility. Ma, Teo, & Wong (2022) regard this stems from low visibility of the environmental benefits that self-collection can provide, similar to Ignat & Chankov (2020) and Kiba-Janiak et al. (2022).

3.5 Preferences in case of failed delivery

From reviewing the literature on consumer preferences for delivery methods, it also becomes evident that there are few papers that study consumer preferences in the case where the consumer cannot attend their preferred home delivery. A failed delivery is often caused by the 'Not-at-home' problem. This is a gap in the current literature that this research aims to fill. It is hard to find out whether current academic literature on the last mile has included preference when delivery fails in their research. Following the review method as was described earlier, only five studies were found to mention consumer preference when a delivery fails. This section will breifly cover these five studies and their findings. For none of these five studies, it was their main research objective to identify consumer preference in case of delivery failure. Preference for failed delivery is in these five cases only briefly mentioned. In a study from 2006, Mcleod et al. (2006) were the first to introduce the concept of a CDP (which includes both Service Point and Parcel Locker) as an alternative delivery location to which failed deliveries could be shipped. The results from a case study in the UK show that using a CDP in case of a failed home delivery could reduce travelled kilometres by consumers by 80%. It should be noted that at the time of this research, it was common to eventually deliver a failed delivery to a carrier depot, which was often located at a significant distance from the consumer. A questionnaire aimed at capturing consumer attitudes towards shopping habits and using a CDP as an alternative delivery location. The results of this questionnaire indicated that 83% of the respondents would consider the use of a CDP for a failed delivery. A case study in New Zealand

Table 2: List of consumer behavioural studies on the intention to use self-collection alternatives

Study	**Behavioural theory applied**	**Influential factors considered**
Yuen et al. (2018)	Innovation Diffusion Theory (IDT)	Compatibility, relative advantage, complexity, triability, observability
Nguyen et al. (2019)	mental accounting theory (MAT)	mental accounts for: time, money, convenience
Yuen et al. (2019)	Resource Matching Theory (RMT), Perceived Value Theory, Transaction Cost Economic Theory	Convenience, privacy security, reliability, perceived value, transaction cost
Ignat & Chankov (2020)	Planned Environmental Behaviour (PEB)	economic, environmental, social
Wang et al. (2020)	Value Co-Creation Theory (VCC)	Innovativeness, self-enhancement value orientation, perceived values, consumers' green knowledge
Zhou et al. (2020)	Unified Theory of Acceptance and Use of Technology (UTAUT)	Performance expectancy, effort expectancy, social influence, perceived risk, perceived satisfaction, behavioral intention, usage behaviour, facilitating conditions
Asdecker (2021)	Theory of Planned Behaviour (TPB)	Perceived behavioural control, attitude towards behaviour, subjective norms
Wang et al. (2021)	Affect-Cognitive-Social Perspectives	Perceived susceptibility, perceived severity, anticapotory emotion, anticipated emotion, action planning, coping planning, subjective norm, usage frequency
Ma et al. (2022)	Unified Theory of Acceptance and Use of Technology (UTAUT)	Intrinsic values, social values, functional values, functional de-valuation, environmental consciousness
German et al. (2022)	Pro-environmental Planned Behaviour (PEPB) and Service Quality (SERVQUAL)	Perceived environmental concern, perceived authority support, subjective norm, attitude, service quality, customer perceived value, customer perceived satisfaction
Wu & Li (2023)	Unclear	Time pressure, perceived behavioural control, need for human interaction, reliability, perception of couriers

on the acceptability of collection and delivery points found similar results, stating that many of the respondents perceive CDPs as a favourable option in case of a failed delivery (Kedia et al., 2017). In New Zealand, failed deliveries should either be arranged for re-delivery or are shipped to a post office or the main depot of the parcel carrier. While studies do provide some information on delivery choice in case of failed delivery, they only ask whether a CDP is an option for a failed delivery and no choices between other options have to be made.

In a case study from Turkey, Vural & Çağlar Aktepe (2022) investigated why a CDP service in Istanbul failed and conducted a survey to capture usage preferences for parcel delivery. The study explores mechanisms that contribute to the success of a CDP, showing in the end why the CDP initiative in Istanbul failed in a developing market. A consumer survey, interviews and secondary data were used to this end. The survey showed that home delivery was preferred and if this failed delivery to the nearest CDP was favoured to delivery to the nearest cargo office (Vural & Çağlar Aktepe, 2022). This is very limited, however, since only two options were given to choose from. The options that were provided here are similar to the options in Mcleod et al. (2006), where the base alternative was delivery to the cargo depot and respondents are asked whether they would consider a CDP.

A second study by Otter et al. (2017) mentions the order of preferred delivery alternatives when the consumer is not home. The study conducted 1019 web-based interviews to achieve the main goal of the study, which is to get a deeper understanding of the needs of e-consumers with regard to different delivery time frames for parcel delivery. In light of different delivery time frames, they mention that night-time delivery might be the most efficient option, as traffic volumes are low. However as Home Delivery is not possible in this time frame, delivery to a reception box or CDP is proposed. Otter et al. (2017) find that if the consumer is not present in the selected time frame, meaning that the delivery would fail, consumers would first want their parcel to be delivered to the reception box (RB) within walking distance, their last choice being a collection-delivery point (CDP) they have to travel to. It is unclear how this data was gathered, and whether there were other alternative delivery options if delivery fails. It is unclear if a closely-located CDP would be more or less favoured than a closely-located RB by the respondents of their study. While this study gives some indication of consumer preference when delivery fails, it is incomplete. However, it should be noted that this is partially due to failed delivery not being the main research goal of the paper.

Lastly, Rai et al. (2021) included a question about preference in case of delivery failure in their study on crowd

logistics. As was already discussed earlier, the concept of a crowdsourced last-mile is another innovation that has the potential to improve the environmental impact of last-mile delivery. The main goal of the study was to get an understanding of the types of consumers that would be interested in a crowdsourced last mile and what type of crowdsourcing is interesting. Four types of consumers were identified, and their use of last-mile delivery options, as well as their preference in case of a delivery failure are presented. Rai et al. (2021) find that people most interested in crowd logistics have a much higher preference to pick up a failed delivery at their neighbours than the other consumer segments. The other segments actually all prefer to pick up the parcel at a collection point. Picking up a failed delivery at a parcel locker is the least preferred option for three out of four consumer types.

To conclude, there has been some research on what delivery options consumers would consider and how consumers would rank these alternative delivery options. However, the current literature does not cover if and how trade-offs are made between alternative delivery options and do not always include all possible delivery options. Such a delivery option is delivery to a neighbour. In the Netherlands, it is common practice to try to deliver the parcel to a neighbour if the delivery fails, and it is expected that this option is highly favoured by the consumer. By designing a DCE that also includes a choice question in case of delivery failure, a realistic choice scenario can be presented in which consumers have to make a decision between several delivery options and have to make trade-offs between those delivery options.

3.5.1 Identifying delivery alternatives

For the delivery options that are available in the Dutch parcel delivery market, the websites of the four largest parcel delivery companies were analysed. Here information provided on the Dutch websites of PostNL, DHL, DPD and GLS is used, as these are the four largest postal and parcel delivery companies in the Netherlands according to the Dutch Authority for Consumers & Market (Autoriteit Consument & Markt, 2021). These options are listed in Table 3. It is assumed that the delivery options these companies offer are a good reflection of the options available in the Dutch parcel delivery market. These are also the three delivery options that are considered in the first choice question that aims at understanding delivery preference for an online ordered product

Another aim of this research is to gather insights into the preferences of consumers for delivery options when they are not home to attend the home delivery. To identify preferences for this scenario, a new set of delivery alternatives has to be identified. To this end, several alternative options were identified in the literature, as summarised by Allen et al. (2007): delivery to neighbours, delivery to a reception box, delivery to a CDP, delivery to a parcel locker station, delivery using smart locks. Again, the options available by the four largest parcel delivery companies are listed in Table 4. The option 'leave the parcel at an agreed place around the house' is widely offered in the Netherlands. In the literature, this option is also called 'unattended home delivery'.

Table 3: Delivery Options

Option	Delivery Companies
Home Delivery	PostNL, DHL, DPD, GLS
Deliver to a Service Point	PostNL, DHL, DPD, GLS
Deliver to a parcel locker	PostNL, DHL

Table 4: Delivery Options when Home Delivery fails

Option	Delivery Companies
Neighbour delivery	PostNL, DHL, GLS
Leave the parcel at an agreed spot around your home	PostNL, DHL, DPD, GLS
Deliver to a Service Point	PostNL, DHL, DPD, GLS
Deliver to a parcel locker	PostNL, DHL
Change the day of delivery	DPD, GLS
Change delivery address	DPD

As this study aims to extend earlier research by Molin et al. (2022), the three alternatives that are included are:

home delivery, delivery to service point, and delivery to parcel locker. The choice for these three alternatives is also well embedded in academic literature, as self-collection alternatives are generally viewed more positively (Asdecker, 2021). These three alternatives are also the three options that are currently offered in the Dutch parcel delivery market by the four largest parcel delivery companies (Autoriteit Consument & Markt, 2020). The delivery options that are bold in Table 4 represent the five delivery alternatives that are selected to be included in the second choice question, which presents respondents with a choice scenario where the preferred home delivery is anticipated to fail. As this study is focused on Parcel Lockers, it is decided not to include delivery to a reception box or delivery using smart locks, and to introduce just one last-mile delivery innovation in the form of the Parcel Locker. Introducing other delivery options which respondents might not be familiar with could make the DCE unnecessarily difficult and might take the focus of the respondents off the Parcel Locker. Although delivery to a Parcel Locker is not a new concept, in the Netherlands there were not many located in the past and the percentage of consumers who have used them is low.

3.6 Design of choice questions

This section will discuss the structure of the DCE and its choice question, as it sets the basis for the remainder of this research. This study aims to find what factors influence consumers' choice of a delivery option for online ordered products, at the online checkout and in case of delivery failure. The preceding literature review has shown that preferences in case of delivery failure have been interest of little research. More specifically, this study aims to determine whether the PL is perceived as a serious delivery alternative in case of delivery failure. As was explained earlier, this study will use a DCE to provide information on trade-offs consumers make between different delivery options. To this end, the DCE will consist of three choice questions, each question providing the respondents with a distinct choice scenario, which will not be discussed in detail in this section, but later in Survey Design. Whether the respondent moves on from one question to the next depends on their answer to the question. It will now be explained how this will work in the survey.

The first question will present the respondent with a choice question asking them to choose a preferred delivery option in the choice scenario 'at online checkout'. This choice question aims to capture consumer preference for delivery options and trade-offs between these options. This choice question will include the Home Delivery delivery option. If a respondent chooses Home Delivery in the first choice question, the respondent will advance to the second choice question. This is structured in this way because it provides us with a sample of respondents who are users of 'Home Delivery'.

The second choice question 'in case of delivery failure' presents respondents with a choice scenario in which they receive a message from the parcel delivery company informing them that the chosen home delivery will take place within a certain time window. The respondent must imagine that they, unfortunately, are not at home in this given time window, and have the possibility to choose an alternative delivery method instead. This choice scenario mimics a situation of delivery failure. Since this question presents respondents with a scenario in which they have previously chosen Home Delivery, it is important that the respondents are actual users of Home Delivery. This is what the structure of the questions ensures. If a respondent does not choose Home Delivery in the first choice question 'at online checkout', they are also not shown the second question 'in case of delivery failure', because they are not part of the population that this choice question wants to address. Respondents are asked to choose their preferred delivery option when the delivery fails. If respondents choose the option 'Another Moment' in this question, they are shown a third-choice question.

This third choice question presents the respondent with the same choice scenario as in the second choice question 'in case of delivery failure', but the delivery option 'Another Moment' is excluded from the set of options. Beforehand, it was expected that the option the reschedule the delivery to another moment could be a dominant delivery option since the option offers the possibility to still receive the parcel by Home Delivery. If this option was chosen too much, there would be an insufficient amount of data on the other delivery options. To account for this risk, the third choice question was designed to exclude 'Another Moment' in order to collect enough data on the trade-offs that are made between the remaining delivery options in case 'Another Moment would be dominant.

3.7 Selection of delivery attributes and other variables

This section will elaborate on the selection of delivery attributes to include for each delivery alternative that was selected earlier. The selection of the attributes is an important part of constructing the DCE as a research tool for this experiment. Next to that, this section will also elaborate on the various socio-demographic variables, shopping characteristics, and attitudes towards delivery methods that will be included in this research.

3.7.1 Selecting delivery attributes

In this study, the selection of attributes and their levels is based on the Literature Review. The literature review has identified a lot of factors that can influence the consumers in their preferred delivery method, listed in Table 1. These factors are either generic delivery attributes such as delivery price and delivery speed, or factors that are specific to an alternative. Such factors are the delivery window and delivery date for the home delivery alternative, and factors such as opening hours and distance for the self-collection alternatives Service Point and Parcel Locker. This section will discuss the factors shortly, and then argue why the factor is included or excluded.

Almost every econometric study on consumer preference in last-mile delivery finds that delivery price is the most critical attribute (Silva et al., 2019; Kiba-Janiak et al., 2022; Rai et al., 2019; Molin et al., 2022; Rossolov, 2021; Merkert et al., 2022). Additionally, various research states that in order to stimulate the use of parcel lockers or service points in favour of home delivery, a monetary incentive is needed Molin et al. (2022); Iannaccone et al. (2021). Moreover, in Poland, an important reason for using a parcel locker was stated to be the lower price Moroz & Polkowski (2016); Lemke et al. (2016). In countries like Poland or Sweden, parcel delivery companies offer differentiating prices for different delivery options, and in these countries, consumers pay less for parcel delivery to a parcel locker than they do for parcel delivery through home delivery. This difference in price, in favour of delivery to a Parcel Locker, can be seen as a price incentive to use the PL. In countries where there are no differentiating prices in the current market, such as the Netherlands, such price incentive through offering differentiating prices is often mentioned as one way to increase the use of PLs. Including price allows this research to study the effect of a price incentive on Parcel Locker demand. Another important feature of including price as an attribute is that it allows for the computation of consumer's willingness-to-pay (WTP) for other delivery features Rohr et al. (2011). As price is often found to be the most important delivery attribute, and because a price incentive is seen as an important feature in stimulating PL use, price is included in the experiment.

Delivery speed is also acknowledged as an important factor in the choice for a delivery option, however much less important than delivery price in most studies. Fast delivery, preferably the next day, is still preferred by the majority of e-consumers. In the studies that incorporate delivery time, less fast delivery results in negative utility, for example, Nguyen et al. (2019); Gawor & Hoberg (2019). Gawor & Hoberg (2019) found that delivery on the same day or 1-2 window yields positive utility, whereas longer delivery times yielded negative utility. It depends on the e-retailers from what options the consumer can choose regarding delivery speed. Some offer only one option, in most cases next-day delivery, while others (such as Zalando) offer standard delivery between 2-3 days for free and next-day delivery as a premium option. However, 98,9% of all parcels are delivered the next day (Autoriteit Consument & Markt, 2021). Currently, there is no difference between traditional Home Delivery and self-collection delivery options in terms of delivery speed, and no future plans to do so. Due to the high number of parcels delivered the next day, and the lack of plans to differ delivery speed of delivery options, it is decided to not include delivery speed as an attribute in the experiment.

Traceability is another generic delivery attribute. Traceability is offered in different ways by parcel delivery companies and in different stages of the delivery process. Parcel delivery companies or e-retailers provide consumers with information about when the parcel is shipped to the parcel delivery company when the parcel has left the distribution centre, and sometimes also with a time window in which the delivery is scheduled to take place. Receiving information on the status of their parcel increases utility among female respondents from Norway (Caspersen & Navrud, 2021). de Oliveira et al. (2017) find that providing information and traceability have the highest relative importance, higher than the cost of transportation. However, as traceability already has a place in the choice context of the experiment, it is not included as an attribute for the different delivery options.

An explicit environmental attribute was considered, as it has got increased attention in the academic literature on last-mile delivery lately (Kiba-Janiak et al., 2022; Caspersen & Navrud, 2021; Caspersen et al., 2022; Ignat & Chankov, 2020). As environmental worries have grown louder, this could be expected. Such an attribute will not be included in this study, as computing a quantitative value of say CO2 emission for a delivery is very

difficult. Many assumptions would have to be made regarding the type of delivery vehicle, distance travelled by this vehicle, as well as the modal choice of pick-up for the service point and parcel locker alternatives. However, the study will ask respondents' sustainability perception of home delivery and parcel lockers, to examine whether these influence delivery choice. The study also indirectly addresses the environmental aspect by including service points and parcel lockers in the DCE, as these are two delivery options that can positively impact the environmental impact of last-mile delivery.

For home delivery, different studies find being able to pick a time slot or the delivery date has varying importance to consumers. Being able to customise the delivery date is preferred Kiba-Janiak et al. (2022). While Rai et al. (2019) find an indifference by consumers towards delivery during working hours, on the weekends or in a 2h time slot. Molin et al. (2022) find most utility is gained when the possibility of choosing evening delivery is added to the weekday delivery option. This could be attributed to the fact that a lot of people are not at home throughout the day. de Oliveira et al. (2017) also find a preference for more flexible delivery hours compared to delivery during business hours. However, the option of choosing a specific time slot is not often provided by e-retailers Edwards et al. (2010). Research has shown that time slots have a significant impact on travelled kilometres and delivery costs on the business side Boyer et al. (2009); Manerba et al. (2018). This could be a probable reason as to why e-retailers do not offer the possibility of choosing a time slot for delivery. The option to select a narrow time slot for delivery is therefore not included as an attribute in the study.

In order to depict the home delivery alternative as realistically as possible, the delivery date and the possibility of evening delivery are included, combined into one attribute 'moment of delivery'. These attributes thus include the day of the week on which delivery is possible and whether deliveries can be made in the evening, as these two attributes are deemed to characterise home delivery to a sufficient extent. The separate attributes are inspired by earlier work from (Nguyen et al., 2019).

A service point or a parcel locker has various sources of utility and disutility, sources such as their location (distance, parking availability) or their quality (opening hours, days before the parcel is returned) (Collins, 2015). Based on these sources, a number of attributes are selected that describe the service point and parcel locker best. It is also important that the chosen attributes and their levels are also useful and can be put into practice.

Scholars show that distance to a parcel station or a service point has the potential to significantly decrease utility for the self-collection alternatives (Iannaccone et al., 2021; Molin et al., 2022; de Oliveira et al., 2017). This is expected since it is logical that the further away a SP or PL is located, the less attractive this delivery option becomes as the effort to pick up the parcel increases. Furthermore, Polish consumers indicate that they expect a parcel locker to be close to their homes (Iwan et al., 2016). Whereas e-consumers from Italy also identify 'close to home' as their most preferred location for a parcel locker Mitrea et al. (2020). In a qualitative study on place-of-delivery innovations, Asdecker (2021) finds spatial impediments, i.e. the proximity of the locker, to be the factor that the majority of respondents identify as the circumstance influencing parcel locker use. It can be concluded that proximity to the consumer is perceived as critical for the consumer to begin using self-collection alternatives. Distance is included for both SP and PL as an attribute in the DCE.

To pick up the parcel at your own convenience is often named by consumers as a major advantage of SP or PL over traditional home delivery, especially the potential 24-hour accessibility of a parcel locker (Iwan et al., 2016; Rai et al., 2019). The opening hours of a SP or PL can both negatively and positively impact the convenience of having a parcel delivered there. Opening hours of a SP or a PL vary based on their location. If a service point is only opened during working hours, this could for some consumers that work during the day mean that there is no gain in convenience for choosing the service point. The same argument holds true for parcel lockers. Opening hours is included as an attribute for both SP and PL because it has the potential to restrict the convenience of the pick-up process, and because for the PL alternative, the more flexible opening hours are what sets it apart from Home Delivery and a Service Point Rai et al. (2019); Iwan et al. (2016); Molin et al. (2022).

Parking availability and the location of the PL are deemed less important and are not included in the DCE. Availability of parking increases, although only to a small extent, the use of CDPs compared to home delivery (Collins, 2015). The importance of the availability of parking space nearby indicates that this share of consumers would probably plan on picking up their parcel by car. Availability of parking is not included because it would only be an important attribute for car-owning consumers, which would limit its relevance compared to other attributes. Parcel lockers can be located at a wide variety of locations: near public transport stations

or gas stations, shopping locations such as supermarkets or shopping centres, or service sites like the post office banks or gyms. Iannaccone et al. (2021) found the type of location to be insignificant for Italian students. Close distance seems to be more important, as is also shown by Iwan et al. (2016) where only a small share of the respondents expect a parcel locker to be close to shopping centres or public transport stops.

Parcels cannot stay in the locker for a long time, just as is the case for parcels at Service Points, as the parcel takes in space that can not be occupied by a new parcel. That is why parcel delivery companies have set a fixed number of days for the Parcel Locker in which the consumer has to pick up the parcel. Otherwise, it will be returned to the sender. For the parcel locker, the number of days before the parcel is returned to the sender (RTS) is a particularly interesting attribute. The longer the RTS period is, the more attractive it is for the consumer (Collins, 2015). Collins (2015) found RTS to be significant when people are planning a pick-up from a shopping location and argue that a longer RTS should have an environmental benefit as this provides consumers with the flexibility to combine the pick-up with a trip they were already going to make. On the contrary, for last-mile delivery companies, a longer RTS period is not favourable. The time before a parcel is returned to the sender can strongly influence the efficiency of the parcel locker (Duin et al., 2020), as it impacts the occupancy rate of the locker. The locker occupancy rate is the percentage of lockers that are occupied. A longer RTS could result in a higher occupancy rate, which means that fewer lockers are available for either delivery or return of other parcels. This in turn means that the Parcel Locker is generating less revenue for the parcel delivery company. The RTS period is included as an attribute for the PL, as this conflict of interest between consumer and company is interesting to investigate.

The preceding attributes are either specific characteristics of a delivery option or more generic characteristics of the delivery process. There are also characteristics of the parcel to be delivered that can influence consumers' choice of a delivery option. These are characteristics such as weight, size, price, and product type. Naturally, very heavy or very large parcels are less suitable to be delivered to a SP or a PL. Such parcels, like washing machines or furniture, greatly inconvenience the pick-up process for the consumer, especially if the consumer does not own a car. So, this is also impacted by the type of product. Furthermore, parcel lockers are not designed to be able to handle very large parcels. In these instances, Home Delivery will be necessary. Results from a case study in the Amsterdam neighbour 'de Pijp' show that 75% of the parcels that were ordered online would fit in a parcel locker (van Amstel, 2018). Lastly, there is the price of the product. There are some consumers who have security concerns regarding the parcel locker (Duin et al., 2020). For products with a higher price, it is likely that security concerns are more prevalent than for lower-value parcels. However, research by Asdecker (2021) find that security is not an issue for the parcel locker. It should be noted that this is based on interviews with just nine respondents. It is decided not to include these characteristics in the DCE, but to include them in the choice context. For the aim of this paper, it is more meaningful to include PL-related attributes that could help to shape this delivery service.

3.7.2 Selecting socio-demographic variables, shopping characteristics, and latent perceptions on delivery options

The frequency of online shopping is often found to influence consumer preference for last-mile delivery innovations (Rai et al., 2021), and is also commonly used in consumer segmentation (Nguyen et al., 2019). Additionally, Ma, Teo, & Wong (2022) find that frequent online shoppers perceive the value of self-collection as lower, which impacts their self-collection preference. Ma, Teo, & Wong (2022) also find consumers who have no experience with self-collection perceive the value of self-collection lower and consider the process as a burden. By including the shopping characteristics: frequency of online shopping, frequency of use of SP, and frequency of use of PL, this research can investigate whether the findings by Ma, Teo, & Wong (2022) are also present in the Dutch population. Besides that, the frequency of use of SP and PL provides information on the current state of self-collection use for parcel delivery in the Netherlands. To test whether the findings by Ma, Teo, & Wong (2022) also exist in this sample of Dutch consumers, some interactions will be estimated between the frequency of using SP/PL and the distance and price attributes of these two delivery options. It is expected that people who use SP or PL more often are willing to pay more for these options and travel longer distances to a SP or PL, because as consumers use the delivery option more they better see their added value.

The finding by Ma, Teo, & Wong (2022) that people who have no experience perceive the value of self-collection as lower indicate that there is another aspect to the current state of self-collection that can be researched. That is, how do Dutch consumers perceive the value of self-collection alternatives? As Ma, Teo, & Wong (2022) shows, this could have a significant effect on the delivery choice. This is interesting for parcel delivery companies to

know because it provides them with information on whether Dutch consumers see value in self-collection and on what aspects parcel delivery companies could try to inform consumers better. Statements on this aim to capture a potential relationship between the perceived value and delivery choice. It is expected that consumers who see more value in self-collection are more likely to choose SP or PL compared to HD. Similar to the goal of adding the interactions between the use of SP/PL, an interaction is estimated between the perceived value of self-collection and the distance to SP/PL. It is expected that consumers who perceive a higher value for self-collection are more willing to travel longer distances to a SP or PL.

In the Netherlands, it is common practice to deliver a parcel to one of your neighbours when the recipient if they are not home. Rai et al. (2021) included a question about preference in case of anticipated delivery failure in their study on crowd logistics, and found that people most interested in crowd logistics have a much higher preference to pick up a failed delivery at their neighbours than the other consumers segments. The other segments actually all prefer to pick up the parcel at a collection point. As one of the main contributions of this study is focused on delivery preference in case home delivery is anticipated to fail, consumer attitudes towards their social relationship with their neighbours and towards parcel delivery to their neighbours are investigated. It was hypothesized that whether a delivery was made to an immediate neighbour or a more distant neighbour could impact the consumers' attitude regarding Neighbour delivery. While for some the option of neighbour delivery may be preferred, others may not like it when the delivery is made to their neighbours. Consumers could feel more burdened to have a parcel delivered to a neighbour they do not know so well. Concerning the attitude towards neighbour delivery, it is hypothesized that people who have a more negative attitude towards different aspects of neighbour delivery are more likely to choose a different delivery option than Neighbour Delivery. Whether the degree of social contact with your neighbour influences the consumers' attitude towards neighbour delivery will be tested through correlation and by including it as a parameter in the choice model. This latter is tested in the model estimation part and will be discussed in the model interpretation.

Recently, Ignat & Chankov (2020) and Kiba-Janiak et al. (2022) among others have focused on the environmental aspect of consumer preference in last-mile delivery. They concluded that a lack of awareness of the environmental benefits of self-collection could be one of the reasons why consumers choose less sustainable delivery options. Earlier, it was decided not to include the environmental aspect as an attribute in the DCE. By including statements in the survey on the perceived environmental sustainability of the delivery options HD and PL, this study aims to provide insights into how Dutch consumers perceive the environmental aspect of the delivery choices and aims to capture whether consumers with a higher notion of the environmental sustainability of a delivery option are more likely to choose that option. It also allows for a comparison between the delivery options Home Delivery and Parcel Locker.

By gathering socio-demographic data the representativeness of the sample of respondents compared to the population can be determined. Second, by including these variables, their impact on utility can be estimated. This also allows for the segmentation of different socio-demographic groups and/or estimating market demand within a specific socio-economic context. Molin et al. (2022) find gender, education, urbanity level, work status and household income to significantly influence consumer preference. Italian consumers with higher education tend to be less likely to choose home delivery (Iannaccone et al., 2021). It is decided to include six basic socio-demographic variables: age, gender, education level, employment status, and income to assess the representativeness of the sample. Further, it can realistically be hypothesized that people of different socio-demographic contexts make different choices. For example, younger people are often associated with being more open to technological changes or innovation, and could therefore be more open to adopting last-mile delivery innovations like the parcel locker. Furthermore, the urbanity of residence of the respondent is included, as well as availability at home. Here, it is hypothesized that the degree of someone's availability at home to receive a parcel could impact their liking for home delivery, or for self-collection. For including urbanity of residence, the level of urbanity has a significant impact on factors relating to efficiency such as regulation and drop density (Mommens et al., 2021). Mommens et al. (2021) state that at the moment, Home Delivery seems more sustainable in rural and suburban areas, whereas self-collection proved to be more sustainable. By including urbanity, one could determine whether demand in these areas matches the findings by Mommens et al. (2021). Last-mile delivery is context-dependent, information on whether preferences for delivery options differ between urban segments adds to the knowledge of this context. For all these socio-demographic variables, their effect on the utility of each alternative will tested. Some interactions between the socio-demographic variables and the delivery attributes will also be estimated. The first group of interactions that is estimated is between age and price of HD, SP and PL. The second group of interactions will be estimated between income and price of HD, SP or PL. Here, it is hypothesized that there is heterogeneity in taste for the price parameters. People

are expected to become less sensitive to higher prices once they are older, or when their income is higher. An interaction between age and distance for SP and PL is also estimated. Here, it is expected beforehand that younger people are more willing to travel longer distances to a SP or PL. It is assumed that they are, in general, more vital and therefore experience less inconvenience from longer distances. Lastly, an interaction between urbanity and the distance to a SP and PL is estimated. The level of urbanity of the residence of a consumer could have an impact on willingness to travel to a SP or PL, as one could perceive travelling through a busy city area as more demanding than travelling the same distance through a quieter suburban or rural area.

3.7.3 Conceptual Model

In the foregoing paragraphs, several categories of factors are discussed that can all influence how consumers make their choice when picking a delivery method, and arguments are given as to why these factors are important to include in this study. Based on these factors, a conceptual model is constructed to graphically present the different categories that are included, the factors are that belong to each category, and their relationship to each other in the light of the DCE. For all the categories of factors, their impact on utility will be tested. Interactions with the delivery attributes will also be included and tested for all three of the other categories of factors. By testing these interactions, it can be established whether heterogeneity in taste for a certain delivery attribute can be explained through one of the other factors that are included in the model.

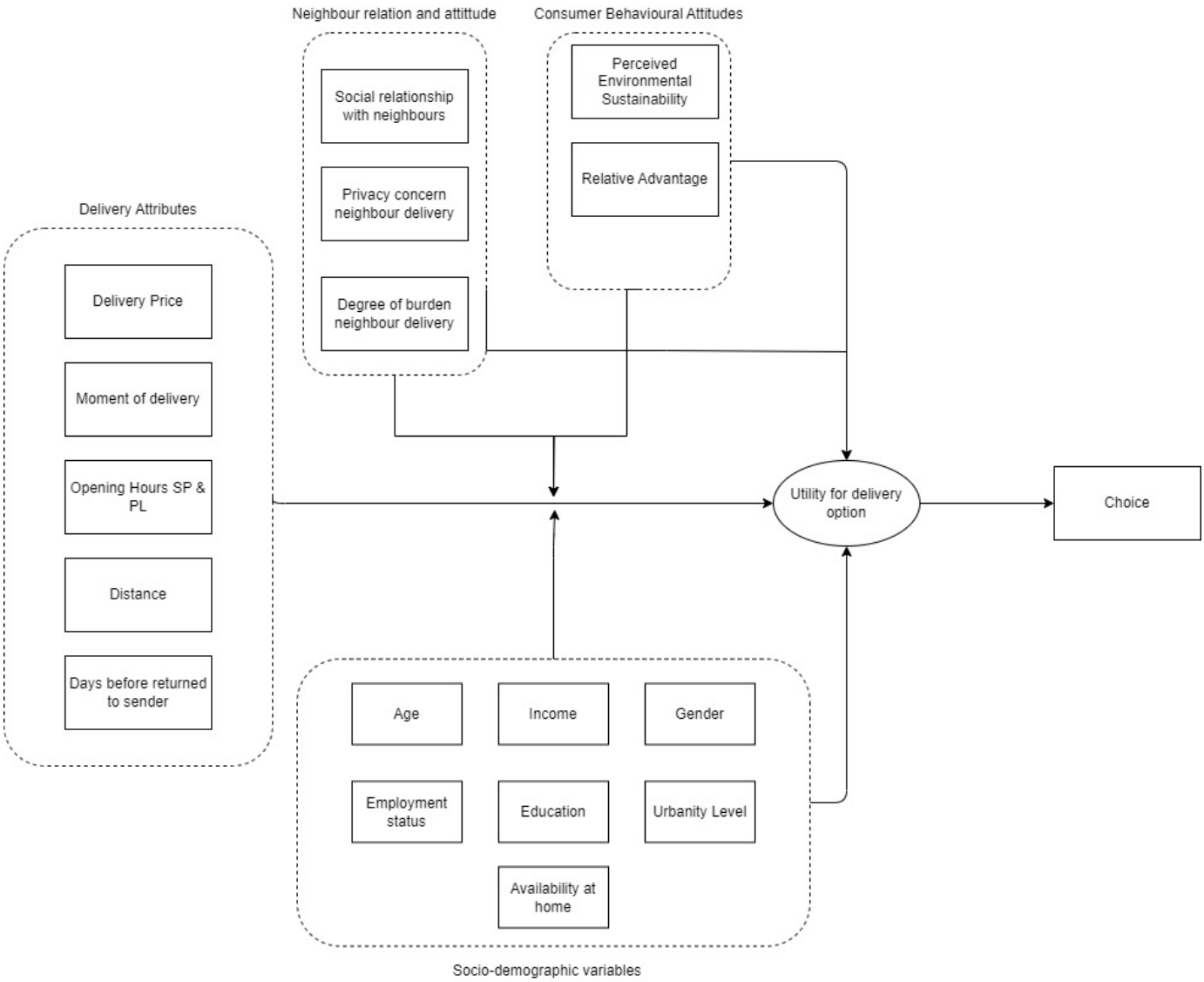

Figure 5: Conceptual model

In this section, the basis for this research is set. Through the literature review, it was identified that there is a research gap regarding the preferences for delivery in case of a failed delivery and to what extent the PL is perceived as a good option in that event. The literature review has identified a string of similar research and the factors related to different parcel delivery methods that they investigated. The aim of this section was to find and select a set of factors that could be included in the DCE, as well as relevant socio-demographic variables, shopping characteristics, and attitudes towards different delivery methods. The delivery attributes that are selected are price, delivery moment (HD), opening hours (SP, PL), distance to the pick-up location (SP, PL), Days before Return to sender (PL). The conceptual model pictured above summarises the factors, variables and attitudes that will be part of the survey. These are used in the next section to further develop the research instrument of this study.

4 Operationalisation

This chapter will cover all the steps in the development of the DCE, the survey, and the process behind the model estimation. The last step in the development of the DCE is to select fitting attribute levels. After that, this section will elaborate on the measurement scales of the various socio-demographic variables, shopping characteristics and attitudes that are included in this study.

4.1 Selecting attribute levels

In this section, attribute levels will be selected for the attributes that were selected in the previous chapter. This section will explain how these attributes can be measured. Suitable levels for these attributes will be selected in order to present the consumer with a realistic depiction of the current delivery situation, and additionally to select attribute levels which represent possible futures for Parcel Lockers in the Netherlands to be able to determine how this might influence consumers delivery choices. An overview for each attribute is given in Table 5.

It is important that the price attribute is expressed in terms of a real monetary value and not in relative terms, as is sometimes done with respect to a discounted delivery cost when a PL or SP is chosen. Delivery is often still offered for either free or free if the shopping amounts to a certain value. But there are also many e-retailers, especially smaller businesses, that always ask for a delivery fee. Research by a Dutch website for coupons looks into the delivery fees for all e-retailers linked to their platform, as well as some other big e-retailers, and finds that seven out of 10 online shops offer free delivery above a certain shopping value. When the free delivery above a certain amount is not taken into account, the average delivery fee is found to be 4.11 euros. Most online shops ask 3.95 euros for delivery. They find that 19 percent of all webshops that are connected to their platform always ask for a delivery fee. The findings of this research can only be found through a webpage (Essenburg, 2022), but no original source can be found. Another indication of a suitable range can be found in how much consumers indicate to be willing to pay for delivery. Here, research by delivery platform Wuunder shows that above 2 euros, consumers consider visiting a local store (Kempe, 2023). Duin et al. (2020) present a case study in Amsterdam, where the delivery cost for the parcel delivery company amounts to around 1.14 euros in the case of standard home delivery, and around 0.92 euros for delivery to parcel lockers. These are however not the total costs and not what e-retailers pay for delivery. A range of [0,2,4,6] euro is deemed to provide a realistic image and leaves room for exploring the impact of more expensive delivery costs. As for the SP and PL alternatives, a range of [0,2] euro is decided upon as it was deemed necessary to incorporate a price incentive in a sense, but it also poses scenarios where both options are evenly expensive and forces respondents to make trade-offs.

The attribute ´moment of delivery´ is a combination of two attributes used by Nguyen et al. (2019), so the selection of the attribute levels is inspired by their work. Evening delivery is increasingly offered and was found by Molin et al. (2022) to add significant utility. Further, providing more flexibility in the delivery date contributes to consumer satisfaction for the delivery process (Xing et al., 2010; Xing & Grant, 2006). Delivery during the day on weekdays was used as the base option, as this is the most commonly offered delivery option by parcel delivery companies. The attribute levels are constructed in such a way that each attribute level is expected to offer more flexibility compared to the former level, either by adding the option of evening delivery or weekend delivery. See Table 5 for the levels that are selected for 'moment of delivery'.

Concerning the attribute levels of 'opening hours' for the SP alternative, a similar logic was followed with 'moment of delivery', each level adding a little more convenience. The opening hours of SPs in the city of Rotterdam were used as a reference. It largely depends on where or within what kind of building or enterprise a service point is located. Some Service Points are only open during working hours, either only during the week or on Saturday. These Service Points are often the smaller shops and stores. Many Service Points are also located within supermarkets or hardware stores, these offer a wider range of opening hours, also in the evening and on both Saturday and Sunday. Four attribute levels were selected to represent both the least flexible opening hours of SPs located within smaller shops and stores, as well as the most flexible opening hours of SPs that are located within larger supermarkets or hardware stores. For the selection of attribute levels, see Table 5.

For the PL alternative, the 24-hour accessibility had to be included as was mentioned to be one of the attractive features of the parcel locker. Not all parcel lockers are located in locations where it is possible to offer 24-hour accessibility, many are also located within supermarkets or hardware stores. Bol.com and Albert Heijn, an online shopping store and supermarket chain, have recently collaborated to start placing parcel lockers in the

supermarkets. It was decided to include the wider opening hours of supermarkets as a first level for the PL alternative, as it provides a bit less convenience but is also common. It is chosen to include the wider opening hours of the supermarkets, as these are often the opening hours of the larger supermarkets, and this is where the PLs of the collaboration of Bol.com and Albert Heijn are located.

For the attribute 'Distance' it was decided to take a wide range. This wide range is favourable in a later phase of the study when estimating consumer choices and computing market shares under different scenarios because this allows for interpolation. Lyu & Teo (2022) mention that consumers' willingness to travel dropped off significantly after 250 meters. Based on this, the lower bound of 200 meters was set, to be able to capture this effect. Research by the Dutch ACM showed that consumers are prepared to walk a maximum distance of 500 to 1000 meters to a SP or PL (Autoriteit Consument & Markt, 2020), based on this 800 meters is included. To be able to capture as wide a range as possible and still provide respondents with distances that require trade-offs, 1400 meters and 2000 meters were chosen. Values of 1400 meters and 2000 meters are still realistic, as the parcel locker network still has a low coverage in the Netherlands. Only 4% of people in the Netherlands have a parcel locker located within walking distance (Autoriteit Consument & Markt, 2020).

In Asian studies on self-collection services, sometimes a time window of 2 or 4 hours is mentioned within which the parcel has to be picked up (Ma, Teo, & Wong, 2022). This is not what will be considered for this attribute in this study, as it is not a common feature in Europe. It is however interesting to incorporate a smaller window than is now common to see how this would impact consumers' choices, so a smaller RTS period of 1 day is included. Often a 7-day period is mentioned within which the parcel has to be picked up, see Rai et al. (2019) or Collins (2015). The two biggest parcel delivery companies in the Netherlands set different RTS periods, PostNL operates a maximum of 3 days and DHL operates a maximum of 7 days for consumers to pick up their parcel from the locker. For white-label parcel locker companies such as Budbee or DeBuren, the RTS period they operate depends on the RTS period that parcel delivery companies, like PostNL and DHL, operate. To capture all market offerings as well as the smaller RTS, it was decided to set the levels for RTS at [1,3,5,7] days.

Table 5: Alternatives, attributes, and levels for first choice question on delivery options at checkout

Alternative	Attribute	Attribute level
Home Delivery	Price	0, 2, 4, 6 euro
	Moment of delivery	Weekdays: only day
		Weekdays: day + evening
		Weekdays: day + evening, Weekends: only day
		Whole week: day + evening
Service Point	Price	0, 2 euro
	Opening hours	Weekdays: daytime
		Weekdays: daytime, Saturday: daytime
		Weekdays: day + evening, Weekends: daytime
		Weekdays and Saturday: daytime + evening, Sunday: daytime
	Distance	200m, 800m, 1400m, 2000m
Parcel Locker	Price	0, 2 euro
	Opening hours	Weekdays and Saturday: daytime + evening, Sunday: daytime
		Whole week: open all day (24/7)
	Distance	200m, 800m, 1400m, 2000m
	Days kept in locker (RTS)	1, 3, 5, 7 days

Table 6: Alternatives, attributes, and levels for second choice question on delivery options in case of delivery failure

Alternative	Attribute	Attribute level
Service Point	Opening hours	Weekdays: daytime
		Weekdays: daytime, Saturday: daytime
		Weekdays: day + evening, Weekends: daytime
		Weekdays and Saturday: daytime + evening, Sunday: daytime
	Distance	200m, 800m, 1400m, 2000m
Parcel Locker	Opening hours	Weekdays and Saturday: daytime + evening, Sunday: daytime
		Whole week: open all day (24/7)
	Distance	200m, 800m, 1400m, 2000m
	Days kept in locker (RTS)	1, 3, 5, 7 days
Delivery to Neighbours	-	-
Leave at an agreed place around the house	-	-
Choose another moment	-	-

4.2 Measuring attitudes on neighbour relation and delivery

To include the social relationship with neighbours and the attitude towards neighbour delivery in this study, several questions and statements have been created in collaboration with the thesis supervisor, Eric Molin. Respondents are asked first to think about their immediate neighbours, i.e. living in the house next to them. Then the same question on social interaction and the statements on neighbours delivery are asked but with more distant neighbours (the four houses next to them) in mind. By incorporating two types of neighbours, immediate and more distant neighbours, it can be investigated whether this influences consumer's attitudes towards neighbour delivery. Parcel couriers also deliver missed parcels to more distant neighbours, so it was decided to describe the more distant neighbours as four houses to each side of the house. Four houses to each side is seen deemed to depict neighbours far enough to be viewed as inconvenient for the recipient, while also being a probable option for the parcel courier to deliver to. The questions and statements will test whether the degree of social interaction with your neighbour affects (i) consumer attitude towards neighbour delivery and (ii) their preference for delivery in case of failed delivery. Table 7 shows the questions and levels for asking for the degree of social interaction with the two types of neighbours. Table 8 shows the statements that are presented to the respondents, which they have to rate on a 5-point Likert scale, ranging from 'does not apply to me at all' to 'applies completely to me'.

4.3 Measuring attitudes towards sustainability of Home Delivery and Parcel Locker

As was already discussed earlier, it is difficult to determine the sustainability of a delivery option. For Home Delivery, it depends on the type of vehicle that is used for the delivery. Using an electric vehicle for delivery makes it much more sustainable than if a fossil-fueled delivery van is used. For the self-collection alternatives SP and PL, the type of vehicle that is used to deliver the parcel to the SP or PL matters, as is the case for Home Delivery. The mode of transport that is used by the consumer to pick up the parcel also greatly affects the sustainability of the delivery option (Collins, 2015; Schnieder et al., 2021). In the case of SP and PL, local factors such as drop-density and regulation also impact the sustainability of self-collection (Mommens et al., 2021), making it even harder to establish whether one option is more sustainable than the other. The

Table 7: Social relation with neighbours

(1)Take the immediate neighbour or neighbours (i.e., those who live right next to you)into consideration, whom you know the best. How well do you know these neighbours? **(2) When you think about the four houses on either side of your home, how well do you know most of these neighbours?**
Not applicable: I have no neighbours
I wouldn't recognize these neighbours on the street
I recognize these neighbours on the street, but I don't greet them or speak to them
I only greet my neighbours
I regularly have a chat with my neighbours
My neighbours and I sometimes visit each other
My neighbours and I engage in many activities together, such as drinking coffee, eating dinner or playing sports

Table 8: Attitude towards neighbour delivery

Does not apply to me at all (1) / Applies completely to me (5) *To what extent do each of these statements apply to you?*
(1) I feel burdened when I have to pick up a package from one of my neighbours
(2) I don't like it when a package is delivered to one of my neighbours because I don't want them to know I ordered something online
(3) I don't like it when a package is delivered to one of my neighbours because then they would know what I approximately ordered online
(4) Since I also accept packages for neighbours, I don't mind picking up a package for myself from a neighbour
(5) I prefer to have a package delivered to my neighbours rather than to a pickup center

statements are adopted from (Wang et al., 2020) and (Yuen et al., 2019). In order to prevent misconception or to falsely depict one option as sustainable and one as not sustainable, the statements are rephrased. The statements are rephrased in such a way that the statements are not posed as a fact but ask respondents to indicate whether they perceive (their opinion) a delivery option as sustainable or not. The statements cover the perceived environmental sustainability of Home Delivery, as well as for Parcel Lockers. The attitude statements and their measurement items are listed in Table 9 below.

4.4 Measuring attitude towards the relative advantage of Parcel Locker over Home Delivery

The last block of the statement asks respondents if and on what aspects they perceive the relative advantage of self-collection compared to home delivery. Several studies that cover the benefits have already been discussed in the Literature Review. For example, the study by Asdecker (2021) gives a good indication of what consumers think are attractive features of the Parcel Locker. Home delivery is still the most common delivery method, and thus the delivery option that the PL has to compete with. Therefore, the statements will measure the value of the parcel locker, compared to home delivery. This means that the attitude will measure the relative advantage of Parcel Locker over Home Delivery. The statements are adopted from Yuen et al. (2018, 2019). The items are measured on a five-point Likert scale, ranging from Strongly disagree (1), to strongly agree (5).

4.5 Measuring socio-demographic variables

Measuring the socio-demographic variables is straightforward and it is assumed that this does not need further explanation. The categories of these variables aim to be inclusive of all possible socio-demographic groups. The measurement scales of these variables are listed in Table 20 in the Appendix.

Table 9: Measurement items

Perceived Environmental Sustainability (PES), Sources: (Wang et al., 2020; Yuen et al., 2019)
Strongly disagree (1)/Strongly agree (5)
PES1: Using (parcel locker/home delivery) would have a positive effect on environment and society
PES2: Using (parcel locker/home delivery) can generate less carbon footprint than other delivery methods
PES3: Using (parcel locker/home delivery) can be more sustainable in the long term
PES4: Using (parcel locker/home delivery) can create fewer negative externalities (e.g. noise or traffic congestion)
Relative Advantage (RA), Sources: (Yuen et al., 2018, 2019)
Strongly disagree (1)/Strongly agree (5)
Receiving parcels in a parcel locker would be better than home delivery, because using a parcel locker:
RA1: Improves my overall reception experience
RA2: Makes it easier to receive my parcel
RA3: Allows me to collect my parcels at my own convenience
RA4: Offers me a more customised service
RA5: Offers me more control over the delivery process

4.6 Measuring shopping characteristics

Additionally, three questions are asked about the online shopping behaviour of the respondents. The first question asks respondents how many parcels they order online per month on average. In 2020, the average number of parcels per household per year is estimated to be 30-35 (Walther Ploos van Amstel, 2021). Per month this would make between 2-3 parcels per household. To include both less frequent and more frequent online shoppers, a range of 'less than 1 time per month' to 'more than 8 times per month' is used. The second and third questions ask respondents to indicate their frequency of use of both SP and PL in the last year. It was decided to ask for the last year, as this is deemed a long enough period to establish whether someone is a frequent user of the SP or PL. As it is possible that respondents have not used a SP or PL in the last year, this option is also included. As more than 90% of the parcels delivered in 2022 are still ordered for home delivery Autoriteit Consument & Markt (2022), it is expected that varying the levels between 'zero' and 'more than 8 times' would provide enough distinction. The measurement scales for the shopping characteristics are listed in Table 23 in the Appendix.

4.7 Survey design

In this section, the context and experiment design of the survey will be discussed briefly. First, the choice contexts of the three distinct choice questions will be discussed. After that, the process of the experimental design of the choice sets is discussed.

4.7.1 Explanation of choice context for choice question 'at online checkout'

For the first choice question 'at online checkout' it is important to provide respondents with a plausible choice scenario, which they can identify themselves with. Since not all attributes can be included in the DCE, some attributes are defined in the context of the choice tasks, to make sure that respondents base their decisions on the same information and as little important information is missing. This prevents respondents from making their own assumptions. To this end, the value, and the type of the product that is ordered online are indicated, as well as the delivery speed. As this research aims to extend former research by Molin et al. (2022), the choice context that is used in their paper will also be used in this paper, if this context is still considered to be applicable now. Research by the Dutch Authority for Consumer and Market shows that in 2022 of all parcels that were delivered, 98,9% were delivered the next day (Autoriteit Consument & Markt, 2021). Based on this, the delivery speed set at 'the next day' is still considered applicable to the current situation. The rationale behind setting a fixed product type and product value is that it should be a product that all respondents can imagine themselves buying, it's of moderate value, and that fits in a parcel locker. Regarding the product value that is used, spending 65 euro is considered to be an appropriate amount. Although the average amount of

an online order has risen to almost 100 euro (Thuiswinkel.org, 2023), this may not be a value that everyone can imagine themselves spending online. A pair of sunglasses or a piece of clothing is considered to still be a type of product that everyone could imagine themselves buying. Therefore it is decided to maintain the value and type of product in the choice context used by Molin et al. (2022) in this study. The three delivery options Home Delivery, Service Point, and Parcel Locker are available in this choice question and are briefly explained to the respondents before continuing to this first choice question. The respondents are asked to choose their most preferred delivery option from the set of alternatives. The respondents are asked to choose their most preferred delivery option from the set of alternatives. Figure 6 below presents this choice context, as well as the complete choice set of all attributes, attribute levels and alternatives presented to the respondent in the choice question 'at online checkout'.

Figure 6: Overview of the choice scenario, delivery alternatives and their attributes and levels, for choice question 'at online checkout'

4.7.2 Explanation of choice context for choice question 'in case of delivery failure'

The second choice question 'in case of delivery failure' in turn will need a choice scenario in which it is made clear to the respondents that home delivery will fail, and that they are assumed to choose an alternative delivery option for the failed delivery. Information services to inform the consumer of the status of the delivery and a time slot of when it could arrive are increasingly used by parcel carriers to provide consumers with a better service. Furthermore, by providing the consumer with a time indication, the parcel carrier also hopes to reduce the chance of a failed delivery. Recently, parcel carrier companies in the Netherlands have started to provide the possibility to through this notification choose an alternative delivery option for when you are not home or if the delivery window does not suit you. Sometimes online stores do not offer other delivery options besides home delivery, forcing consumers to choose this option even though it might not fit their needs or their schedule. Additionally, delivery information, at the time of the purchase or later in the delivery process, is not always accurate. In the Netherlands, 13-22% of the parcels are not delivered on the agreed day (Multiscope, 2023). In such cases, being notified beforehand can benefit both the consumer and the delivery company, as delivery failure can be prevented. So, respondents will be notified by message with an indication of the delivery time window. Then, the scenario will tell them that the respondent will not be at home in this window and that the delivery will fail. The new options 'Neighbour Delivery', 'Choose Another Moment' and 'Leave at an agreed place around the house' are introduced to them and a short explanation is provided, as these delivery options do not have any attributes in the DCE itself. The respondents are asked to choose their most preferred delivery option from the set of alternatives. Figure 7 below presents this choice context, as well as the complete choice set of all attributes, attribute levels and alternatives presented to the respondent in the second choice question 'in case of delivery failure'.

Figure 7: Overview of the choice scenario, delivery alternatives and their attributes and levels, for choice question 'in case of delivery failure'

4.7.3 Explanation of choice context for choice question 'in case of delivery failure, Another Moment is not available'

The third choice question follows the second choice question and presents the respondent with the same choice scenario that is sketched in the second choice question but without the option to reschedule the delivery to Another Moment. So, for an explanation of this choice scenario, see the section above.

4.7.4 Structure of the survey

The survey consists of five distinct parts. The first part of the survey consisted of questions regarding online shopping frequency and previous use of SP and PL. The second part focuses on consumers' perception of their social relationship with their neighbours and their attitude towards parcel delivery to their neighbours.

The questions and statements on this are listed in Tables 7 and 8. In the third part, this study presents the respondents with the DCE, which consisted of three choice questions. This DCE follows the structure that is discussed earlier in Chapter 3. The fourth part consists of three blocks of statements on the perceived sustainability of home delivery, the perceived sustainability of parcel lockers, and the perceived advantage of self-collection over home delivery. These can be found in Table 2. The fifth and last part of the survey asks respondents for socio-demographic data on gender, age, income, working status, educational level, and urbanity level of residence.

4.7.5 Construction of choice tasks

For all three choice questions, an explanation of the corresponding alternatives, attributes, and their levels is presented prior to the DCE. The attributes and their corresponding levels are used to construct alternatives and choice sets. As the study presents labelled discrete choice sets, these choice sets have to be generated simultaneously. Ngene software was used to construct an orthogonal design for the choice tasks (ChoiceMetrics, 2012). Initially, a set of 20 choice tasks was generated. These choice tasks were blocked into two blocks each consisting of 10 choice tasks, in order to limit the time the survey would take and to prevent survey fatigue, as a larger number of choice tasks requires more effort. More than 15 choice tasks do not provide extra information from the respondent Hoogerbrugge & van der Wagt (2006) and are therefore not recommended. Figure 8 shows the experimental design used in this study. After the blocking procedure, the design is still orthogonal, however, the two blocks are not. Most importantly, after the blocking procedure, the attribute levels are balanced within both blocks. The Qualtrics software was used to equally distribute the two choice blocks among the respondents. The choice tasks within each block are also presented in a random order to the respondents. This was done to prevent survey exhaustion from impacting the same choice task towards the end of the DCE.

Design										
Choice situation	HD.price	HD.deliverymoment	SP.price	SP.openin	SP.distanc	PL.price	PL.openin	PL.distanc	PL.rts	Block
1	0	1	0	1	200	0	1	200	1	1
2	0	2	2	2	1400	2	2	2000	3	2
3	6	2	0	3	800	2	2	1400	5	2
4	2	3	2	2	2000	0	2	1400	5	1
5	0	4	0	4	200	2	1	1400	7	1
6	2	4	0	1	1400	0	2	200	7	2
7	2	3	0	1	800	2	1	2000	3	2
8	4	1	0	2	800	0	2	800	7	2
9	4	4	2	2	800	0	1	1400	1	2
10	2	2	2	4	800	0	1	800	7	1
11	6	4	0	4	1400	0	1	800	1	2
12	6	2	2	1	2000	2	1	200	3	1
13	2	1	2	4	200	2	2	200	1	2
14	0	2	0	3	2000	0	2	2000	1	1
15	6	1	0	2	1400	2	1	2000	5	1
16	4	4	2	1	200	2	2	800	5	1
17	6	3	2	3	200	0	2	2000	3	1
18	4	1	2	3	1400	0	1	1400	7	2
19	0	3	2	3	2000	2	1	800	5	2
20	4	3	0	4	2000	2	2	200	3	1

Figure 8: Experimental design to generate choice tasks

4.8 Data preparation

This section discusses the data preparation phase. To estimate a choice model on the data that is gathered by the survey, the delivery attributes that are included in the choice questions as well as socio-demographic information, shopping habits and questions on attitudes have to be coded into the right format. Concerning the attitudes, a factor analysis is performed on the indicators of the attitude in order to construct a LV, and an associated factor score per respondent is computed based on this analysis.

4.8.1 Coding choices per choice question

In the first choice question the choices are coded as follows:

- Home delivery = 1
- Service Point = 2
- Parcel Locker = 3

In the second choice question the choices are coded as follows:

- Service Point = 1
- Parcel Locker = 2
- Delivery to Neighbour = 3
- Another Moment = 4
- Agreed place around the house = 5

4.8.2 Coding delivery attributes

For Home Delivery, two attributes needed to be coded accordingly. The price attribute is of ratio scale and is assumed to be linear, therefore the real values used in the experiment are also used as input in the model. The attribute 'Delivery Moment' consists of four categories. This attribute is dummy coded into three variables, where 'Weekdays: during the day' is used as the reference category. The price attribute of PL and SP also is of ratio measurement, and therefore the real values used in the experiment will also be used for these variables in the model. The attribute RTS for the PL alternative is also of ratio level, and thus its real values are used in the corresponding variable in the model. The same applies to the distance attribute of PL and SP, but these are converted from meters to kilometres. The reasoning behind this is that if measured in meters, this would lead to very small parameter estimates. The attribute 'Opening hours' for the SP alternative consists of four levels and is dummy-coded into three variables. The least flexible level 'Weekdays: during daytime' is used as the reference category. The attribute 'Opening hours' for PL consists of two levels and is coded into a binary variable. The reference category, coded as 0, is again the least flexible option 'Weekdays and Saturday: daytime + evening, Sunday: daytime'. As the delivery attributes and their levels do not vary among the first and second choice question, these variable codings apply to both of these choice questions. The coding of the attributes and their labels can be found in Table 10.

4.8.3 Coding Shopping characteristics

Three questions were posed on shopping behaviour. The first question collects data on shopping frequency, the different levels can be ranked, however, the interval between the other options are not the same. As the variable indicates an increasing level of shopping frequency, and for simplicity reasons, this variable is coded linearly, with 1 representing the least frequent shopping. Then there are the two questions on the frequency of use of SP and the frequency of use of PL. Again, the levels indicate an increasing frequency of use of the alternative. In this case, there was also the possibility to indicate to have not used a SP or a PL. These variables are also coded linearly, starting at 0 with no use. An overview of the coding of these characteristics is shown in Table 23 in the Appendix

4.8.4 Coding socio-demographic variables

The survey collected data on age for the respondents' year of birth. To include age as a ratio variable, the respondent's age was calculated by subtracting their year of birth from 2023. Although this is a generalization, it is determined best as it makes the interpretation of age in the model more intuitive. Availability at home, the level of education, income, and urbanity level are all coded and are assumed to be of interval level for simplification reasons. The variables are coded linearly. Gender consists of three categories, and is dummy-coded into two variables, using 'Male' as the reference category. Furthermore, employment status consisted of five categories. These are grouped into three categories: 'non-working', 'part-time working', and 'full-time working', and are dummy coded into two variables. Non-working serves as the reference category. Table 21 in the Appendix presents an overview of the coding of socio-demographic variables.

Table 10: Coding of attributes for model estimation

Attributes	labels for dummy and coding			
Home Delivery				
Delivery price HD (euro)	0	2	4	6
Delivery moment HD	DM1_HD	DM2_HD	DM3_HD	
Weekdays: only day	0	0	0	
Weekdays: day + evening	1	0	0	
Weekdays: day + evening Weekends: day	0	1	0	
Whole week: day + evening	0	0	1	
Service Point				
Delivery price SP (euro)	0	2		
Opening hours SP	SP_OH1	SP_OH2	SP_OH3	
Weekdays: only daytime	0	0	0	
Weekdays: daytime Saturday: daytime	1	0	0	
Weekdays: day + evening Weekends: daytime	0	1	0	
Weekdays and Saturday: day + evening Sunday: day	0	0	1	
Distance SP (km)	0.2	0.8	1.4	2.0
Parcel Locker				
Delivery price PL (euro)	0	2		
Opening hours PL	PL_OH			
Weekdays and Saturday: day + evening Sunday: day	0			
Open all day, all week (24/7)	1			
Distance PL (km)	0.2	0.8	1.4	2.0
Days before Returned to Sender (RTS)	1	3	5	7

4.8.5 Coding Relative Advantage

To include the construct of Relative Advantage, a factor analysis is performed using SPSS. All indicators score a high enough factor loading (between 0.624 to 0.822) on the same factor. See Figure 9 in the Appendix for the factor loadings per indicator. The Cronbach's alpha reported for the factor is 0.839. To use a sum score to construct a factor score, the Cronbach's alpha should be > 0.70, or > 0.80 in the case of more than 10 indicators. A new latent variable Relative Advantage (RA) is now constructed by summing the values of all 5 indicators and taking the average.

Factor Matrix[a]

	Factor 1
RA1	,659
RA2	,822
RA3	,624
RA4	,723
RA5	,744

Extraction Method: Principal Axis Factoring.

a. 1 factors extracted. 6 iterations required.

Figure 9: Factor loadings RA, from SPSS

4.8.6 Coding Perceived Environmental Sustainability

For the constructs regarding the perceived environmental sustainability, the same approach is used as above to determine how the latent variable will be constructed. All statements regarding PL load high on the same factor (0.609 to 0.909). See Figure 11 in the Appendix for the factor loadings per indicator. The Cronbach's alpha is 0.871. A new latent variable 'Perceived Environmental Sustainability PL' (PES PL) is constructed by summing the scores on the indicators and taking the mean value. The same statements for HD also load high on the same factor (0.706 to 0.894), see Figure 10 in the Appendix. The Cronbach's alpha is 0.884. A new latent variable 'Perceived Environmental Sustainability HD' (PES HD) is constructed by summing the scores on the indicators and taking the mean value.

Factor Matrix[a]

	Factor 1
PES_HD_1	,876
PES_HD_2	,894
PES_HD_3	,772
PES_HD_4	,706

Extraction Method: Principal Axis Factoring.

a. 1 factors extracted. 6 iterations required.

Figure 10: Factor loadings PES HD, from SPSS

Factor Matrix[a]

	Factor 1
PES_PL_1	,816
PES_PL_2	,953
PES_PL_3	,817
PES_PL_4	,606

Extraction Method: Principal Axis Factoring.

a. 1 factors extracted. 9 iterations required.

Figure 11: Factor loadings PES PL, from SPSS

4.8.7 Coding Neighbour contact and Neighbour delivery attitude

The question on social contact with neighbours is measured on a seven-point scale, starting at 'Not applicable: I have no neighbours', with each level indicating an increasing degree of social contact. Therefore, this attribute is coded linearly, starting at 0 and ending at 6, indicating the highest degree of social contact. Table 22 in the Appendix shows this. It is decided to take the answers on the statements regarding the more distant neighbours because this type of neighbour better corresponds with where the parcel deliverer might drop off a missed delivery. To determine how to include the statements regarding neighbour delivery, a factor analysis is performed in SPSS. The results of this analysis showed that from the 5 statements, only two measure high on the same factor (see Figure 12 below). Upon closer inspection of the statements, only statements two and three measure a disliking to neighbour delivery in the same sense. It is decided to combine the two statements into one factor 'PRIVACY', that covers the concern of privacy on neighbour delivery. The two indicators both have a factor loading of 0.899 on this one factor. The Cronbach's alpha is 0.894. The factor score is computed as the mean value on both statements. This analysis is performed on the statements regarding distant neighbours. Additionally, the first indicator of neighbour delivery is coded separately as 'BURDEN', and is coded as 1 to 5 as it was measured on a five-point Likert scale.

Pattern Matrix[a]

	Factor 1	2
DN_LMD2	,982	
DN_LMD_3	,832	
DN_LMD_4		,851
DN_LMD_5		,522
DN_LMD_1		-,398

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.[a]

a. Rotation converged in 5 iterations.

Figure 12: Factor loadings Neighbour delivery, from SPSS

4.9 Model estimation process first choice question 'at online checkout'

The Methodology section describes two types of choice models: the MNL and the ML. As the ML model is computationally more demanding, it is chosen to first estimate the parameters on an MNL model before estimating an ML model on the choice data. This approach is taken for both the choice data sets of the first and second choice questions. This section provides an overview of the steps that are taken to arrive at the final model. In the Appendix, a more detailed account of this procedure is given. The choice model is estimated using the Apollo software package in R Hess & Palma (2019).

First, only the delivery attributes that are included in the choice question are included in the model estimation, as well as alternative specific constants for the SP and PL alternatives. As these attributes concern the main effects that are investigated in this study, they are important to keep in the choice model even if they are non-significant.

Second, all socio-demographic variables are added to the model. Socio-demographic variables are added to the model to determine whether certain socio-economic or demographic segments of consumers experience higher utility for one or more of the delivery options. All three alternatives include interactions between age and price, income, and price. For the two self-collection alternatives, interactions between age and distance are added, as well as an interaction between the level of urbanity and distance. By including these interactions, it is possible to establish whether there is heterogeneity in the sample for the delivery attributes price and distance that can be explained by age, income, or level of urbanity. Additionally, in this step, a linearity test is performed for the HD price attribute and the RTS attribute for the PL alternative. By testing for non-linearity for the HD price attribute, it is possible to determine whether utility decreases more rapidly with increasing HD price. The same holds for the RTS attribute. This can inform policymakers on the trade-off between different attribute levels. Linearity is tested by including a quadratic component in the utility function. Estimated parameters that are not significant at the conventional level of 0.05 (p-value) are not included in the next step of the model estimation procedure. If the estimated parameter is close to the conventional level of significance, it is argued to include them in the next step. The parameters that are added in this step of the model are listed below. Bold parameters are found to be significant in this step.

- Age
  - Age SP
  - **Age PL**
- Gender
- **Education**
- **Work status**
- **Income**
- Availability at home
- Urbanity of residence
- **Interaction: Age + Price**
  - **Interaction for HD**
  - Interaction for SP and PL
- **Interaction: Income + Price**
- Interaction: Age + Distance
  - Interaction for SP
  - **Interaction for PL**
- Interaction: Urbanity + Distance
- Linearity test HD Price
- Linearity test PL RTS

Third, shopping characteristics, as well as some interactions are added in this step. Interactions between the frequency of SP use and both distance and price are included in the model. For the PL alternative, interactions between the frequency of PL use and distance and price are also included. Similar to the previous step, insignificant parameters are excluded from the next estimation step, if not argued otherwise. The parameters that are added in this step of the model are listed below. Bold parameters are found to be significant in this step.

- **Frequency of online shopping**
- **Frequency of use of SP**
- **Frequency of use of PL**
- **Interaction: use of SP + SP Price**
- Interaction: use of SP + SP Distance
- Interaction: use of PL + PL Price
- **Interaction: use of PL' + PL Distance**

Lastly, latent variables are added. It is decided to include the latent variables (LV) 'relative advantage' (RA) and 'perceived environmental sustainability' (PES). This is the fourth and last iteration of estimating the MNL choice model. The latter Latent Variable PES is measured for both PL and HD. Two interactions are also included: interaction between factor score on RA and distance to either the SP or the PL. Again, insignificant parameters are excluded. This last iteration results in the final MNL model estimated on the first choice question 'at online checkout' data set. The model includes 41 parameters and reports a final LL of -1484 and a Rho-square of 0.35. The parameters that are added in this step of the model are listed below. Bold parameters are found to be significant in this step. The parameters that are added in this step of the model are listed below. Bold parameters are found to be significant in this step. Below, Table 11 shows the final parameter estimates for the MNL choice model.

- **Relative Advantage**
- **Perceived Environmental Sustainability HD**
- Perceived Environmental Sustainability PL
  - **Perceived Environmental Sustainability PL - Parcel Locker**
  - Perceived Environmental Sustainability PL - Service Point
- Interaction: Relative Advantage + Distance

Table 11: Final MNL model parameter estimates - Choice question 'at online checkout'

	Estimate	s.e.	t.rat.(0)	p(1-sided)
Alternative Specific Constants				
ASC_SP	-2.435313	0.591841	-4.1148	1.94E-05
ASC_PL	-7.73517	0.728109	-10.6236	0
Delivery attributes				
BETA_HDPRICE	-0.847514	0.058089	-14.59	0
BETA_HD_DM1	-0.237031	0.191801	-1.2358	0.108263
BETA_HD_DM2	-0.362387	0.175746	-2.062	0.019605
BETA_HD_DM3	0.16962	0.16596	1.0221	0.153377
BETA_SPPRICE	-0.737059	0.130674	-5.6404	8.48E-09
BETA_SP_OH1	-0.181483	0.175053	-1.0367	0.149931

Continued on next page

Table 11: Final MNL model parameter estimates - Choice question 'at online checkout' (Continued)

BETA_SP_OH2	-0.15742	0.19195	-0.8201	0.206078
BETA_SP_OH3	-0.023043	0.155542	-0.1481	0.441113
BETA_SPDISTANCE	-0.995933	0.174418	-5.71	5.65E-09
BETA_PLPRICE	-1.063231	0.113143	-9.3972	0.00E+00
BETA_PL_OH	0.038228	0.12688	0.3013	0.381596
BETA_PLDISTANCE	-1.365854	0.203548	-6.7102	9.72E-12
BETA_RTS	0.212564	0.027392	7.7602	4.22E-15
Socio-demographics				
BETA_EDUSP	0.176926	0.064201	2.7558	0.002927
BETA_EMP1SP	0.781159	0.207963	3.7562	8.62E-05
BETA_EMP2SP	0.750802	0.194869	3.8528	5.84E-05
BETA_EDUPL	0.26828	0.068501	3.9164	4.49E-05
BETA_EMP1PL	0.73176	0.22027	3.3221	4.47E-04
BETA_EMP2PL	0.748145	0.204168	3.6643	1.24E-04
BETA_INCSP	-0.119061	0.041632	-2.8598	2.12E-03
BETA_INCPL	-0.124773	0.042845	-2.9122	1.79E-03
Interactions				
Inc_Price_HD	0.028863	0.009094	3.1739	7.52E-04
Inc_Price_SP	0.043738	0.01896	2.3068	1.05E-02
Inc_Price_PL	0.075612	0.019298	3.9181	4.46E-05
Age_Dist_SP	0.005719	0.003798	1.5058	6.61E-02
Age_Dist_PL	0.010904	0.00404	2.6992	3.48E-03
FreqPL_Dist_PL	0.319815	0.132105	2.4209	0.007741
FreqSP_Price_SP	-0.07341	0.044603	-1.6458	4.99E-02
Shopping characteristics				
BETA_FREQ_SP	-0.384526	0.056158	-6.8472	3.77E-12
BETA_USESP_SP	0.589527	0.071342	8.2633	1.11E-16
BETA_FREQ_PL	-0.347912	0.058843	-5.9125	1.69E-09
BETA_USESP_PL	0.268553	0.063539	4.2266	1.19E-05
BETA_USEPL_PL	0.286537	0.173033	1.656	4.89E-02
Attitudes				
BETA_SP_RA	0.771536	0.105756	7.2955	1.49E-13
BETA_PL_RA	1.24894	0.118467	10.5426	0.00E+00
BETA_PESPL_PL	0.570973	0.105166	5.4293	2.83E-08
BETA_PESHD_SP	-0.499898	0.089218	-5.6031	1.05E-08
BETA_PESHD_PL	-0.280099	0.094112	-2.9762	1.46E-03

Estimating ML model on data first choice question

The next step in the model estimation procedure is to estimate a ML model on the choice data. Because the likelihood estimation function in the ML model is not closed form, simulation is required to integrate and estimate the model parameters. The choice models are estimated in R using the Apollo package for choice modelling (Hess & Palma, 2019). Halton draws are employed for the simulation, 500 Halton draws are used for estimating the model. Increasing to 1000 draws did not result in different parameter estimates, so it was

decided to run 500 draws as the parameters were stable at this number and fewer draws meant less computational time. The parameters for the variables and interactions that are significant in the MNL model are used in estimating the ML model. The choice data consists of 10 choices per respondent, making it panel data. The ML model automatically accounts for this panel structure. In the estimation of the ML model, the first step is to test for nesting effects. Both the SP and the PL are self-collection alternatives. It is assumed that these two alternatives have more in common with each other than with the HD alternative. Some people may have a preference for a self-collection alternative over home delivery. If this preference is not measured through the attributes of the alternative, it ends up as unobserved utility in the error term of the utility function of these alternatives. It is then likely that the error terms of these alternatives are correlated. To account for this, a shared error component, 'SIGMA SELFCOLL', is added to the utility functions of the SP and PL alternatives.

The parameters estimated for the delivery attributes of the choice question constitute the core part of the model because these attributes define the different delivery options and represent policy levers that stakeholders can pull to influence consumers. Therefore both significant and insignificant parameters of the delivery attributes attributes are of interest, and all these parameters are included in the model at all times.

In the second iteration, all parameters for the delivery attributes were allowed to vary randomly. The results of the first step of the ML model estimation showed that the delivery attributes: *Delivery moment*, *Opening hours SP*, *Opening hours PL*, are not significant. By estimating a sigma, the possibility that the delivery attributes are insignificant is due to the large heterogeneity in the sample for these attributes and their levels that cancel each other out. For the other delivery attributes *price*, *distance*, *RTS*, sigma's are also estimated. While estimating a sigma only provides information on whether there is heterogeneity and not why this is, the sigma's are still estimated because this does provide valuable knowledge for future research. If there is heterogeneity in the sample for one or more of the attributes, future research could focus on determining where this heterogeneity comes from in order to better grasp what consumer groups are for example (already) willing to travel longer distances to a PL or to pay more for using a PL. If there is no heterogeneity in the sample for a certain attribute, it could indicate that such research is not necessary and effort can be shifted towards other areas. The sigma's for RTS, HD Price, PL distance are all significant. The shared error component is also still significant. The insignificant estimated sigmas are excluded from the model, and the model is estimated again.

In the third and last iteration of the ML model, all parameters that were included in the fourth iteration of the MNL model are added. The parameters for education, availability at home, frequency of use of PL and the interaction between online shopping frequency and price were no longer significant for the SP alternative. For the PL alternative, availability at home, frequency of use of PL, and the sigma for the RTS parameter are no longer significant. These parameters are excluded from the model, and the model is estimated again. After this iteration, the frequency of use of PL is insignificant for the PL alternative and is excluded from the model. The model is estimated again, and this results in the final model. This model consists of 40 parameters and reports a final LL of -1333 and a Rho-squared of 0.41. The parameter estimates for the final ML model are shown in Table 12 below. A Likelihood Ratio Test is performed to determine the probability that the second iteration model performs better is due to coincidence. The LRS equals 270 and df = 21. Based on this and the Chi-square table, it can be concluded that the probability that the second iteration model performs better than the first iteration model due to coincidence is smaller than 5%.The final utility functions for the alternatives HD, SP and PL are shown in the equations below. This gives an overview of the variables that are added in the final choice model for each delivery alternative.

$$V_{HD} = \beta_{Price,HD} * HD_{Price} + \beta_{HD,DM1} * HD_{DM1} + \beta_{HD,DM2} * HD_{DM2} + \beta_{HD,DM3} * HD_{DM3} + (IncPrice_{HD} * Inc * HDPrice)$$

$$V_{SP} = ASC_{SP} + (\beta_{Price,SP} * SP_{Price} + \beta_{SP,OH1} * SP_{OH1} + \beta_{SP,OH2} * SP_{OH2} + \beta_{SP,OH3} * SP_{OH3} + \beta_{SP,Distance} * SP_{Distance}) + (\beta_{Inc,SP} * Inc + \beta_{Avail,SP} * AtHome + \beta_{Emp1,SP} * Part + \beta_{EMP2,SP} * Full + \beta_{FREQ,SP} * Frequency + \beta_{UseSP,SP} * Use_{SP} + \beta_{UsePL,SP} * UsePL + \beta_{SP,RA} * RA + \beta_{PESHD,SP} * PESHD) + (AgeDistSP * Age * SP_{Distance} + IncPrice_{SP} * Inc * SP_{Price}) + EC_{SELFCOLL}$$

$$V_{PL} = ASC_{PL} + (\beta_{Price,PL} * PL_{Price} + \beta_{PL,OH} * PL_{OH} + \beta_{PL,Distance} * PL_{Distance} + \beta_{PL,RTS} * PL_{RTS}) + (\beta_{Inc,PL} * Inc + \beta_{Edu,PL} * Edu + \beta_{Avail,PL} * AtHome + \beta_{Emp1,PL} * Part + \beta_{EMP2,PL} * Full + \beta_{FREQ,PL} * Frequency + \beta_{UseSP,PL} * Use_{SP} + \beta_{UsePL,PL} * UsePL + \beta_{PL,RA} * RA + \beta_{PESHD,PL} * PESHD + \beta_{PESPL,PL} * PESPL) + (AgeDistPL * Age * PL_{Distance} + FreqPLDist_{PL} * PL_{Distance} * Use_{PL} + IncPrice_{PL} * Inc * PL_{Price}) + EC_{SELFCOLL}$$

In the estimation process of the ML model, the Apollo software raises a warning that states that some eigenvalues of the Hessian are positive, indicating convergence to a saddle point. This could mean that the optimization is stuck at a local maximum of the LL function. To try and steer away from this saddle point, three things can be done. The first thing that is tried is setting other starting values for the parameters. At the start, these are all set at 0. The estimates from the final iteration of the MNL model are used as the new starting values. Unfortunately, this still results in the same warning and the model still converges to a saddle point. Second, another optimizer can be set, to try and see whether another optimizer avoids the issue. Besides the standard option 'bfgs' Apollo also offers BHHH and NR as optimizers. Both were tried but encountered the same issues. The final option is to simplify the model that is to be estimated. The variance in the data could be too low to support the estimation of all model parameters. This is undesirable, as even insignificant parameters of delivery attributes are an important part of the model. In addition, the difference in the remaining estimated parameters before and after excluding insignificant parameters from the model has been investigated. This difference was small and the parameters remained in the same order of magnitude. Therefore, it is decided not to take any further steps to try and move towards a maximum.

Table 12: Final ML model choice question 'at online checkout': parameter estimates

	Estimate	s.e.	t.rat.(0)	p(1-sided)
Alternative Specific Constants				
ASC_HD	0			
ASC_SP	-2.9066	1.020905	-2.8471	0.002206
ASC_PL	-9.7798	1.315485	-7.4344	5.25E-14
Home Delivery				
Price	-1.24968	0.097038	-12.8782	0
Delivery Moment (DM)				
DM0 - Weekdays: only day	0			
DM1 - Weekdays: day + evening	-0.27303	0.223582	-1.2212	0.111009
DM2 - Weekdays: day + evening, Weekends: day	-0.18732	0.205946	-0.9096	0.181526
DM3 - Whole week: day + evening	0.32398	0.185506	1.7465	0.040363
Service Point				
Price	-0.89009	0.152489	-5.8371	2.66E-09
Distance	-1.24598	0.194427	-6.4084	7.35E-11
Opening hours (OH)				
OH0 - Weekdays: daytime	0			
OH1 - Weekdays: daytime, Saturday: daytime	-0.19343	0.151368	-1.2779	0.10065
OH2 - Weekdays: day + evening, Weekends: daytime	-0.06268	NaN	NaN	NaN
OH3 - Weekdays and Saturday: day + evening, Sunday: daytime	-0.05359	0.169758	-0.3157	0.376114

Continued on next page

Table 12: Final ML model choice question 'at online checkout': parameter estimates (Continued)

Parcel Locker				
Price	-1.16057	0.129067	-8.992	0
Distance	-1.81842	0.263119	-6.911	2.41E-12
Opening hours	0.02196	NaN	NaN	NaN
Days before returned to sender (RTS)	0.23407	0.030249	7.7382	5.00E-15
Socio-demographic variables				
Education - SP	0.16569	0.132332	1.2521	0.105274
Availability at home - SP	-0.10448	0.06623	-1.5776	0.057334
Part-time employed - SP	0.97341	0.362815	2.6829	0.003649
Full-time employed SP	1.02623	0.357483	2.8707	0.002048
Education - PL	0.31534	0.159437	1.9778	0.023973
Availability at home - PL	-0.04417	0.092249	-0.4789	0.316019
Part-time employed - PL	0.97578	0.44927	2.1719	0.014931
Full-time employed PL	1.13812	0.441266	2.5792	0.004951
Income SP	-0.14621	0.053245	-2.746	0.003016
Income PL	-0.1699	0.065822	-2.5813	0.004922
Interactions				
Age + distance - SP	0.01119	0.004566	2.4502	0.007139
Age + distance - PL	0.01739	0.005855	2.9697	0.00149
Income + price - HD	0.04126	0.014273	2.8907	0.001922
Income + price - SP	0.04895	0.021016	2.3292	0.009924
Income + price - PL	0.0753	0.022473	3.3508	4.03E-04
Shopping frequency + distance - PL	0.39229	0.154251	2.5432	0.005493
Shopping frequency + price - SP	-0.06584	0.051662	/1.2745	0.101236
Shopping characteristics				
Shopping frequency - SP	-0.50446	0.111012	-4.5442	2.76E-06
frequency use of SP - SP	0.61343	0.118212	5.1893	1.06E-07
frequency use of PL - SP	0.33977	0.243868	1.3932	0.081772
Shopping frequency - PL	-0.51176	0.137401	-3.7245	9.78E-05
frequency use of SP - PL	0.2855	0.138154	2.0666	0.019388
frequency use of PL - PL	0.52824	0.320914	1.6461	0.049876
Attitudes				
RA - SP	1.05464	0.208443	5.0596	2.10E-07
RA - PL	1.73875	0.256688	6.7738	6.27E-12
PES PL - PL	0.73919	0.143088	5.166	1.20E-07
PES HD - SP	-0.61395	0.172193	-3.5655	1.82E-04

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Table 12: Final ML model choice question 'at online checkout': parameter estimates (Continued)

PES HD - PL	-0.44378	0.21398	-2.0739	0.019044
Shared error component				
self-collection	1.02832	0.234759	4.3803	5.93E-06
Sigma´s				
Price HD	-0.24171	0.071269	-3.3914	3.48E-04
PL Distance	0.35417	0.141124	2.5096	0.006043
RTS	0.05315	0.038412	1.3837	0.083228

4.10 Model estimation process second choice questions

First, the most basic MNL model was estimated on the data, only including parameters for the delivery attributes in the SP and PL alternative utility functions. As the other three alternatives in this second choice question were not depicted by any delivery attributes, only by a short description, the utility functions of these alternatives consist of just an alternative specific constant (ASC) to start with. An ASC was also added to the utility function of the SP and PL alternative. In the estimation of the choice model on the data of the second choice question, it is decided to set the Neighbour Delivery as the reference alternative. It is done this way because Neighbour Delivery can be seen in the event of a failed delivery as the base alternative, the most common alternative delivery option in the Netherlands. If no one is home to receive your parcel, it is common practice to try and deliver the parcel to a neighbour instead. The ASC of Neighbour Delivery is fixed at zero, to clearly depict that it is the reference alternative. Since Neighbour Delivery serves as the reference alternative, this also means that to include socio-demographic variables or shopping characteristics, these variables will be added to all but the Neighbour Delivery utility function.

All socio-demographic variables are added: age, gender, income, education, working status, availability at home, and urbanity level of residence. These are added to all utility functions except for Neighbour Delivery as it serves as the reference alternative. In the end, 19 parameters impact the utility functions significantly. These are included in the next step. This second iteration of the model includes 31 parameters and reports a final LL of -1052. To compare this second iteration to the first iteration, the Likelihood Ratio Test is used. The LRS equals 302 and the df equals 19. The probability that the second iteration model performs better than the first iteration model due to coincidence is smaller than 5%. The parameters that are added in this step of the model are listed below. Bold parameters are found to be significant in this step.

- Age
  - Age SP
  - Age PL
- Gender
- Education
- Work status
- Income
- Availability at home
- Urbanity of residence

The third step is to include shopping characteristics: shopping frequency, frequency of use of PL and SP. Again, these characteristics are included in all utility functions except the Neighbour Delivery one. The impact of shopping frequency is significant for all alternatives except for PL. The frequency of use of a PL is insignificant for all alternatives. Lastly, the impact of the frequency of use of SP on the utility for PL is also insignificant. Insignificant parameters are excluded from the model. Thus, the model at the end of the third iteration includes 36 parameters and reports a final LL of -1027. To compare the performance of the third iteration model to the

model of the second iteration, the Likelihood Ratio Test is used. The LRS equals 50 and the df equals 5. The probability that the third iteration model performs better than the second iteration model due to coincidence is smaller than 5%. The parameters that are added in this step of the model are listed below. Bold parameters are found to be significant in this step.

- **Frequency of online shopping**
- **Frequency of use of SP**
- **Frequency of use of PL**

Lastly, the latent variables are added to the model. The latent variables 'Relative Advantage' (RA), 'Perceived Environmental Sustainability PL' (PES PL), 'Perceived Environmental Sustainability HD' (PES HD), 'Privacy Parcel Delivery' (PRIVACY) are added to the model. In this step, the degree of burden that someone perceives from picking up a parcel at their neighbours is also added as 'BURDEN', which is the first question on attitudes towards neighbour delivery (see Table 8). The LV 'RA' was added to the SP and PL alternatives, as well as the LV 'PES PL' and LV 'PES HD'. The LV 'PRIVACY' and 'BURDEN' are added to the utility functions for all four alternatives. The parameters for 'RA' on SP and PL are significant. 'BURDEN' also has a significant impact on the utility of all 4 alternatives. There was no significant impact measured of PRIVACY, PES PL or PES HD on the utility functions. In the end, 6 new parameters are added to the model. This fourth, and final, iteration of the MNL model consists of 41 parameters and reports a final LL of -974. The Rho-squared is 0.2525. To compare the performance of the fourth iteration model to the model of the third iteration, the Likelihood Ratio Test is used. The LRS equals 106 and the df equals 5. The probability that the fourth iteration model performs better than the third iteration model due to coincidence is smaller than 5%. All significant parameters are included in the next phase, estimating a ML model. The parameters that are added in this step of the model are listed below. Bold parameters are found to be significant in this step. The final parameters estimates for the MNL choice model for the second choice question are shown in Table 13 below.

- Relative Advantage
- Perceived Environmental Sustainability HD
- Perceived Environmental Sustainability PL
- Privacy
- Degree of Burden

Table 13: Final MNL model parameters estimates - Choice question 'in case of delivery failure'

	Estimate	**s.e.**	**t.rat.(0)**	**p(1-sided)**
Alternative Specific Constants				
ASC_NEIGH	0	NA	NA	NA
ASC_SP	-3.11735	0.75	-4.1565	1.62E-05
ASC_PL	-7.7552	1.152415	-6.7295	8.51E-12
ASC_MOMENT	-6.18637	0.809221	-7.6448	1.04E-14
ASC_AHOUSE	-7.34023	0.792814	-9.2585	0
Delivery attributes				
BETA_SPDISTANCE	-1.00218	0.218101	-4.595	2.16E-06
BETA_SP_OH1	0.92168	0.341462	2.6992	0.003475
BETA_SP_OH2	0.55234	0.391998	1.409	0.079412
BETA_SP_OH3	0.27071	0.288883	0.9371	0.174354
BETA_PLDISTANCE	-0.97899	0.235006	-4.1658	1.55E-05
BETA_PL_OH	0.37725	0.293089	1.2871	0.099023

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Table 13: Final MNL model parameters estimates - Choice question 'in case of delivery failure' (Continued)

BETA_RTS	0.04274	0.06134	0.6967	0.242997
Socio-demographics				
BETA_EDUSP	0.16351	0.098842	1.6543	0.049033
BETA_INCSP	-0.07708	0.03646	-2.114	0.017257
BETA_EDUPL	0.78213	0.167079	4.6812	1.43E-06
BETA_URBANPL	-0.20417	0.069309	-2.9458	0.001611
BETA_INCPL	-0.08759	0.049546	-1.7679	0.038538
BETA_AGEMOMENT	0.04452	0.00875	5.0883	1.81E-07
BETA_GENDER1_MOMENT	1.27117	0.230832	5.5069	1.83E-08
BETA_EDUMOMENT	0.40753	0.110242	3.6967	1.09E-04
BETA_AVAILMOMENT	0.28368	0.096704	2.9335	0.001676
BETA_EMP2MOMENT	0.91996	0.270306	3.4034	3.33E-04
BETA_INCMOMENT	-0.17075	0.046771	-3.6507	1.31E-04
BETA_AGEAHOUSE	0.07647	0.008881	8.6105	0
BETA_GENDER1_AHOUSE	0.65933	0.229322	2.8751	0.002019
BETA_EDUAHOUSE	0.65937	0.114399	5.7638	4.11E-09
BETA_URBANAHOUSE	-0.23485	0.046127	-5.0914	1.78E-07
BETA_EMP1AHOUSE	-1.03057	0.32011	-3.2194	6.42E-04
BETA_EMP2AHOUSE	-0.75571	0.304733	-2.4799	0.006571
BETA_INCAHOUSE	-0.08068	0.040376	-1.9981	0.022854
Shopping characteristics				
BETA_FREQ_SP	-0.17916	0.086627	-2.0682	0.019309
BETA_USESP_SP	0.39739	0.100321	3.9612	3.73E-05
BETA_FREQ_AHOUSE	0.28436	0.080216	3.5449	1.96E-04
BETA_USESP_AHOUSE	0.23536	0.102073	2.3058	0.010562
BETA_FREQ_MOMENT	-0.18361	0.088519	-2.0742	0.019029
BETA_USESP_MOMENT	0.34749	0.103889	3.3449	4.12E-04
Attitudes				
BETA_RA_SP	0.45198	0.153865	2.9375	0.001654
BETA_RA_PL	1.14209	0.226614	5.0398	2.33E-07
BETA_BURDEN_SP	0.72936	0.115613	6.3086	1.41E-10
BETA_BURDEN_PL	0.80035	0.15192	5.2682	6.89E-08
BETA_BURDEN_MOMENT	0.62814	0.117328	5.3537	4.31E-08
BETA_BURDEN_AHOUSE	0.83006	0.111304	7.4576	4.41E-14

Estimating ML model on data second choice question 'in case of delivery failure'

Table 14: Final parameter estimates ML model - Second choice question

	Estimate	s.e.	t.rat.(0)	p(1-sided)
Alternative Specific Constants				

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Table 14: Final parameter estimates ML model - Second choice question (Continued)

ASC_NEIGH (Reference)	0	NA	NA	NA
ASC_SP	-7.75174	1.98197	-3.9111	4.59E-05
ASC_PL	-12.44611	2.20716	-5.639	8.55E-09
ASC_MOMENT	-6.92044	0.88646	-7.8068	2.89E-15
ASC_AHOUSE	-8.05263	0.89719	-8.9754	0
Service Point				
Distance	-1.33199	0.29641	-4.4937	3.50E-06
Opening hours (OH)				
OH0 - Weekdays: daytime				
OH1 - Weekdays: daytime, Saturday: daytime	1.0559	0.44109	2.3938	0.008337
OH2 - Weekdays: day + evening, Weekends: daytime	0.51056	0.5093	1.0025	0.158057
OH3 - Weekdays and Saturday: day + evening, Sunday: daytime	0.27239	0.33257	0.8191	0.206377
Parcel Locker				
Distance	-1.18466	0.26529	-4.4655	3.99E-06
Opening hours	0.35005	0.36119	0.9692	0.166232
Days before returned to sender (RTS)	0.03308	0.06224	0.5315	0.297553
Socio-demographic variables				
Education - SP	0.46797	0.2671	1.752	0.039885
Income - SP	-0.18662	0.09463	-1.972	0.024303
Eduation - PL	1.15283	0.3054	3.7749	8.00E-05
Urbanity - PL	-0.25756	0.08493	-3.0328	0.001211
Income - PL	-0.18408	0.10244	-1.7969	0.036179
Age - MOMENT	0.06372	0.01034	6.1646	3.53E-10
Female - MOMENT	1.41389	0.26213	5.3939	3.45E-08
Education - MOMENT	0.47052	0.11804	3.9861	3.36E-05
Availability at home - MOMENT	0.22825	0.09886	2.3089	0.010474
Full-time working - MOMENT	1.12268	0.27938	4.0184	2.93E-05
Income - MOMENT	-0.23512	0.05123	-4.5896	2.22E-06
Age - AHOUSE	0.0948	0.01068	8.8764	0
Female - AHOUSE	0.87447	0.26174	3.341	4.17E-04
Education - AHOUSE	0.67456	0.12222	5.5194	1.70E-08
Urbanity - AHOUSE	-0.25376	0.04751	-5.3407	4.63E-08
Part-time working - AHOUSE	-0.60744	0.28514	-2.1303	0.016572
Income - AHOUSE	-0.17618	0.04238	-4.1569	1.61E-05
Shopping characteristics				
Frequency of use SP - SP	0.33275	0.13767	2.417	0.007825

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Table 14: Final parameter estimates ML model - Second choice question (Continued)

Shopping frequency - AHOUSE	0.22575	0.08757	2.5781	0.004968
Frequency of use SP - AHOUSE	0.24079	0.11921	2.0199	0.021699
Shopping frequency - MOMENT	-0.19014	0.09382	-2.0266	0.021351
Frequency of use SP - MOMENT	0.36124	0.11825	3.0548	0.001126
Attitudes				
Relative advantage - SP	1.18417	0.43505	2.722	0.003245
Relative advantage - PL	2.07277	0.47575	4.3569	6.60E-06
Degree of burden - SP	1.09642	0.27787	3.9458	3.98E-05
Degree of burden - PL	1.03889	0.29879	3.477	2.54E-04
Degree of burden - MOMENT	0.65606	0.12344	5.3149	5.34E-08
Degree of burden - AHOUSE	0.90956	0.12251	7.4242	5.67E-14
Shared error component				
SIGMA_SELFCOLL	3.00894	0.39101	7.6953	7.11E-15

As for the data on the first choice question data set, the second choice question also consists of multiple choices per respondent. The number of repeated choices however depends on how many times they have chosen Home Delivery in the first choice question. In total, 810 choices were made by 188 respondents. Similar to the ML model that was estimated on the data of the first choice question, 500 Halton draws are used for estimating the model. Increasing to 1000 draws did not result in different parameter estimates, so it was decided to run 500 draws as the parameters were stable at this number and fewer draws meant less computational time. In the first step, nesting effects are tested. Similar to the estimation process of the ML model on the first choice question, a shared error term is estimated for the SP and PL alternatives. A shared error component is added to the utility functions of SP and PL, again called 'SIGMA SELFCOLL'. This shared error component is significant. The shared error component is found to be significant (p-value = 0.0000). This implies there is shared variation in the error terms of SP and PL. This first iteration of estimating the ML model, reports a final LL of -1081 and a Rho-squared of 0.17. The model consists of 12 parameters.

In the next step, the parameters for the delivery attributes are allowed to vary randomly. A similar distribution and number of draws as for the first choice question is used. In the next step, the parameters for the delivery attributes are allowed to vary randomly. An explanation as to why this is decided is given in ML model estimation process on the data for the first choice question. None of the random parameters that were estimated turned out to be significant. This leaves the model in this second iteration unchanged from the model of the first iteration.

Lastly, all socio-demographic variables, shopping characteristics, and latent variables that were significant in the MNL model are included in the last step of estimating the ML model. Of the parameters that were added in this step, only two parameters are insignificant: shopping frequency on the utility for SP, and full-time employment on the utility for AHOUSE. These parameters are then excluded from the model. This results in the final model estimation for the ML model, shown in Table 14 below. The final ML model for the second choice questions reports a final LL of -887 and a Rho-squared of 0.3198, and includes 40 parameters. To compare the performance of the final iteration of the ML model to the first iteration of the ML model, the Likelihood Ratio Test is used. The LRS equals 388 and the df equals 28. The probability that the fourth iteration model performs better than the third iteration model due to coincidence is smaller than 5%. Below, the utility functions for the delivery alternatives are shown. This gives an overview of the variables that are added in the final choice model for each delivery alternative.

$$V_{NEIGH} = ASC_{NEIGH}(fixed)$$

$$V_{SP} = ASC_{SP} + (\beta_{SP,OH1} * SP_{OH1} + \beta_{SP,OH2} * SP_{OH2} + \beta_{SP,OH3} * SP_{OH3} + \beta_{SP,Distance} * SP_{Distance}) + (\beta_{Inc,SP} * Inc + \beta_{Edu,SP} * Edu + \beta_{UseSP,SP} * Use_{SP} + \beta_{SP,RA} * RA + \beta_{Burden,SP} * Burden) + EC_{SELFCOLL}$$

$$V_{PL} = ASC_{PL} + (\beta_{PL,OH} * PL_{OH} + \beta_{PL,Distance} * PL_{Distance} + \beta_{PL,RTS} * PL_{RTS}) + (\beta_{Inc,PL} * Inc + \beta_{Edu,PL} * Edu + \beta_{Urban,PL} * Urban) + (\beta_{Burden,PL} * Burden + \beta_{PL,RA} * RA) + EC_{SELFCOLL}$$

$$V_{MOMENT} = ASC_{MOMENT} + (\beta_{Inc,MOMENT} * Inc + \beta_{Avail,MOMENT} * AtHome + \beta_{EMP2,MOMENT} * Full + \beta_{Age,MOMENT} * Age + \beta_{Edu,MOMENT} * Edu + \beta_{Female,MOMENT} * Female + \beta_{FREQ,MOMENT} * Frequency + \beta_{UseSP,MOMENT} * Use_{SP} + \beta_{Burden,MOMENT} * Burden)$$

$$V_{AHOUSE} = ASC_{AHOUSE} + (\beta_{Inc,AHOUSE} * Inc + \beta_{Urban,AHOUSE} * Urban + \beta_{EMP1,AHOUSE} * Part + \beta_{Age,AHOUSE} * Age + \beta_{Edu,AHOUSE} * Edu + \beta_{Female,AHOUSE} * Female + \beta_{FREQ,AHOUSE} * Frequency + \beta_{UseSP,AHOUSE} * Use_{SP} + \beta_{Burden,AHOUSE} * Burden)$$

This section selected the attribute levels that were the last step in developing the Discrete Choice Experiment. Most importantly, the first part of this section has elaborated on how the different attributes, variables, characteristics and attitudes will be measured in the survey, and how they are coded in order to be part of the choice modelling part of this research. The most important conclusions from the second part of this section relate to the model estimation process. The model estimation process has resulted in the development of two Mixed Multinomial Logit Choice models (ML models) on the data of choice questions 'at online checkout' and 'in case of delivery failure'. These ML models are able to account for the panel data structure that is present in the data of this research. The results of these choice models will be discussed in the section Model Interpretation.

5 Data Analysis

This section presents the data analysis of the survey. First, a brief description of the data-gathering process is given. Next, the characteristics of the sample of respondents are discussed in relation to the research population. Finally, the section will analyse the results of the survey that concern all non-DCE questions, as such the answers to all statements regarding attitudes are discussed.

5.1 Data gathering

The survey was administered online, via social media, among the personal social network of the researcher. Further, the survey was also posted on SurveyCircle and SurveySwap, websites that allow researchers to fill out other surveys and participate in each other's studies. Finally, the survey was distributed by market research company Datacoll to achieve a sufficient amount of respondents. The survey was administered online using Qualtrics software (Qualtrics Development Company, 2005). The final survey was preceded by a pilot study among 8 respondents to test the survey's functionality and to get rid of some inconsistencies and ambiguities. After the pilot study, the final survey ran for two weeks between 10 July 2023 and 24 July 2023.

5.2 Data sample

The survey was opened by a total of 275 respondents. 223 of these respondents completed the survey. A total of 7 respondents were excluded from the sample because they did not belong to the target group of this survey. They either did not order a product online in the last 6 months, or they were younger than 18 years. Furthermore, 5 responses are excluded because the respondent completed the survey extremely fast, and from examining their answers they seemed to click on answers in a random manner. At last, three responses were excluded because they belonged to the researcher testing the survey when it was distributed.

Table 15 represents the distribution of the socio-demographics of the respondents in the data sample. There is an almost equal portion of males and females, and one person identifies as non-binary. There is an over-representation of respondents in the age brackets of 21–30 years old and 51–60 years old, while people older than 60 years as well as people under the age of 20 are underrepresented compared to the Dutch population. It should be noted however that the survey required respondents to be at least 18 years of age to participate. On the Educational level, there is an over-representation of academically schooled people, and an under-representation of people educated at elementary school —, high school – and middle vocational levels. Looking at income, there is a large over-representation of people earning less than 10.000 euros per year, while incomes up to 50.000 are slightly over-represented and incomes higher than 50.000 are slightly underrepresented. The way of distributing the survey, i.e. in the social network of this student, is the most likely reason for the over-representation of the age group 21-30 and income segment lower than 10,000 euros per year. Unfortunately, there is little data on the population of e-consumers in the Netherlands to compare the sample of this survey with. Data gathered by the Dutch Central Bureau for Statistics shows that people with a higher income, and people with a secondary and higher education shop online more frequently (Central Bureau for Statistics, 2022). Based on this, the impact of the under-representation of people educated at elementary school —, high school – and middle vocational levels in this sample is somewhat limited. Furthermore, the over-representation of income lower than 10,000 euros might result in the sample of respondents being more sensitive to the price attributes compared to the population.

Regarding the level of urbanity of the respondents' residences, almost half of the respondents indicate that they live in a big city, either in the centre of a city or outside the centre. One-third of the respondents live in and around a village or outside the centre of a small city, while 7% of the respondents indicate to live rural. The data from CBS shows that there are little differences between varying degrees of rural and urban regarding the percentage of people who shop online (Central Bureau for Statistics, 2022). Regarding the availability at home during the day, 60% of the respondents indicated to be either rarely or occasionally at home throughout the day. Just 1.5% of the respondents indicate to are always at home throughout the day. However, as a bit more than 17% indicate to be often at home throughout the day during the week, one-fifth of the respondents are frequently at home during the day.

Table 15: Distribution of socio-demographic variables in the sample

Socio-demographic variable		**Distribution**
Gender	Male	51,4%
	Female	48,1%
	Non binary / third gender	0,5%
Age	11-20	1,9%
	21-30	45,2%
	31-40	11%
	41-50	11,5%
	51-60	20,1%
	61-70	8,2%
	71-80	1%
	81-90	0,5%
Education level	Elementary school	0,5%
	High school diploma or middle vocational (MBO)	14,4%
	Higher professional education (HBO) or university without a degree	15,8%
	Bachelor's degree (HBO or university)	31,2%
	Master's degree	35,6%
	Doctorate/PhD	2,4%
Work status	Unable to work	1,4%
	Student	25,9%
	Unemployed / Retired	8,1%
	Part-time working	20,6%
	Full-time working	43,8%
Income	10.000	21,1%
	10.000 - 19.999	11,1%
	20.000 - 29.999	7,2%
	30.000 - 39.999	12%
	40.000 - 49.999	14,4%
	50.000 - 59.999	7,7%
	60.000 - 69.999	6,3%
	70.000 - 79.999	3,4%
	80.000 - 89.999	2,9%
	90.000 - 99.999	0,5%
	100.000	11,5%
Urbanity level	Rural	7,2%
	Outside of centre of village	11%
	Centre of village	12,5%
	Outside centre of small city / town	12%
	Centre of small city / town	5,3%
	Suburb of big city	4,3%
	Outside centre of big city	23,6%
	Centre of big city	24%
Availability at home	Rarely	22,1%
	Occasionally	37,5%
	Sometimes	21,6%
	Often	17,3%
	Always	1,4%

5.2.1 Shopping characteristics

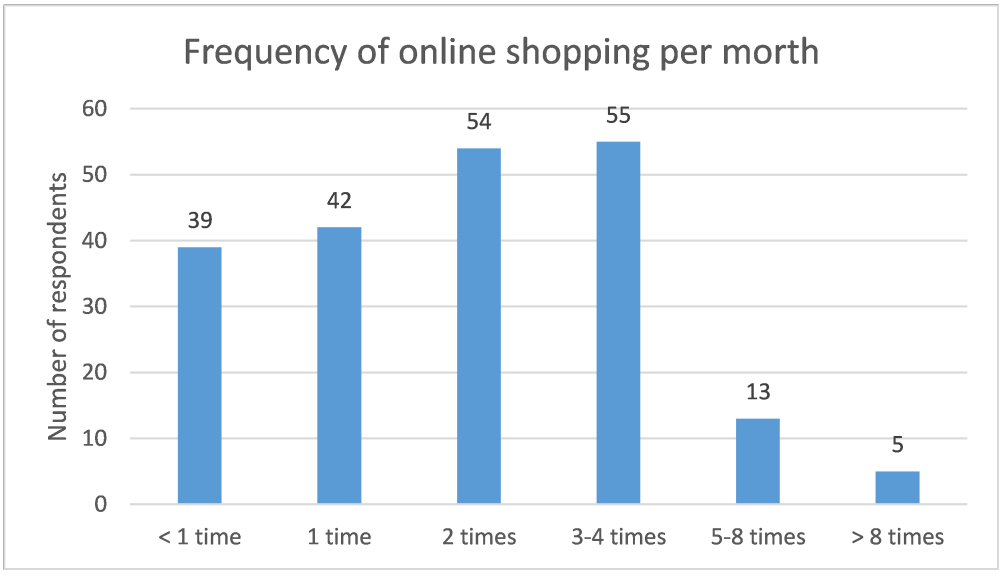

Figure 13: Average online orders per month

Figure 13 above shows the distribution of average monthly online purchases per month. Half of the respondents indicated to on average order a product online 2 times or 3–4 times a month. This seems to resemble the Dutch population somewhat, as the average number of parcels delivered per year is around 24 (van Zaane, 2022), on average two per month. Almost 20 percent of the respondents indicate that on average they order less than one product online per month. There is a smaller group of less than 10 percent of the respondents who on average order more than 5 products online per month.

Regarding the frequency of use of a SP when ordering products online, the majority of 70 percent of the respondents had used a SP in the last year. However, this also leaves a rather large group of 28 percent of the respondents who indicated to have not used a SP in the last year. The low usage of Parcel Locker in the Netherlands is confirmed by the findings of this survey, as more than 4 out of 5 respondents indicated to have not used a PL in the last year. Only a very small number of respondents seem to use a PL regularly, as a bit more than 10 percent of the respondents had used a PL one or two times in the last 6 months, and as little as three respondents indicated to have used a PL more than 6 times in the last year. The high number of respondents who have not used a PL in the last year could also mean that they have never used one or are not familiar with the concept. Compared to the results in the thesis by (Kosicki, 2020), who reported that around 90 percent had not used a PL in the last year, there seems to be only an increase of about 7 percent over three years time. Considering that the average number of parcels delivered to a household per year is around 24, this data seems to indicate that on average the majority of the parcel is delivered at home and not at SPs or PLs. The sample matches the population in this pattern of behaviour. Recently published data from 2022 shows that 81,5% of the parcels in the Netherlands is delivered at home, whereas only 8% to a Service Point. The number of deliveries to parcel lockers is not yet tracked separately.

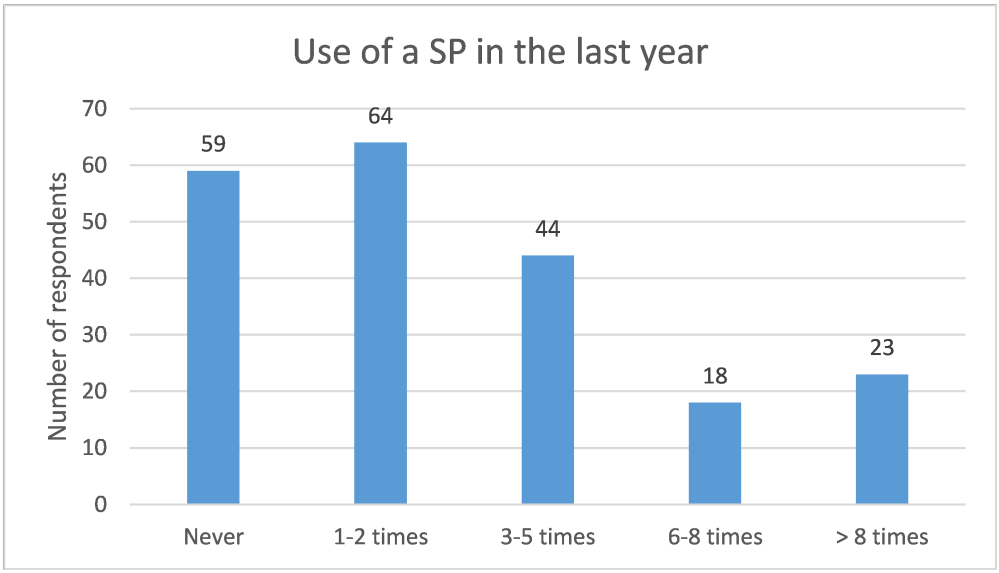

Figure 14: Use of a SP in the last year

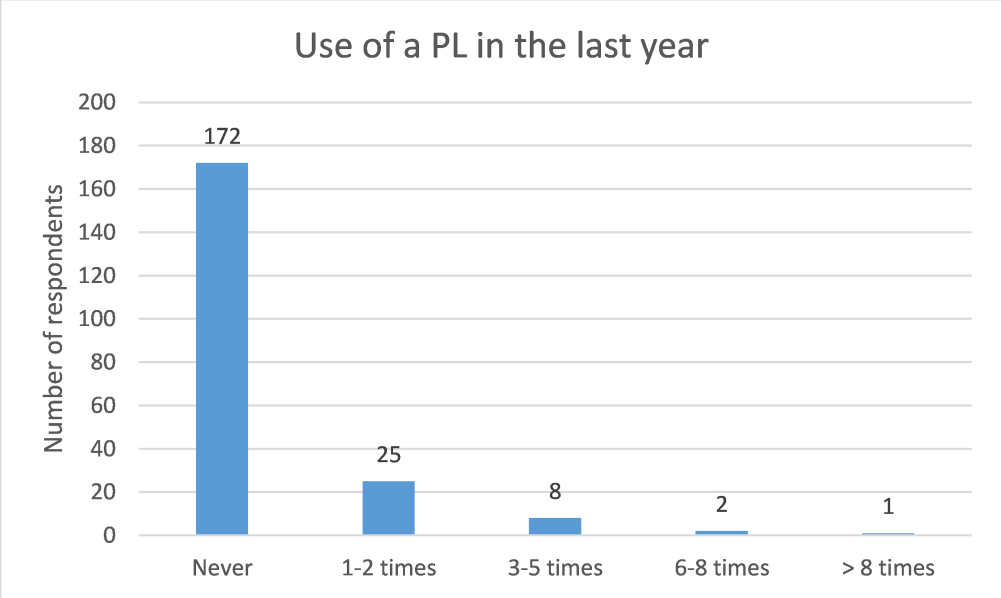

Figure 15: Use of a PL in the last year

5.2.2 Neighbour relationship and attitude towards Neighbour delivery

This study also asked respondent to indicate their level of social interaction with their neighbours. This was done in the context of their immediate neighbours, and their more distant neighbours. Below, Figure 16 shows the distribution of the degree of social contact respondents indicate to have with their neighbours. The majority of the respondents, around 90%, indicate having some form of social contact with their immediate neighbours, with most of the respondents regularly having a chat with their neighbour. Around 10 percent indicate to either not recognize them on the street or not greet them when they encounter them. Five people state they engage in social activities with their neighbours. So, for the majority of the respondents, their social bond with their neighbours is limited to greetings and chats during encounters. Only a small group of respondents seem to have formed a social bond beyond those encounters and actively engage in activities.

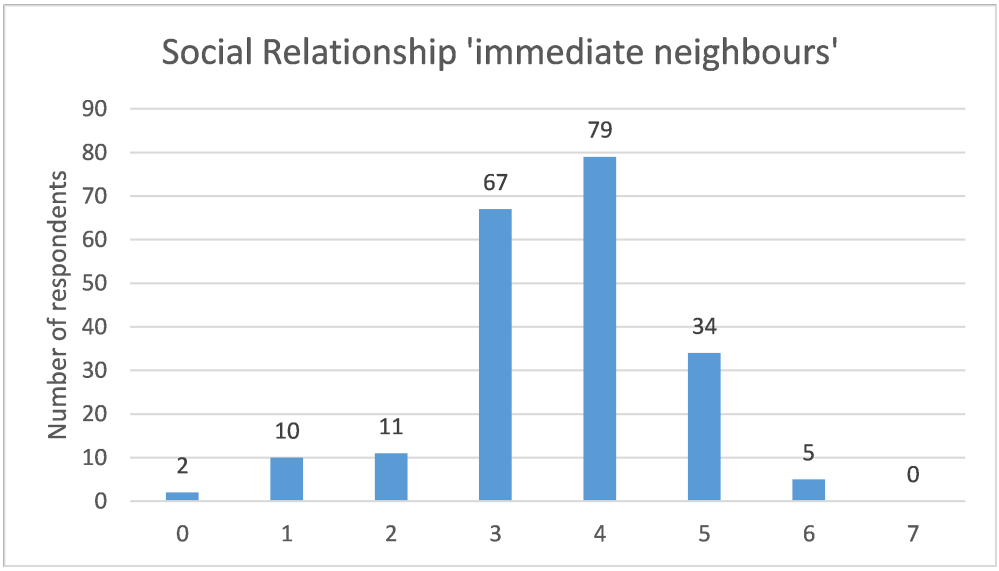

Figure 16: Degree of social contact with immediate neighbours

The results for the same question but on distant neighbours, shown in Figure 17, show that social contact slightly decreases with more distant neighbours. In this context, most people greet these neighbours, around one-third. Slightly less than one-third of the respondents still regularly have a chat with these neighbours. The number of people who do not recognize their neighbours has increased from 10 to 34 people. As this indicator was coded 0 to 6, a mean value is also computed to see whether a shift is made. For close neighbours, the average value of social contact is 3.6, so somewhere between greeting them and regularly talking to them. In the context of distant neighbours, the average is 3.0, so only greeting them. This indicates overall a lesser social bond with more distant neighbours. It is expected that the bond with one's immediate neighbours is more sociable because you are more likely to encounter each other on the street or go to them with a problem or question.

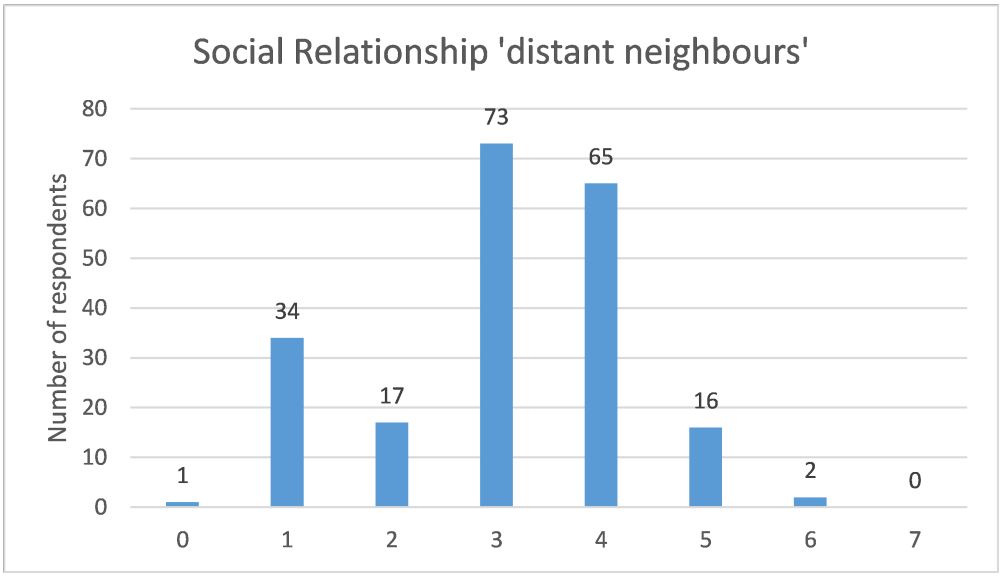

Figure 17: Degree of social contact with distant neighbours

Combined with these questions are a number of statements regarding parcel delivery to neighbours. First, the statements in the context of the immediate neighbour are discussed. About 16 percent of the respondents feel burdened if their parcel had been delivered to one of their neighbours. This could be because you could see that you inconvenience your neighbour because you are not home, and they have to collect the parcel, but also because the neighbours could feel that now they are stuck with your parcel and have to wait for you, or because you do not want to be dependent on your neighbour. The majority of 60 percent do not feel burdened in any

way to pick up a parcel at their neighbour's. Most of the respondents seem to have no problem with their neighbour seeing what they ordered or with them knowing that they have ordered a product online. In both cases, only a very small group finds it a problem that neighbours know about their e-consuming behaviour. Over 80 percent of the respondents agree (partially or fully) that because they sometimes collect parcels for their neighbours, it should not be a problem for their neighbours to do the same for them. This could indicate that consumers view Neighbour delivery as a kind of service from one neighbour to another, and expect them to reciprocate this. The last statement asks the respondent directly whether they would prefer delivery to their immediate neighbour over delivery to a pick-up point. There seems to be no consensus on this point. Although the largest group of respondents, 25%, state this does not apply to them. The results indicate that the majority of the consumers do not view Neighbour Delivery as a burden or inconvenience, but rather view it as a kind of neighbourly gesture towards one another. However, the lack of burden towards neighbour delivery does not directly translate to Neighbour Delivery being favoured above delivery to a Service Point in case of delivery failure. Additionally, there is also a group of consumers who dislike Neighbour Delivery and feel inconvenienced or burdened by it. These consumers would prefer (the choice of) an alternative delivery option.

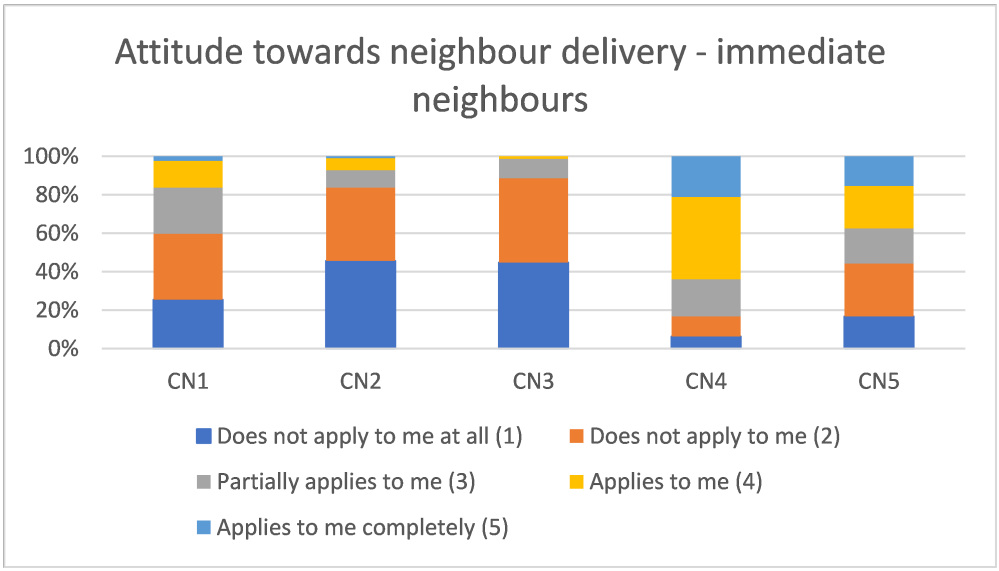

Figure 18: Attitude towards neighbour delivery for immediate neighbours

Now the results of the statements are again interpreted, but in the context of the more distant neighbour. It is especially interesting to compare the results to that of immediate neighbours, to detect possible shifts in attitude. Regarding the first statement, a little bit more people seem to experience a higher degree of burden if they have to pick up a parcel from their neighbours. This could be because they link more distant neighbours with more inconvenience because of a longer distance or lesser social bond. The largest proportion of respondents still do not feel burdened. However, compared to immediate neighbours, respondents seem to be more pronounced when it comes to feeling burdened or not. In comparison to the immediate neighbours, it seems to have an effect both ways. On the second statement, some people seem to move to the middle, indicating that it partially applies to them that they do not like their neighbours knowing they ordered something online. There is however no big shift, the majority still do not mind if their neighbours know that they've ordered online. Regarding the neighbours knowing what you have ordered, a small share of the respondents who did not find it problematic for immediate neighbours seem to perceive it as more of a problem to them if their distant neighbours would know what they ordered online. A possible explanation for this could be that people care less about the topic of privacy if the social bond with their neighbour is stronger. In the case of delivery to a more distant neighbour, more people dislike that the neighbour could know what they have ordered. A similar result is found for the fourth statement. A share of around 10 percent of the respondents shifts, indicating that they find accepting a parcel for their neighbours to be less of a good reason to have a parcel delivered to one of their neighbours. While for the majority, over 75%, accepting a parcel for their neighbour is still a good reason, there are some people for whom the 'service of accepting a parcel for a neighbour' seems to be less prevalent for distant neighbours. This again could be due to a weaker social bond perceived with distant neighbours. As was the case for the preference of neighbour delivery over delivery to a Service Point for immediate neighbours, not much has changed. The share of people preferring neighbour delivery over pick-up point has slightly increased compared to those not preferring it. However, some people also indicate to a greater extent to find it undesirable.

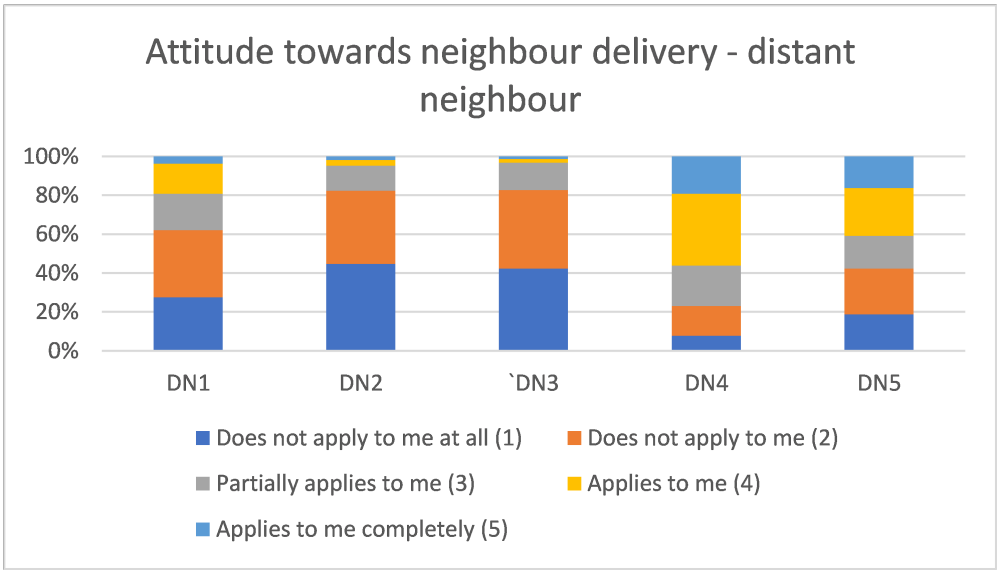

Figure 19: Attitude towards neighbour delivery for distant neighbours

While moving the context to more distant neighbours has resulted in some small shifts, on average it does not seem to indicate to matter much whether the neighbour is your immediate neighbour or a more distant one in regard to consumer attitude towards neighbour delivery. This can also be gathered from inspecting the mean values for social contact earlier discussed, and the mean scores on the Likert scales on the attitude statements. These averages barely changed for all statements on neighbour delivery in both contexts, while the degree of social interaction did decrease.

From computing a correlation matrix between the degree of social interaction with close neighbours and the answers to the following statements on neighbour delivery, it shows that there is a small negative significant correlation between social interaction and feeling burdened by having a parcel delivered to a neighbour. There is also a small positive significant correlation between the degree of social interaction and (1) both not minding having parcels delivered to and from your neighbours and (2) preferring neighbour delivery over a pick-up point.

5.2.3 Relative Advantage of the parcel locker over home delivery

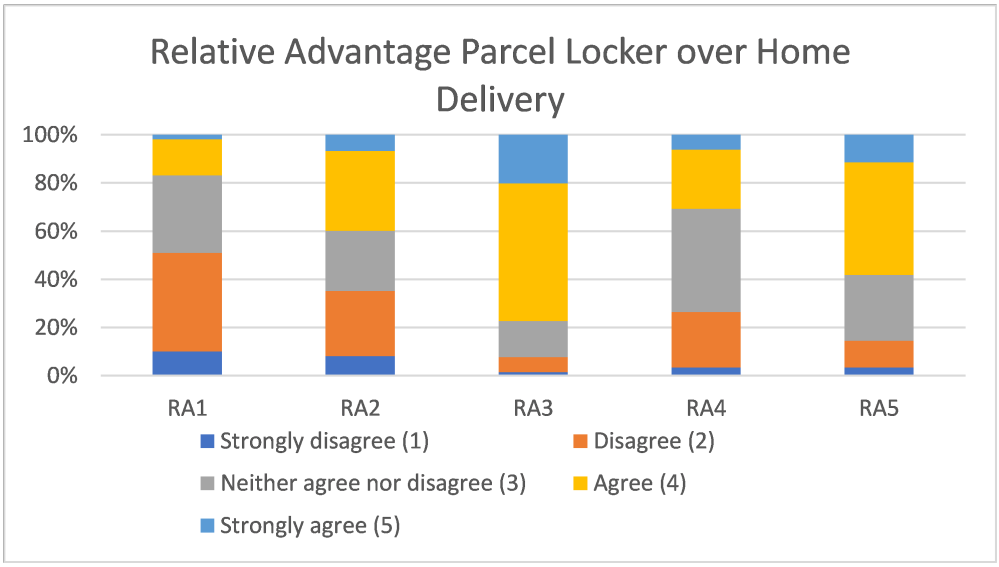

Figure 20: Relative Advantage of the Parcel Locker over Home Delivery

Home delivery is still the most common delivery method. So, seeing how people perceive the Parcel Locker compared to Home delivery could provide an indication as to why most people still choose Home Delivery. It could also provide information on whether people do not see value in Parcel Lockers where they could. A first look at the distribution of the answers shows that more than 80 percent of the respondents do not agree or are neutral to the statement that using self-collection improves their overall reception experience. Only a small group of e-consumers perceive the parcel locker as a positive contributor to their reception experience. The same holds true for the fourth statement, where almost 70 percent do not agree or are neutral to self-collection offering a more customised service. However, it should be noted that relative to the first statement, a much larger part is neutral instead of disagreeing. There also seems to be a small segment of respondents who very negatively view both the impact of self-collection on receiving a parcel and the overall reception experience. Interestingly, a larger segment of respondent agrees that self-collection makes it easier to receive their parcel compared to home delivery. The most promising advantage of self-collection perceived by the respondents is that it allows you to collect the parcel at your own convenience. Almost 80 percent of the respondents agree with this advantage. Also, the majority of respondents feel that the parcel lockers offer more control over the delivery process. The results of these two statements point in the same direction, the ability of the consumer to be the one to determine when they pick up and receive their parcel seems to be the biggest advantage that respondents see in self-collection compared to home delivery. One could expect that the increased amount of control that the parcel locker offers would also translate to consumers perceiving the reception experience as an improvement to their reception experience or ease of receiving a parcel. The results do not indicate this. A possible explanation for this could be that although the parcel locker offers the convenience of more control and collecting your parcel at your own convenience, this still does not weigh up to the convenience of Home Delivery and the inconvenience of the trip to the parcel locker.

5.2.4 Perceived Environmental Sustainability

Earlier studies have sometimes surprisingly found that consumers do not seem to incorporate environmentally friendlier delivery methods into their choices. This is often linked to a lack of knowledge regarding the positive environmental impact self-collection can have on the delivery process (Ignat & Chankov, 2020). Regarding the sustainability of PL, the majority of the respondents see the potential environmental benefits that parcel lockers can have in the last-mile delivery process. A much smaller share of 15 to 20 percent of the respondents feels that home delivery can contribute positively to the environment, generate less emission than other delivery methods, be more sustainable in the long term, or could create fewer externalities. So, the majority of the respondents are of the understanding that (i) home delivery contributes negatively to the sustainability of last-mile delivery and the environment, now and in the future, and (ii) parcel lockers do have the potential to contribute positively to the sustainability of the last-mile delivery process as well as that of society. This should be put into perspective. Other recent developments in last-mile delivery, such as the delivery by cargo bikes or the use of electric vehicles to deliver parcels, do not rely on fossil fuels and can therefore make home delivery much less burdensome on the environment. However, the findings are not surprising. In the current state of last-mile delivery, many vehicles still run on fossil fuels. The findings regarding the perceived environmental sustainability of parcel lockers are somewhat surprising, given that lack of knowledge on this topic is often cited as a reason for customers not choosing self-collection alternatives. Although most respondents view home delivery as a less sustainable option compared to parcel lockers, this does not seem to influence their choice of delivery options. Possible reasons could be that the current offer does not meet the standards of consumers to replace home delivery, or they do not incorporate sustainability into the decision for a delivery option.

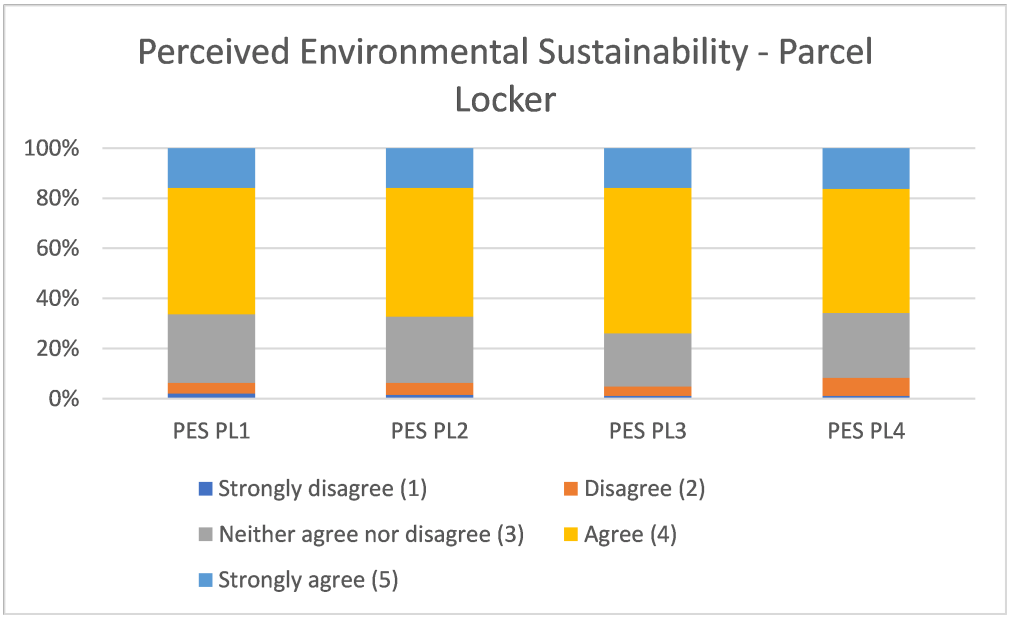

Figure 21: Perceived Environmental Sustainability Parcel Locker

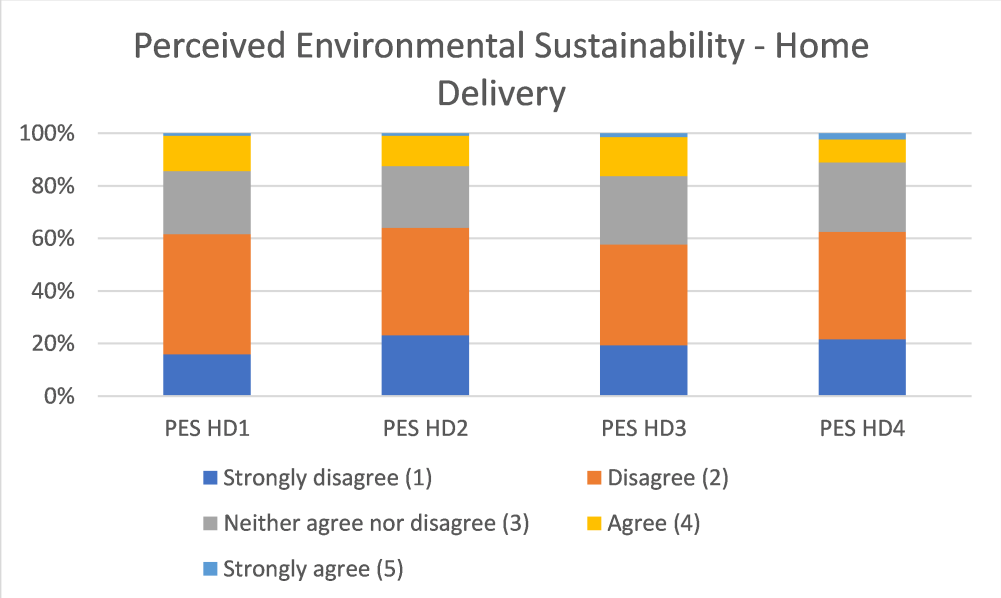

Figure 22: Perceived Enviromental Sustainability Home Delivery

This section has analysed the characteristics of the sample of this data, and the results of the survey on the various questions on neighbour relations, and attitudes towards different delivery methods. Low-income groups are over-represented, as well as the age groups 21-30 and 51-60 years old. Lower-educated people are under-represented. Unfortunately, there is no data on the e-consumer population in the Netherlands, so it is unknown what this means for our data analysis. Most respondents indicate to only greet or have a brief talk with their immediate neighbours. This degree of social contact decreases for more distant neighbours. Most respondents indicate feeling no concerns regarding the delivery of a parcel to one of their neighbours. This is also not influenced by the type of neighbour. There is however a small group of respondents who do not feel comfortable with neighbour delivery due to privacy concerns, or they indicate to feeling burdened when picking up their parcel from the neighbours. The most promising advantage of self-collection perceived by the respondents is that it allows you to collect the parcel at your own convenience. The majority of the respondents perceive delivery to a PL to be environmentally sustainable, more so than respondents perceive Home Delivery as such.

6 Model interpretation

In this section, the results of the two different choice models that were estimated on the data of the choice questions 'at online checkout' and 'in case of delivery failure' will be presented and discussed. The estimated parameters will be interpreted and the results will be discussed in relation to last-mile delivery.

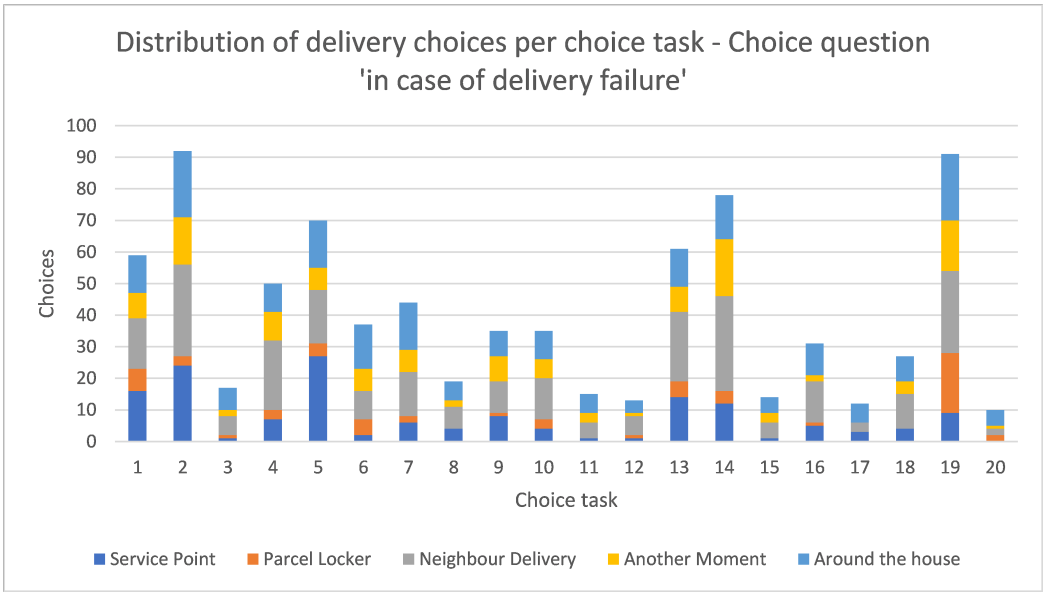

Figure 23: Distribution of choices per choice task - Choice question 'at online checkout'

First, the estimates of the final choice model on the choice question 'at online checkout' are interpreted. An overview of these estimates can be found in Table 16 A total of 208 respondents made 10 choices each, resulting in a total of 2080 choices that are observed. Of these choices, the Home Delivery alternative was chosen in 40% of the cases, the Service Point alternative was chosen in 31% of the cases, and 29% of the choices were made for the Parcel Locker alternative. The choices are pretty evenly distributed, indicating that the choice tasks encourage sufficient trade-offs to be made between the alternatives. These choices are influenced by the delivery attributes that are included (or not included) and by the chosen attribute levels. Most notably, the price for Home Delivery in the choice question ranges between 0 and 6 euros, whereas the price for SP and PL was either 0 or 2 euros. Thus, in most cases, the SP and PL alternatives are cheaper than the HD alternative or at the same low price, which should positively impact the choice probability for the SP and PL alternatives.

Since the SP and PL alternatives are both self-collection delivery methods, the alternatives are expected to have more in common with each other than with the HD alternative. To account for this, a shared error component is estimated on the choice data, 'SIGMA SELFCOLL'. This shared error component is found to be significant and of moderate magnitude, $\eta = 1.14$. From this, the correlation between SP and PL can be calculated (Train, 2003) through the following equation:

$$\frac{\eta}{\eta + \frac{\pi^2}{6}} \tag{5}$$

The correlation between SP and PL equals 0.41. This correlation between the two alternatives is not particularly high. However, the correlation does show that respondents who have chosen either SP (or PL) from an earlier choice set, are more likely to choose PL (or SP) from a new choice set. It confirms that SP and PL have more in common with each other than with HD, and that there are unobserved factors that impact the utility of both alternatives similarly. It also implies that SP and PL compete more with each other than they compete with HD, because of the similarities of the alternatives. The obvious reason for this is that both alternatives are pick-up alternatives, that require the consumer to perform the last step of the delivery process themselves. Some consumers might dislike the idea that they have to leave the house for a product that they ordered online and have to travel to a pick-up point. Other consumers might like the idea of self-collection since it provides them with more control over the delivery process, and because it does not require them to be home at certain times that may be inconvenient.

Alternative specific constants (ASC) were estimated for the SP and PL alternatives. No ASC was estimated for the HD, as one alternative has to serve as a reference to compare the other ASCs to. As HD is the most common delivery method, it was an obvious choice as reference alternative. The results show that for both SP and PL the ASC are negative and significant. That the ASCs are negative means that for both alternatives, there are unobserved factors not included in the model that on average negatively impact the utility of SP and PL relative to the utility of HD. Possible unobserved factors can be a dislike to make the last leg of the delivery by yourself, for both SP and PL. That the ASC is larger in magnitude for PL could be contributed to several factors that SP and PL do not share. Such as an aversion to the use of PL because it is an unknown alternative, that the technology is new which makes it hard to use, but also that PLs are unmanned and meaning there is no human contact in the delivery.

Table 16: Final parameter estimates ML model - Choice question 'at online checkout'

	Estimate	s.e.	t.rat.(0)	p(1-sided)
Alternative Specific Constants				
ASC_HD (reference)	0			
ASC_SP	-2.673964	0.872513	-3.0647	0.00109
ASC_PL	-9.308316	1.203656	-7.7334	5.22E-15
Home Delivery				
Price	-1.25028	0.097009	-12.8883	0
Delivery Moment (DM)				
DM0 - Weekdays: only day (reference)	0			
DM1 - Weekdays: day + evening	-0.245132	0.244945	-1.0008	0.15847
DM2 - Weekdays: day + evening, Weekends: day	-0.203297	0.263412	-0.7718	0.220121
DM3 - Whole week: day + evening	0.303029	0.199097	1.522	0.064003
Service Point				
Price	-1.005151	0.116929	-8.5963	0
Distance	-1.182279	0.207294	-5.7034	5.87E-09
Opening hours (OH) (reference)				
OH0 - Weekdays: daytime	0			
OH1 - Weekdays: daytime, Saturday: daytime	-0.202005	0.161506	-1.2508	0.105512
OH2 - Weekdays: day + evening, Weekends: daytime	-0.054201	0.054329	-0.9977	0.159223
OH3 - Weekdays and Saturday: day + evening, Sunday: daytime	-0.071345	0.212656	-0.3355	0.368627
Parcel Locker				
Price	-1.123573	0.126258	-8.8991	0
Distance	-1.838371	0.275728	-6.6673	1.30E-11
Opening hours	0.037068	NaN	NaN	NaN
Days before returned to sender (RTS)	0.243074	0.028724	8.4624	0
Socio-demographic variables				
Part-time employed - SP	1.035659	0.406523	2.5476	0.005423

Continued on next page

Table 16: Final parameter estimates ML model - Choice question 'at online checkout' (Continued)

Full-time employed SP	1.236656	0.387545	3.191	7.09E-04
Education - PL	0.138865	0.077113	1.8008	0.035867
Part-time employed - PL	1.023437	0.482157	2.1226	0.016893
Full-time employed PL	1.318353	0.451003	2.9232	0.001732
Income SP	-0.148622	0.063894	-2.3261	0.010007
Income PL	-0.169656	0.07135	-2.3778	0.008708
Interactions				
Age + distance - SP	0.00961	0.004704	2.043	0.020526
Age + distance - PL	0.016733	0.005814	2.8779	0.002002
Income + price - HD	0.040198	0.014462	2.7795	0.002722
Income + price - SP	0.05129	0.020621	2.4873	0.006436
Income + price - PL	0.072667	0.021868	3.323	4.45E-04
Shopping frequency + distance - PL	0.490074	0.106019	4.6225	1.90E-06
Shopping characteristics				
Shopping frequency - SP	-0.474002	0.110113	-4.3047	8.36E-06
frequency use of SP - SP	0.614261	0.114219	5.3779	3.77E-08
Shopping frequency - PL	-0.46013	0.130268	-3.5322	2.06E-04
frequency use of SP - PL	0.362219	0.136228	2.6589	0.00392
Attitudes				
RA - SP	1.132151	0.2106	5.3758	3.81E-08
RA - PL	1.78473	0.248894	7.1707	3.73E-13
PES PL - PL	0.712848	0.135845	5.2475	7.71E-08
PES HD - SP	-0.704217	0.173482	-4.0593	2.46E-05
PES HD - PL	-0.529829	0.206258	-2.5688	0.005103
Shared error component				
Self-collection	1.120344	0.229708	4.8773	5.38E-07
Sigma´s				
Price HD	-0.238811	0.069163	-3.4528	2.77E-04
PL Distance	0.458432	0.115251	3.9777	3.48E-05

6.1 Interpretation for choice question 'at online checkout', estimates for delivery attributes

6.1.1 Price

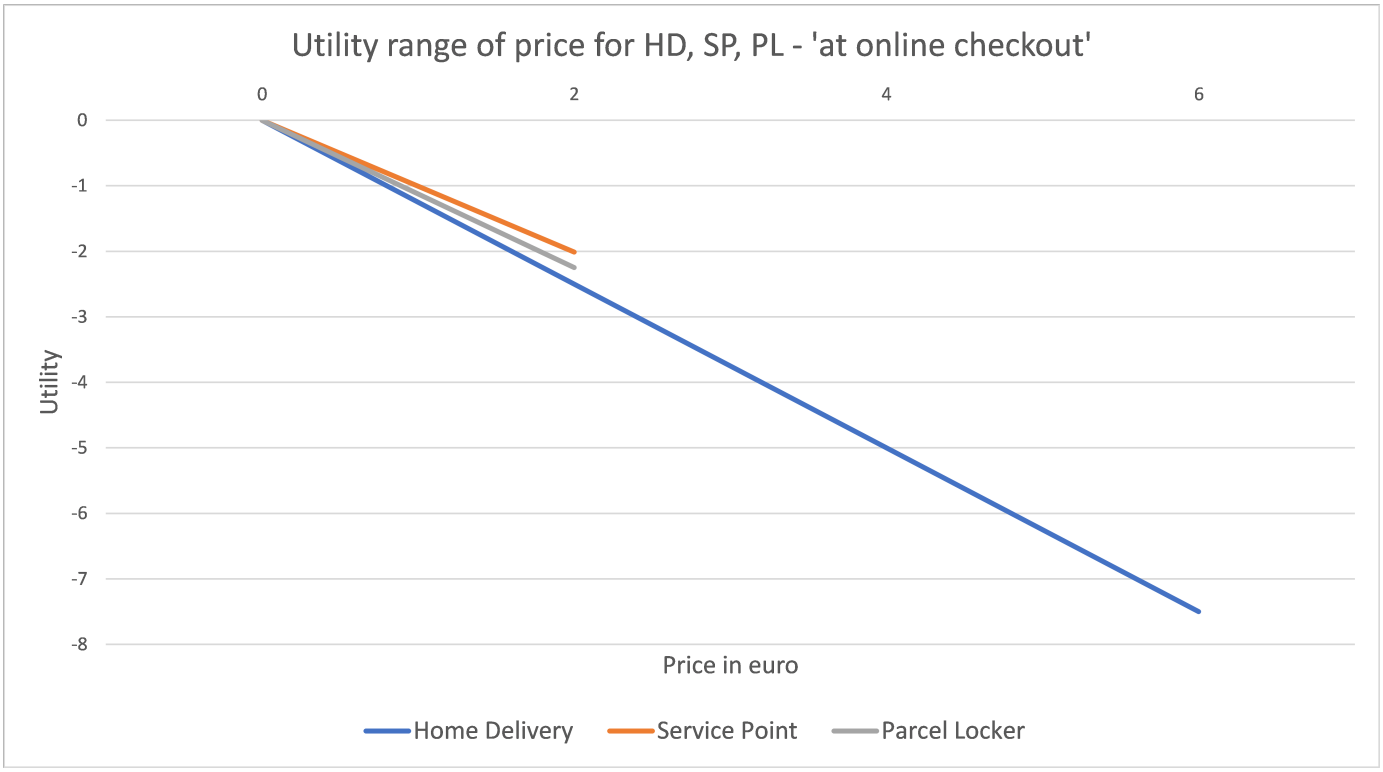

Figure 24: Comparison if the price parameters for HD, SP and PL

A separate price parameter was estimated for all three alternatives. The parameters of each alternative will be discussed separately. The parameter estimate for the price of HD (-1.25) is negative and significant. The negative sign of the parameter estimate is expected, as higher prices are a logical source of disutility. An interaction effect between age and price, income and price was tested. The interaction between income and price was significant, and also larger in magnitude compared to the interaction of age and price. The interaction parameter income and price HD (0.04) is positive, indicating that with increasing income, the sensitivity for HD price decreases. As this interaction is significant, this interaction should be taken into account when interpreting the main effect of the price of HD. The following part of the utility function therefore represents the full effect of price on the utility for HD:

$$\beta_{\text{price\_hd}} \cdot \text{price\_hd} + \text{inc\_price\_hd} \cdot \text{price\_hd} \cdot \text{inc}$$

To give an example of how this works: for a consumer who earns a middle income of 30.000 - 39.999 euro (coded as 4), a one euro increase in price for HD decreases the utility they experience for the HD alternative by 1.09. A consumer earning 80.000-89.999 euro (coded as 9) experiences a decrease in utility of 0.89 for the HD alternative when the price increases by one euro. The parameter for the price of HD was also allowed to vary randomly in the model estimation process to identify possible taste heterogeneity in the sample towards the price of HD. This parameter, SIGMA PRICEHD, is significant. This indicates that besides the heterogeneity for price that is explained by income, there is more heterogeneity in taste for HD price. Non-linearity of the price parameters for HD was tested, but this parameter was insignificant. It can be assumed that utility decreases linearly per extra euro that HD costs. For each increase in the price of HD, consumers experience equal amounts of dissatisfaction.

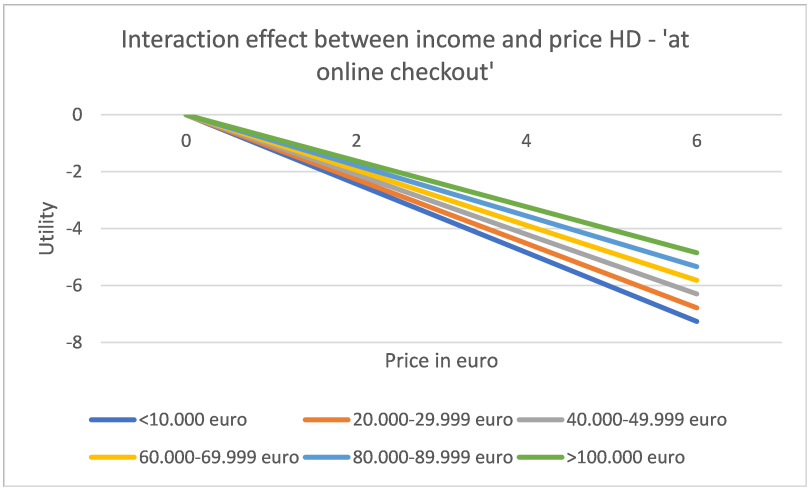

Figure 25: Interaction between income and price of HD

The price parameter for the SP alternative (-1.00) is significant and also negative, as is expected. Interactions were estimated between price and age, and price and income. The interaction effect between price and income (0.05) is significant and positive as is the case for HD. This means that as respondents earn a higher income, their sensitivity to price decreases. The following part of the utility function therefore represents the full effect of price on the utility for SP:

$$\beta_{\text{Price\_SP}} \cdot \text{Price\_SP} + \text{Inc\_Price\_SP} \cdot \text{Price\_SP} \cdot \text{inc}$$

The same example as earlier is used to demonstrate the effect: for a consumer who earns a middle income of 30.000 - 39.999 euros (coded as 4), a one euro increase in price for SP decreases the utility they experience for the SP alternative by 0.84. A consumer earning 80.000-89.999 euros (coded as 9) experiences a decrease in utility of 0.59 for the SP alternative when the price increases by one euro. The parameters for SP were also allowed to vary randomly to test for taste heterogeneity in the price for SP, however, this sigma was not significant. Meaning there is no additional heterogeneity in price sensitivity.

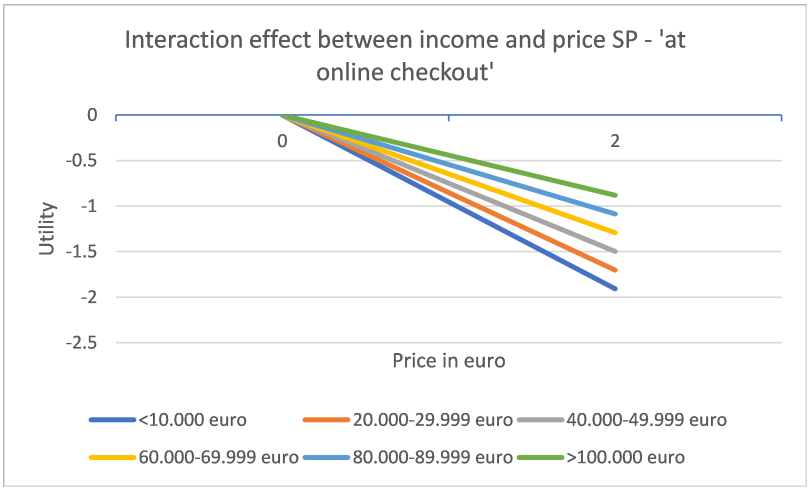

Figure 26: Interaction between income and price of SP

The price parameter estimated for the price of the PL alternative is significant and negative. The PL price parameter equals -1.12. As for the HD and SP alternatives, interactions for the price were estimated with both age and income. The interaction with income (0.07) is significant. The full effect of price on utility is therefore given by the following part of the utility function of PL:

$$\beta_{\text{Price\_PL}} \cdot \text{Price\_PL} + \text{Inc\_Price\_PL} \cdot \text{Price\_PL} \cdot \text{inc}$$

To demonstrate the effect of price, the same example is used: for a consumer who earns a middle income of 30.000 - 39.999 euros (coded as 4), a one euro increase in price for PL decreases the utility they experience

for the PL alternative by 0.83. A consumer earning 80.000-89.999 euros (coded as 9) experiences a decrease in utility of 0.47 for the PL alternative when the price increases by one euro. No additional heterogeneity in price was identified, as the estimated sigma for PL price was insignificant.

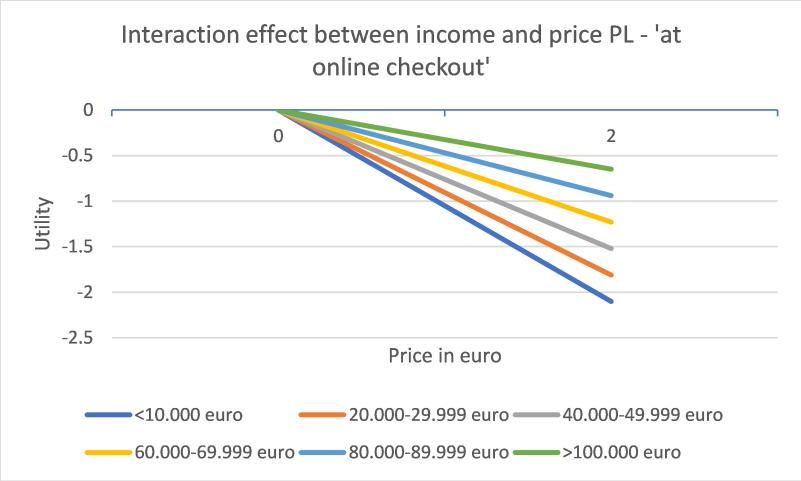

Figure 27: Interaction between income and price of PL

To test whether the price parameters of SP and PL are statistically different from each other, the confidence intervals at 95% level of significance are calculated, given the following formula: $\beta \pm 1.96 \cdot SE$ The confidence intervals of SP price and PL price overlap, meaning that the difference between the two parameters is not significant. The same formula is applied to the interaction parameter 'income + price' for SP and PL. These confidence intervals also overlap. So, as there is no statistically significant difference between the two price parameters, they can be interpreted in the same way.

For all three price parameters, the price parameter decreases with increasing income. Consumers become less sensitive to price increases when they earn a higher income. This finding was expected. However, as illustrated by the examples, consumers experience a larger decrease in utility from a price increase in Home Delivery than they experience from a price increase for the SP or PL alternatives. Consumers are thus less sensitive to a price increase when it comes to an SP or PL than when the price of HD increases. A possible explanation for this could be that consumers have gotten used to free home deliveries and find it harder to part with this luxury than is the case for SP or PL.

6.1.2 Delivery moment and opening hours

For the HD alternative, the delivery moment provides information about what day of the week and what time of the day delivery is possible. The attribute was dummy coded, and the attribute levels are structured in a way that every level is expected to increase utility compared to the previous level. All three dummy-coded categories for 'delivery moment' are not significant at the 95% threshold.

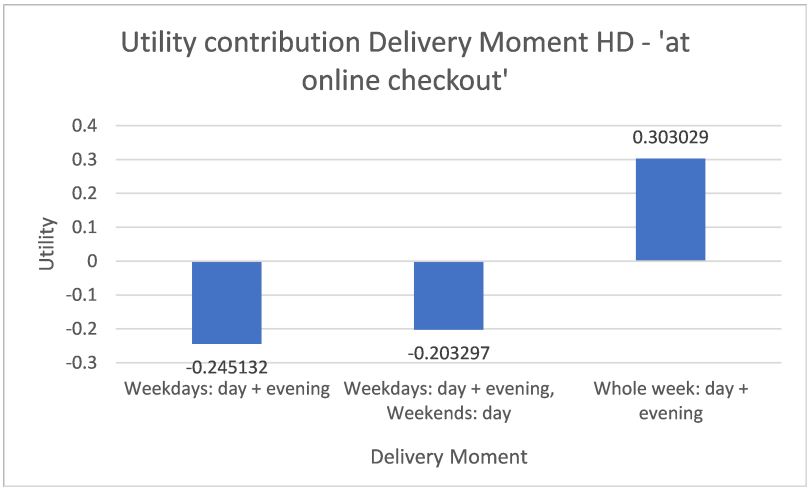

Figure 28: Utility contribution of every expansion of the delivery moment for HD - Choice question 'at online checkout'

What is most surprising and unexpected, is the fact that the parameter estimates indicate an expansion of the delivery moment to include evening delivery (-0.24, DM1) and delivery on weekends during the day (-0.20, DM2) would result in less utility for the HD alternative compared to only delivery during the day on weekdays. Only an expansion of the delivery moment to include both evening and weekend delivery seems to contribute positively to the utility experienced for the HD alternative. The dummy parameters for 'delivery moment' were allowed to vary randomly, to investigate whether opposing preferences between individuals might cancel each other out. However, all estimated sigma's were not significant, meaning that there were no opposing preferences in the sample that caused these results. Possible explanations for the negative parameters for the expansion to either evening or weekend delivery could be that consumers do not like to be disturbed during the evening or the weekend, and do not view these moments as moments that should be used for parcel delivery. However, the positive increase in utility caused by the expansion to both evening and weekend delivery refutes this explanation. Another explanation could be that the description of 'delivery moment' in the DCE and what the different levels meant was unclear and misinterpreted by the respondents.

Similar levels of expansion were used in this study, as were used in the study by Molin et al. (2022). In their study, including evening delivery increased utility the most. Further expansion on this delivery moment did not lead to a higher increase in utility, even though these expansions were framed as extra delivery opportunities for consumers. So, despite the findings by Molin et al. (2022) not being entirely the same as those of this study, both findings are surprising and seem to indicate that what were previously thought to be straightforward expansions on the delivery moment that would increase utility, are actually not that straightforward in that aspect.

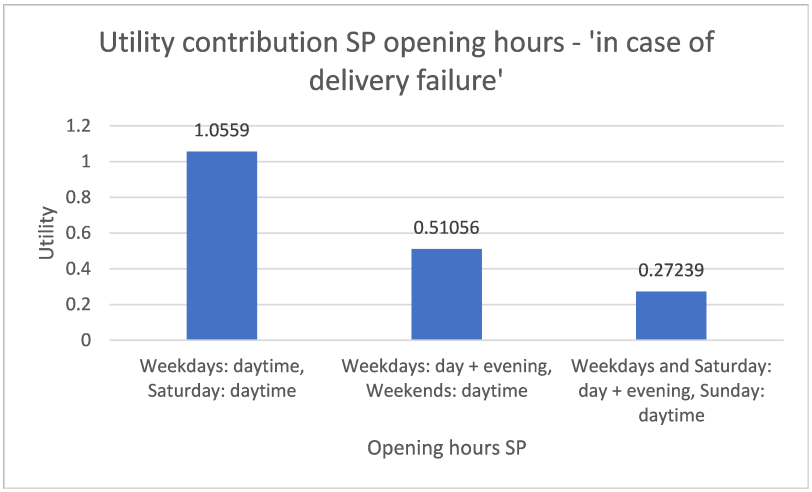

Figure 29: Utility contribution of every expansion of the opening hours of SP - Choice question 'at online checkout'

Similar results are discovered for the opening hours of the SP alternative. As was the case for the delivery moment, each level was expected to increase utility compared to the former level as it provides more flexible opening hours of the SP in this case. All three dummy variables for the opening hours of the SP are insignificant at the 0.05 threshold. Once again, there are unexpected results regarding the negative signs of the estimated parameters. The estimated parameters for SP OH1 (-0.20), SP OH2 (-0.05), and SP OH3 (-0.07) indicate that each expansion of the opening hours results in a decrease in utility. So, instead of an increase in utility for each expansion, each expansion results in a decrease in utility compared to the base opening hours 'Weekdays: daytime'. These findings are unexpected, and in contrast to the findings of Molin et al. (2022) and de Oliveira et al. (2017), who find that expanding the opening hours for collecting a parcel results in an increase in utility. A possible reason for the findings of this study could be that consumers do not like to take time out of their (free) evenings or weekends to collect a parcel from a Service Point. The findings indicate that it should be sufficient for consumers if SPs are only open during the day on weekdays. After these hours, there would be no need to operate the SPs as consumers do not experience increased utility from an expansion of opening hours. The findings suggest that opening hours during the day on weekdays offers consumers enough convenience. More narrow operating hours would mean a decreased cost of running the SP. However, if the same amount of parcels were picked up from a SP in a narrower time frame, this would mean increased working pressure. Operating an SP is often associated with high working pressure and high cost relative to income, so narrower operating hours would not always be advantageous.
Finally, the estimated parameter for PL (0.03) opening hours is inspected. The parameter is positive, which was expected, as the second level was an expansion of the opening hours of a PL to 24 hours each day of the week. An expansion to 24/7 opening hours increases the utility for the PL. However, this contribution to utility is insignificant and very small. Consumers see little extra value in an expansion of the opening hours from 'Weekdays and Saturday: daytime and evening, Sunday: daytime' to the PL being open 24/7. These findings contradict earlier findings, which state that the possibility to operate 24/7 is one of the most attractive features of the PL (see for example Iwan et al. (2016) and increases the utility of the PL (for example Molin et al. (2022); Iannaccone et al. (2021)). A possible explanation for this finding could be that there is too little difference between the two levels, that respondents view the levels as more or less equal and see no real advantage to the locker being open 24/7 compared to only during commercial opening hours. This means that the opening hours 'Weekdays and Saturday: daytime and evening, Sunday: daytime' provide the consumer with a wide enough time window to collect their parcel at their convenience. An expansion to 24/7 operating hours would be unnecessary in this case.

6.1.3 Distance

As expected, both the estimated parameters for SP distance (-1.18) and PL distance (-1.84) are negative, so the utility of both the SP and the PL decreases as the distance increases. One interaction turned out to be significant and large in magnitude, between the frequency of PL use and PL distance (0.49). As this parameter is positive, it means that consumers who have used a PL more often in the last year experience a lesser decrease in utility for an increase in distance to a PL. This result is interesting, as it indicates that more frequent users of the PL are more willing to travel longer distances to a PL to collect their parcel. This effect was not found

between SP use and SP distance.

Interactions were also estimated between distance and age. It was hypothesized beforehand that younger people would find it less of a problem to travel a longer distance to collect their parcel. The interactions for SP (0.009) and PL (0.016) are small but positive and significant. This means that the opposite of what was hypothesized is found true. With increasing age, consumers experience less of a decrease in utility for an increase in distance. So, with increasing age the sensitivity to distance decreases. This can possibly be due to higher car ownership among adults, which could decrease the effort that has to be made for a further trip. No data was collected on car ownership, but in future research, it would be interesting to determine whether there is a link between car ownership and distance and SP/PL use, as collecting parcels from a SP or PL by car contrasts with the environmental aim of self-collection. An interaction between the level of urbanity of residence and distance was estimated but was insignificant. Next to consumers of different age and users of different frequency of the PL, who experience a decrease in utility from increased distance differently, the significant sigma for PL distance (0.45) shows that there is additional taste heterogeneity for the distance to a PL.

The full effect of the distance parameters for SP and PL has to be estimated based on both the main parameter and the interactions. Therefore, to compare the SP and PL distance parameters, the following part of the utility function represents the full effect of distance on the utility for SP:

$$\beta_{\text{Distance\_SP}} \cdot \text{Distance\_SP} + \text{Age\_Distance\_SP} \cdot \text{Distance\_SP} \cdot \text{Age}$$

To demonstrate the effect of distance on utility: for a consumer of 30 years of age, a 1 km increase in distance results in a decrease in utility of -0.89. For a consumer of 50 years of age, an equal increase in distance results in a decrease in utility of -0.70. The following part of the utility function represents the full effect of distance on the utility for PL:

$$\beta_{\text{Distance\_PL}} \cdot \text{Distance\_PL} + \text{Age\_Distance\_PL} \cdot \text{Distance\_PL} \cdot \text{Age} + \text{FreqPL\_Dist\_PL} \cdot \text{Distance\_PL} \cdot \text{FreqPL}$$

To demonstrate the effect of distance on utility: for a consumer of 30 years of age who has used a PL 1-2 times in the past year, a 1 km increase in distance results in a decrease in utility of -0.84. For a consumer of 50 years of age with the same PL use, an equal increase in distance results in a decrease in utility of -0.51.

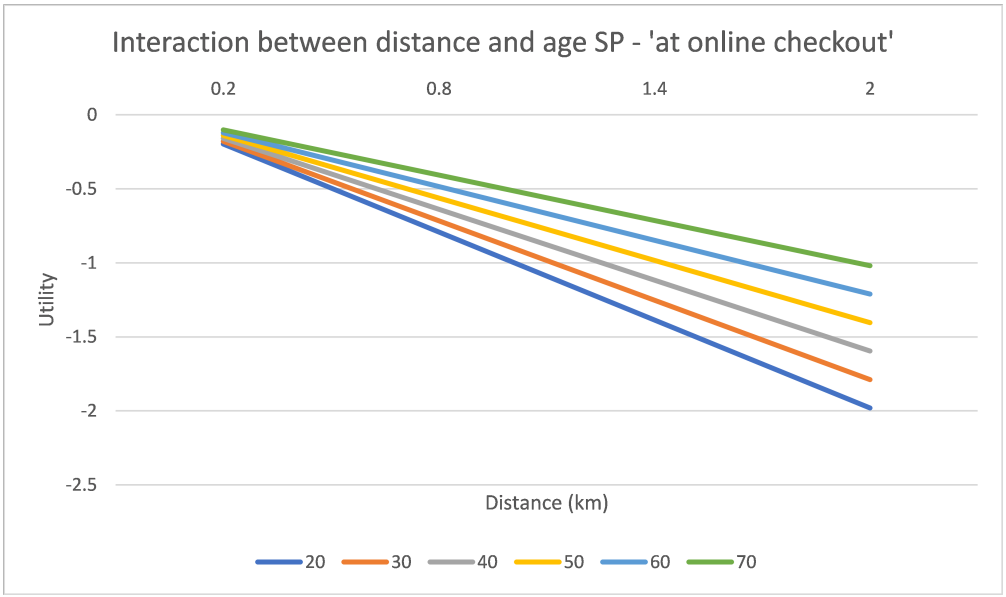

Figure 30: Interaction effect between age and distance to SP - Choice question 'at online checkout'

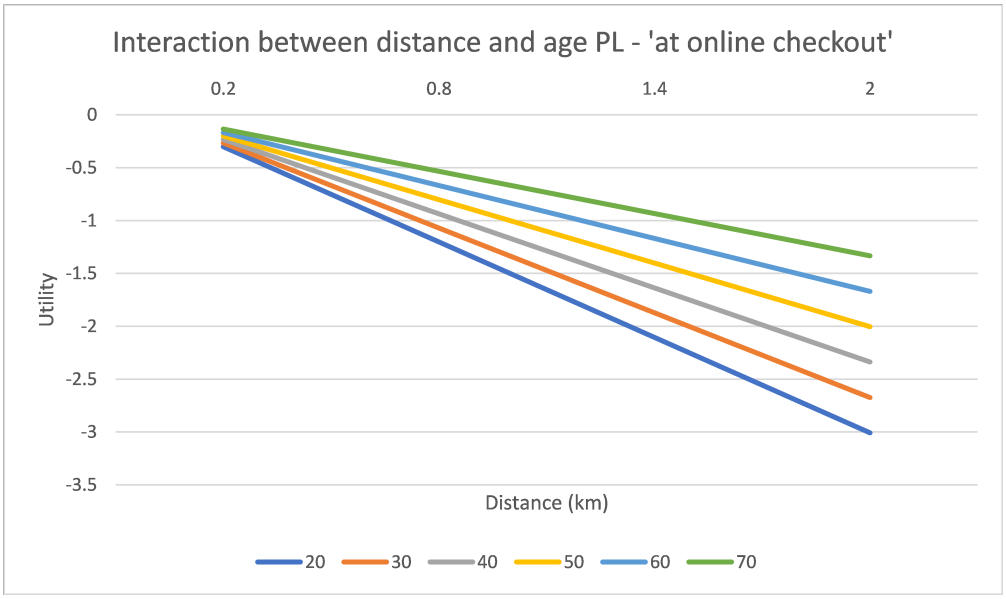

Figure 31: Interaction effect between age and distance to PL - Choice question 'at online checkout'

First, the findings in this section show that, as expected, consumers experience less utility for a the self-collection alternatives when the distance one has to travel to collect their parcel increases. Furthermore, it was shown that with increasing age, consumers are more willing to travel longer distances to a SP or PL to collect their parcels. It is hypothesized that this could be due to car ownership, which would make the pick-up less demanding, but since no data is collected on car ownership in this study, this could be a topic for future research. Lastly, more frequent users of the PL are more willing to travel longer distances to the PL. This is interesting for parcel locker companies, as it indicates that when consumers use the PL more often they care less about distance and are more likely to use the PL again.

6.1.4 RTS

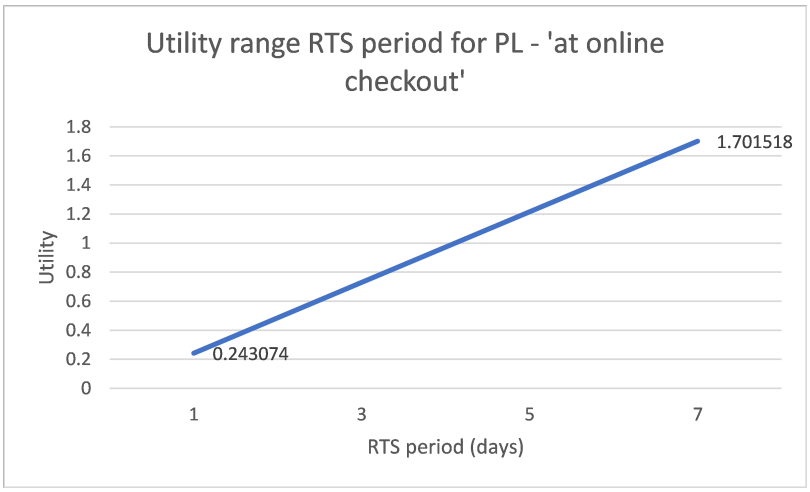

Figure 32: Utility contribution of RTS period PL - Choice question 'at online checkout'

The parameter for RTS is positive and significant (0.24), which indicates that a longer period to pick up a parcel from a PL is preferred by the respondents. For every extra day that the parcel can stay in the locker, utility for the PL alternative increases by 0.24. This effect is expected, as a longer period before the parcel is returned to the sender allows the consumer more flexibility in picking up the parcel. For parcel locker companies, shorter RTS periods are beneficial. A shorter RTS period means that more parcels are able to be delivered to and collected from the locker. This way, the locker is able to generate more economic revenue. Non-linearity of the parameter was tested, as it could be that after a certain length of the RTS, an extra day would lead to a lesser

Table 17: Relative importance delivery attributes - Choice question 'at online checkout'

Parameter	**Range**	**Parameter estimate**	**min. utility contribution**	**max. utility contribution**	**Utility range**	**Relative importance**
Price HD	0-6 euro	-1.25028	0	-7.50168	7.50168	40.2%
Delivery moment HD	-	-	-	-	-	-
Price SP	0-2 euro	-1.005151	0	-2.010302	2.010302	10.8%
Opening hours SP	-	-	-	-	-	-
Distance SP	0.2-2.0 km	-1.182279	-0.2364558	-2.364558	2.1281022	11.4%
Price PL	0-2 euro	-1.123573	0	-2.247146	2.247146	12.0%
Opening hours PL	-	-	-	-	-	-
Distance PL	0.2 - 2.0 km	-1.838371	-0.3676742	-3.676742	3.3090678	17.7%
Days before returned to sender (RTS)	1-7 days	0.243074	0.243074	1.701518	1.458444	7.8%

increase in utility. The non-linear parameter was insignificant, indicating that for each day that is added to the RTS period, the consumer experiences the same increase in utility. For parcel locker companies, it would have been beneficial if the extra utility dropped off after a certain amount of days, as this would indicate to them where they could set a RTS period that decreases inconvenience for consumers while also not being too long to impact the economic profit of the locker.

6.1.5 Relative importance

The estimated parameters indicate how a change in the attribute influences the utility of a certain delivery alternative. The relative importance of the delivery attributes for this choice question allows for comparing the attributes in their impact on driving a delivery choice. The relative importance of the attributes is computed by establishing the range in attribute level per attribute and multiplying the lower and higher bound of this range with the parameter estimate, these values are shown in Table 17 below. This difference is the utility range, and these can be compared among the attributes. The relative importance computations are listed in Table 17. From computing the relative importance of the delivery attributes (that were significant) in this choice question, it is evident that the Price of HD is the most important attribute in the trade-off, followed by the distance to PL. There is a difference between the PL distance and the SP distance which stems from the larger parameter estimate for the PL distance since the range is the same. The RTS has the smallest relative importance compared to the other delivery attributes that are found significant. Within the setting of this choice question, the most important attribute of the HD alternative is the price. For the SP and PL alternatives, the most important attribute driving the choice for the self-collection alternatives is the distance to the SP or PL. Distance is more important when choosing self-collection alternatives SP or PL than the price for these alternatives. To conclude, within the setting of this choice question, consumers are most influenced in their choice between the three delivery options by the price of Home Delivery, and then by the distance that has to be travelled to pick up their parcel. For policymakers, the findings suggest that policies aimed at positioning and pricing Home Delivery as a luxury service and shortening the distance from consumer to PL location could increase PL uptake the most.

6.1.6 Mean impact of socio-demographic variables, shopping characteristics and latent variables – Choice question 'at online checkout'

Employment status
For both the SP alternative and the PL alternative, working part-time (SP = 1.03, PL = 1.02) or full-time (SP = 1.23, PL = 1.32), turned out to have a positive and significant impact on the utility of SP and PL relative to HD. The reference category is non-working. So compared to non-working respondents, respondents who either work part-time or full-time experience more utility for the self-collection alternatives than they do for the HD alternative. A possible explanation for this could be that working people spend less time at home, and are not able most of the time to attend home deliveries. This would also explain why full-time working people experience a bit more utility from the pick-up alternatives compared to part-time workers and non-working. It could also be that since people who work might have busier schedules and less time on their hands, they like the flexibility that SP and PL offer (Lachapelle et al., 2018). Another possible reason could be that people often commute to work by car, bike or public transport, and see the self-collection alternatives as advantageous over HD because they can conveniently incorporate the pick-up in their commute. To conclude, self-collection alternatives are more attractive to consumers who either work part-time or full-time, which could be expected since the flexibility that SP and PL offer compared to HD might fit their obligations better.

Income
Income has a small but significant and negative effect on the utility of SP (-0.15) and PL (-0.17) compared to HD. This means that with a higher income, respondents experience less utility for the self-collection alternatives compared to HD. A possible explanation for this could be that Home Delivery is more expensive than SP or PL in most cases, but because of increasing income, this difference in price is not perceived as restrictive when choosing Home Delivery. Besides this main effect of income, income also impacts utility through an interaction variable with price. The effect of this interaction variable has been showed and discussed earlier. Increasing income resulted in a lower decrease in utility in case of a price increase, for all three alternatives. One of the policies to steer consumers towards PLs, is increasing the price of HD and keep the self-collection delivery options cheaper. The findings suggest that consumers in a higher-income segment (i) experience more utility for Home Delivery and (ii) are less influenced by a price incentive aimed at increased use SP or PL for delivery.

Frequency of online shopping
The frequency of online shopping has a large negative effect on the utilities of both the SP (-0.47) and PL (-0.46) alternatives. The parameters show that the more products respondents order online, the less utility they experience for the self-collection alternatives compared to HD. This result is in line with findings of an earlier study by Ma, Teo, & Wong (2022), who found that more frequent shoppers perceive the value of self-collection as lower. A possible explanation could be that the effort of picking up the parcel becomes more burdensome when the consumer has to make this trip more frequently. More frequent use of the service point positively impacts the utility of the SP and PL alternatives. So, being a more frequent user of a service point increases utility experienced for SP (0.61) and PL (0.36) compared to home delivery. The effect is stronger for the SP alternative than for the PL alternative. This could be expected, as the parameter concerns the previous use of SP for delivery. As the SP alternative is more widespread in the Netherlands than PLs, this effect could mean that people who more frequently use SPs for their delivery are also more interested in adopting PL. This result indicates to policymakers that the population of frequent SP users might be a good group to promote the PL among.

Relative advantage of PL over HD
Respondents scoring a higher factor score on the latent variable 'Relative Advantage' experience higher utility for the self-collection alternatives than for the home delivery alternative. This is expected, as the indicators that measure this attitude are framed in such a way that they specifically ask for a comparison between home delivery and parcel lockers. So, when respondents agree to a greater extent with parcel lockers being more advantageous than home delivery, it is to be expected this also increases utility for both SP and PL. Here, there is a larger difference between the self-collection alternatives. The increase in utility is higher for the PL alternative (1.76) than for the SP alternative (1.14). The most likely explanation is that SPs are similar to parcel lockers, but not identical and therefore also not identical in how respondents perceive their advantages. The results indicate that respondents do not view service points and parcel lockers the same in regard to the advantages of both. Factors such as the absence of human contact could explain this. For parcel delivery companies, the results are encouraging because it shows that there is actually a link between consumers seeing value in PL and them choosing it as their preferred delivery option.

Perceived Environmental Sustainability

Lastly, the impact of latent variables 'Perceived Environmental Sustainability PL' (PES PL) and 'Perceived Environmental Sustainability HD' (PES HD) is discussed. Starting with PES PL, this attitude has a positive and significant impact on the utility of PL (0.71). Respondents that perceive the sustainability of the PL as high, experience more utility for the PL compared to HD. This result seems to indicate that for some respondents the choice of a delivery option is influenced by environmental concerns. What is surprising is that the attitude has no significant impact on the utility of SP. With regard to environmental benefits, SPs and PL are quite similar. An explanation could be that since service points are more widespread and have been used for a longer time, respondents do not view the SP in the same light as they do with the PL. They might view the PL as new and innovative, and therefore as more sustainable. One shortcoming of this study is therefore that the perceived environmental sustainability of SP was not measured. Additionally, the results indicate that awareness of the potential environmental benefits of Parcel Lockers can be a great driver of PL use.

The PES HD LV has a negative and significant impact on the utilities for SP (-0.70) and PL (-0.53) compared to HD. Respondents who to a greater extent perceive HD as environmentally sustainable experience less utility for the self-collection alternatives SP and PL compared to HD. These results indicate that the degree of perceived environmental sustainability of a delivery method does impact the utility experienced for said delivery method. Although these results may not be surprising, not all studies come to these results (Kiba-Janiak et al., 2022; Ignat & Chankov, 2020). It is generally expected that environmental concerns translate to choices for more sustainable delivery options. However, it is not always true that Home Delivery is less sustainable than SP or PL. So, it is important for parcel delivery companies to provide consumers with the right information when it comes to the sustainability of a delivery option, as these results show that is does influence consumer choice.

6.2 Model interpretation choice question 'in case of delivery failure'

This section will discuss the results of the second choice question 'in case of delivery failure'. The second choice question focuses on the consumer preference for a delivery method in case home delivery fails. Every time participants chose the HD alternative in the first choice question, they were shown a follow-up question with a new choice task and scenario. In the end, a total of 810 choices over 188 respondents were observed. Because of the set-up of the question, not all respondents made the same number of choices in this question, as can be seen in Figure 33 below. Choice tasks 1, 2, 5, 14 and 19 are five out of six most reviewed choice tasks and were the choice tasks in the first choice question in which Home Delivery was offered for free. It is unsurprising that these were chosen most often. As a result, these occur most often in the second choice question. It is important to notice here that 'price' is not included as a delivery attribute in this question.

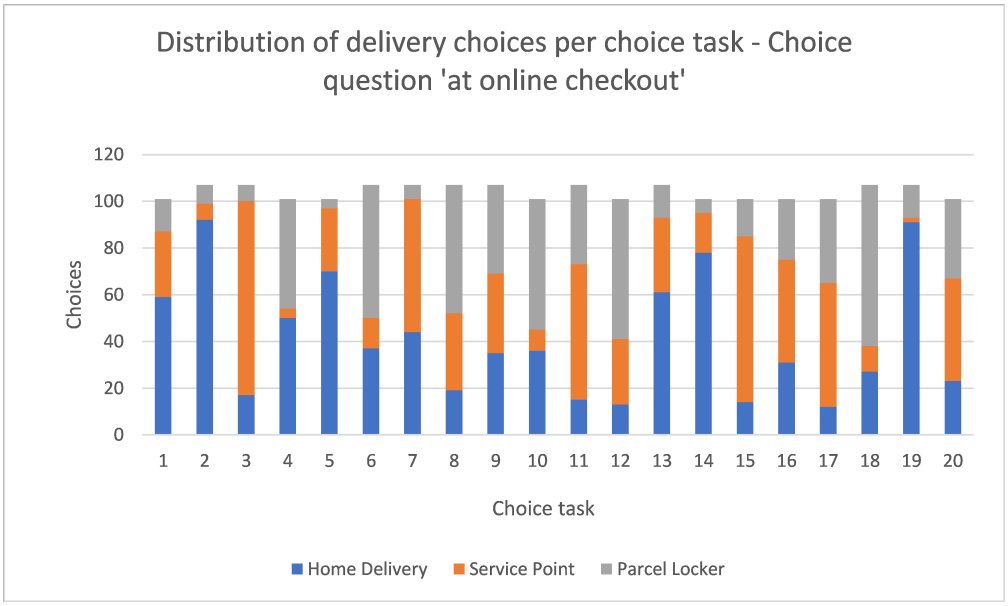

Figure 33: Distribution of choices per choice task - Choice question 'in case of delivery failure'

Of the 810 choices, 18.4% are made for SP, 7.5% are made for PL, 32.8% of the choices are made for Neighbour Delivery (NEIGH), 15.7% of the respondents choose Delivery At Another Moment (MOMENT), and finally

25.6% of the choices are made for 'Leave At Agreed Place Around the House'(AHOUSE). From these distributions, as well as the distributions for the different choices tasks, it becomes clear that at this moment the PL is not considered as a serious option in case of delivery failure. Figure 33 shows that in none of the choice tasks the PL is the most preferred option. Instead, delivery to a neighbour is the most preferred delivery option in case home delivery fails.

It is evident that there is a strong preference in the sample for delivering a missed parcel to a neighbour or to leave the parcel at an agreed place around the house. SP and PL are both self-collection alternatives and can therefore be regarded as more similar. The same can however be said for the other three alternatives in this question, as all these three delivery alternatives offer a kind of door delivery that is similar to HD. A possible reason as to why these alternatives are chosen more frequently could be due to their similarity to HD. As this question is a direct follow-up on the first choice question where they choose HD, respondents might feel that they do not want to compromise on the convenience that HD offers.

The SP and PL alternatives are both self-collection delivery methods, so it is anticipated that these alternatives have more in common with each other than with the other alternatives. On the choice data, "SIGMA SELFCOLL", a shared error component is estimated to account for this. The magnitude of this shared error component, $\eta = 3.00$, is found to be quite large and significant. From this, the correlation between SP and PL can be calculated (Train, 2003) through the following equation:

$$\frac{\eta}{\eta + \frac{\pi^2}{6}} \tag{6}$$

The correlation between SP and PL equals 0.65, which is relatively high. This relatively high correlation between SP and PL shows that respondents who have chosen either SP (or PL) from an earlier choice set in this choice question, are more likely to choose PL (or SP) from a new choice set. As expected, the results confirm that SP and PL have more in common with each other than with the other three alternatives and that there are unobserved factors that impact the utility of both alternatives similarly. It also implies that SP and PL compete more with each other than they compete with HD, because of the similarities of the alternatives. Some consumers might dislike the idea of self-collection since it requires a trip to pick up the parcel, which consumers could perceive as an additional (unwanted) effort. Another factor could be that they feel that online-ordered products should be delivered to their home and should not require them to make a trip. However, consumers might also like the idea of self-collection in the case of a failed delivery, as it makes them independent from their neighbours to receive a parcel.

Alternative specific constants (ASC) were estimated for all alternatives except for the SP alternative. Since only differences in utility matter in the model, one alternative must serve as a reference. All estimated ASCs are significant at the conventional threshold of 0.05. The results show that the ASCs for PL, MOMENT, and AHOUSE are all negative. This means that relative to the SP alternative, there are unobserved factors that are not included in this model that on average negatively impact the utility of PL, MOMENT, and AHOUSE compared to the utility of the SP alternative. For the NEIGH alternative, it is the other way around, the parameter is positive and therefore indicates that there are unobserved factors that are not included in the model that on average have a positive impact on the utility of NEIGH compared to that of the SP. The positive ASC for NEIGH is not that surprising, as it became apparent from reviewing the statements on neighbour delivery, that most of the people did not mind picking up a parcel at the neighbours and had little issues with neighbours knowing anything about their online shopping. With delivery to the neighbour not feeling like a burden, and having your parcel delivered close to home compared to SP, the positive utility for Neighbour delivery could be expected. For the PL alternative, a negative ASC could also be expected, because of some qualities of the PL, that it is unmanned, and also because the use of PLs is still relatively scarce and unknown to many. The negative ASCs for MOMENT and AHOUSE are a bit surprising when looking at the choice distributions. The MOMENT alternative is the only alternative that does not still ensure that the consumer can receive their parcel on the day that was intended. As for the AHOUSE alternative, which was chosen in more cases than SP, an unobserved factor that influences utility strongly could be a security concern, i.e. what if the parcel is carelessly placed around the house and vulnerable to theft?

6.2.1 Opening hours

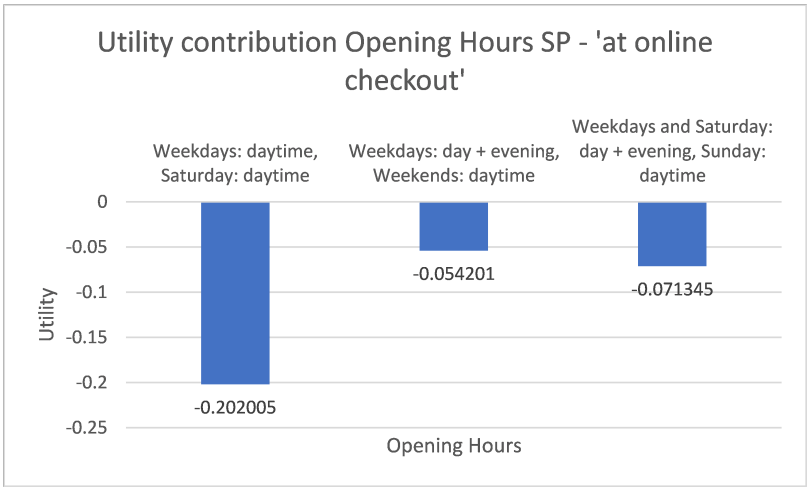

Figure 34: Contribution of each expansion of SP opening hours - Choice question 'in case of delivery failure'

For the SP alternative, opening hours during the day on weekdays serve as the reference category. As was already mentioned earlier, every level is intended to provide an increase in flexibility and as a consequence, an increase in utility is expected with every expansion. An expansion of this reference category in opening hours to also include being open on Saturdays during the day (SP OH1) yields a significant and positive (1.06) increase in utility. This is as expected. However, further expansions on these opening hours do not result in a higher increase in utility than the first expansion. This is unexpected, as the expansions provide the consumer with more flexibility to collect their parcel from a SP compared to opening hours 'during the day on weekdays and Saturday' and it was expected that these expansions would increase utility more. Possible reasons could be that respondents do not like to take time out of their (free) evenings to pick up their parcels. As 'during the day' was specified as being open from 9-18, the results seem to indicate that respondents perceive opening hours during the week and on Saturday as sufficiently long, which provides them with a wide enough time window to collect their parcels. The impact on the utility of expanding the opening hours of the SP to also include Saturdays is equal to that of an 800-meter difference in distance to a SP. For parcel delivery companies this would mean that if SPs are located further from consumers, they can try to mitigate this decrease in utility by an expansion of the opening hours of the SP.

For the PL alternative, opening hours 'Weekdays and Saturday: daytime + evening, Sunday: daytime' serves as the reference category. An expansion on this reference level of opening hours to the PL being open all day, all days of the week (24/7), results in an increase in utility (0.35) that is insignificant (p-value of 0.16). The increase in utility is expected since the expansion of the opening hours would add to the flexibility the PL offers and would increase the attractiveness of the delivery option. The finding is similar to the results of the model estimation on the first choice question. It is unexpected that it is not significant, as this is a characteristic of the PL that was deemed a great advantage (Verlinde et al., 2018; Iwan et al., 2016). The parameters for 'opening hours' were allowed to vary randomly, to investigate whether opposing preferences between individuals might cancel each other out. However, all estimated sigma's were not significant, meaning that there were no opposing preferences in the sample that caused the unexpected results. The expansion to 24/7 availability mostly adds the possibility of collecting the parcel during the night or early morning. The most reasonable explanation is that the reference level already offers long enough opening hours for respondents to collect their parcels at their convenience and that the other level adds little to this. While this may seem negative, it doesn't necessarily have to be. It provides PL companies with valuable information, as the opening hours of PL are often determined by their location. Both the model parameter estimates for 'at online checkout' and 'in case of delivery failure' seem to indicate that 24-hour availability of the PL is a characteristic that the consumer deems unnecessary if the parcel locker is already open on Weekdays and Saturday during the day and evening and on Sunday during the day.

6.2.2 Distance

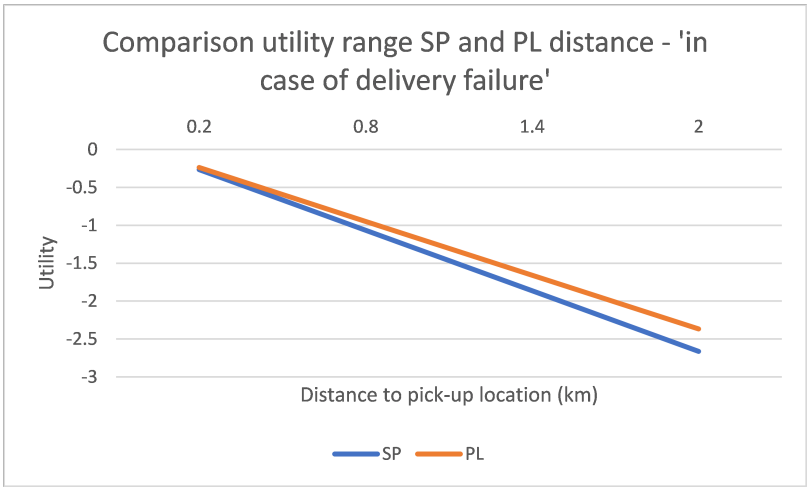

Figure 35: Comparison between SP distance and PL distance utility contribution - Choice question 'in case of delivery failure'

As expected, the distance parameters for PL and SP are negative and significant. The utility of SP (-1.33) and PL (-1.18) decreases when the distance increases to the location of the SP or PL. An increase of one kilometre in distance to a SP leads to a decrease in utility for SP of 1.33. For the PL, a one-kilometre increase in distance leads to a bit smaller decrease in utility of 1.18. In the context of a failed delivery, consumers are a bit less sensitive to the distance to a PL than they are to the distance to a SP. To compare these results to those of the distance parameters of the choice question 'at online check out', this sensitivity has switched. Respondents become less sensitive to an increase in distance for PL while becoming more sensitive to an increase in distance for SP. That this relationship has switched 'in case of delivery failure' is surprising, especially given the fact that the SP is much preferred over the PL by respondents in this choice question. A possible explanation could be that there was heterogeneity in taste for the PL distance 'at online checkout', which is no longer apparent in the PL distance 'in case of delivery failure', and that the sample of respondents in this choice question belonged to the group less sensitive to PL distance. The results indicate that in case of delivery failure, and when consumers only focus on distance, they would be more likely to choose to travel to a PL that is 1 km away to pick up their parcel than they would for a SP that is also 1 km away.

6.2.3 RTS

Unexpectedly, the estimated parameter for RTS is insignificant and very small in magnitude (0.03). So, increasing the RTS period barely increases utility for the PL. While an increase in the attribute contributed significantly to the utility of the PL alternative 'at online checkout', it does not have the same impact here 'in case of delivery failure'. It was expected that in the absence of the price attribute, other delivery attributes such as RTS might become more important in the trade-off. This is not shown by the results. The share of choices made for the PL alternative is very low, 7.5%, which translates to just 61 choices of the total of 810. The low number of observations for the PL alternative can cause bias in parameter estimates, as there is less information on the preferences for this alternative. This could be a possible reason as to why the impact of the attribute is small and insignificant. Another possible reason could be that since it is a missed delivery, consumers are likely to pick up the parcel directly on the day of delivery since they were already planning on receiving the parcel. This would mean that a RTS of 1 day would already be sufficient for the consumer and would explain why a longer RTS period barely increases utility. The results show that 'in case of delivery failure', the RTS period does not influence the choice for the PL alternative. This also means that parcel locker companies or parcel delivery companies cannot use a longer RTS period to try and attract more users.

6.2.4 Relative importance of delivery attributes choice question 'in case of delivery failure'

The same steps as before are followed in order to compute the relative importance of the delivery attributes in the second choice question. The attributes and their relative importance can be seen in Table 18. As the

Table 18: Relative importance of delivery attributes - choice question 'in case of delivery failure'

Parameter	Range	Parameter estimate	min. utility contribution	max. utility contribution	Utility range	Relative importance
Opening hours SP	Weekdays (day) - Weekdays + Saturday (day)	1.0559	0	1.0559	1.0559	19%
Distance SP	0.2-2.0 km	-1.33199	-0.266398	-2.66398	2.397582	43%
Opening hours PL	-	-	-	-	-	-
Distance PL	0.2 - 2.0 km	-1.18466	-0.236932	-2.36932	2.132388	38%
Days before returned to sender (RTS)	-	-	-	-	-	-

relative importance is only computed for the significant delivery attributes, only three attributes are considered. Because of the smaller number of attributes, differences between the attributes are magnified. This also has to do with price being excluded from this choice scenario. The delivery alternatives that were added in this second choice scenario do not have (delivery) attributes. So, the relative importance relates to the attributes of the alternatives that do have attributes. In this setting, distance to SP has the largest relative importance, compared to distance to PL and the extension of Opening hours of the SP to the second level. The results indicate that in case of delivery failure, distance to the SP or PL location is the most influencing factor in consumers' choice of an alternative delivery option. In the case of the PL, distance is the only PL-related delivery attribute that policymakers can employ to increase the demand for the PL. Simultaneously, policymakers could also make the SP a less attractive option compared to the PL by decreasing the number of SPs, and thus increasing the distance from the consumer to the pick-up location.

6.2.5 Mean impact of socio-demographic variables, shopping characteristics and attitudes – Choice question 'in case of delivery failure'

In this section, the impact of socio-demographic variables, shopping characteristics, and attitudes towards parcel delivery options on the utility of different delivery options will be discussed in the context of a failed delivery.

Level of education
To start with, the impact of socio-demographic variables on utility is discussed. It is important to note that Neighbour Delivery was chosen as the reference alternative, so the impact on utility is relative to the Neighbour Delivery option. The results show that a higher level of education increases utility compared to Neighbour Delivery for all four alternatives: SP (0.47), PL (1.15), MOMENT (0.47), and AHOUSE (0.67). Interestingly, the parameter is much higher for the PL alternative, meaning that for the PL a higher level of education leads to the highest increase in utility. A possible explanation for this could be the way that the online survey was distributed, which was distributed among the personal network of the researcher as well as of the supervisor. It is likely that this network encompasses higher educated people involved in last-mile delivery, and therefore more familiar with the concept of the PL and its benefits. For parcel locker companies, this result could also indicate that there is a gap in awareness among lower-educated consumers about the PL as a delivery option in the context 'in case of delivery failure', but also 'at online checkout' since a similar effect of education on the utility of PL was found.

Income
The impact of income on the utility of SP (-0.19), PL (-0.18), MOMENT (-0.23), and AHOUSE (-0.18), is negative and of the same magnitude for all four alternatives. An increasing level of income results in increased utility for the Neighbour Delivery alternative. So, with increasing income, consumers are more likely to opt for delivery to their neighbours in case of a failed delivery. A possible explanation could be that consumers with a higher income are more trusting of their neighbours and thus feel more comfortable relying on them to receive

their parcels. Research showed that trust in neighbours increased among Americans with higher income (Gao, 2016). These results could indicate that for parcel locker companies, lower income segments are better suitable to introduce PLs too.

Urbanity
Furthermore, we see that consumers who live in areas that are more urban perceive less utility for the PL (-0.26) and AHOUSE (-0.25) delivery options. For the Leave around the house alternative, this is as expected. More urban areas are often apartment buildings or buildings that are closely located to each other. This leaves these residential areas with few suitable options to leave the parcel at a secure place. For the PL alternative, a possible explanation could be that the level of urbanity also means that there is increased traffic on the way to the PL or the consumer anticipates few parking spots that are a burden to this journey. The negative parameter for PL is not encouraging for PL companies, as urban areas are often areas where the PL is expected to operate best.

Age
Age has a significant impact on the utility of the delivery option 'Another Moment' (0.06) and 'Leave around the house' (0.10). With increasing age, the utility of 'Another Moment' increases compared to the other alternatives. Older consumers are more likely to opt for the option of rescheduling the delivery to another moment or to have the parcel be left in a secure place around the house. Older consumers might feel less comfortable with new delivery options like the SP and PL, and rather keep the comfort of a home delivery. Another explanation might be that people of increasing age tend to live in more quiet neighbourhoods, or live there longer and trust the neighbourhood better than younger people who tend to live more in cities or move around a lot.

Employment status
Working status impacts the utility of the delivery options 'Another Moment' in the case of full-time working consumers (1.12) and 'Leave around the house' in the case of part-time working consumers (-0.61). The utility of 'Another Moment' increases if consumers work full-time compared to part-time or non-working. Possibly this is due to the fact that these consumers know that they are often not home for deliveries, but if they get the opportunity to reschedule they expect to be able to pick a time that does suit them and they keep the convenience of home delivery. Part-time workers on the other hand experience less utility for the 'Leave around the house' alternative.

Gender
Being female, compared to males and people identifying as a third gender, increases utility for both the 'Another Moment' (1.41) alternative and the 'Leave around the house' (0.87) alternative. Time spent on childcare and the household could be a possible explanation for this. Women spend on average more time on childcare and the household Roeters (2017). If this means that women are more often at home for these tasks, it could explain why they would choose 'Another Moment' since they are more likely to be at home at another time. From the childcare perspective, these options also allow the consumer to not make a trip away from their home to collect a failed delivery.

Availability at home
Consumers who spend more time at home throughout the week experience more utility for 'Another Moment' (0.23). This impact could be expected, as the consumer is more likely to be able to choose a new delivery moment that will suit them if they are available at home more frequently.

Frequency of SP use
The impact of frequency of SP use on the utility of SP (0.33), 'Another Moment' (0.24), and 'Leave around the house' (0.36) is positive and significant for the three delivery alternatives. More frequent users of the SP over the last year are more likely to choose the delivery options SP, MOMENT, or AHOUSE than they are to choose PL or Neighbour Delivery. This result is expected for SP, as previous SP use should be a good indicator of whether someone likes to use the service. It is then somewhat surprising that there is no effect on PL, as the delivery options are quite similar. Why the previous use of SP also increases utility for MOMENT and AHOUSE is unclear.

Frequency of online shopping
Online shopping frequency increases the utility of 'AHOUSE' to a small extent (0.22), while it decreases the utility of 'MOMENT' to a small extent (-0.19). So, consumers who make purchases online more frequently feel more inclined to choose to let a failed delivery be delivered at an agreed place around the house and less inclined to reschedule the delivery to another moment. When consumers make more purchases online, it could be that the delivery process might become more of a burden as it happens more frequently. In that case, rescheduling

only leads to prolonging that burden, while having the parcel be left somewhere around the house relieves the consumer of this possible burden and requires the least effort to collect a failed delivery.

Degree of burden neighbour delivery
While the impact of the former socio-demographic variables and shopping characteristics has been relatively small in some cases, the degree of burden consumers feel towards neighbour delivery results in a large increase in utility for all alternatives that are not Neighbour Delivery. This is as expected, as the degree of burden relates to picking up a parcel from a neighbour. Especially its impact on the utility of SP (1.10) and PL (1.04) is rather large in magnitude. For consumers who experience picking up a delivery from a neighbour as a burden, the SP and PL delivery options become more attractive. The results show that there is a segment of consumers who dislike the current 'standard' Neighbour Delivery in case of delivery failure, and would rather opt for delivery to either a SP or PL. The use of self-collection can thus be increased by providing this segment of consumers with that possibility. However with the aim of increasing PL use, since consumers seem to have more interest in SP in case of delivery failure than they do in PL, providing this possibility will not immediately cause an increase in PL use.

Relative advantage of PL over Home Delivery
Lastly, a positive attitude of consumers towards the advantage of PL over HD increases the attractiveness of SP (1.18) and PL (2.07). This result is as expected, as the attitude measures the value consumers perceive Parcel Lockers have compared to Home Delivery. Consumers who rate Parcel Lockers more advantageous are more likely to choose SP and to an even greater extent PL in the case that their delivery fails. These results provide opportunities for parcel locker companies, as they show that people who see value in the PL feel more inclined to opt for delivery to a PL in case of a failed delivery. In both the contexts 'at online checkout' and 'in case of delivery failure', respondents who perceive the value of Parcel Locker positively are more likely to use the PL. So, for parcel locker companies to increase the use of PLs, the focus can also be on educating consumers on PLs and on raising awareness of its potential benefits.

Table 19: Final parameter estimates ML model - Choice question 'in case of delivery failure'

	Estimate	s.e.	t.rat.(0)	p(1-sided)
Alternative Specific Constants				
ASC_NEIGH (Reference)	0	NA	NA	NA
ASC_SP	-7.75174	1.98197	-3.9111	4.59E-05
ASC_PL	-12.44611	2.20716	-5.639	8.55E-09
ASC_MOMENT	-6.92044	0.88646	-7.8068	2.89E-15
ASC_AHOUSE	-8.05263	0.89719	-8.9754	0
Service Point				
Distance	-1.33199	0.29641	-4.4937	3.50E-06
Opening hours (OH)				
OH0 - Weekdays: daytime	0			
OH1 - Weekdays: daytime, Saturday: daytime	1.0559	0.44109	2.3938	0.008337
OH2 - Weekdays: day + evening, Weekends: daytime	0.51056	0.5093	1.0025	0.158057
OH3 - Weekdays and Saturday: day + evening, Sunday: daytime	0.27239	0.33257	0.8191	0.206377
Parcel Locker				
Distance	-1.18466	0.26529	-4.4655	3.99E-06
Opening hours	0.35005	0.36119	0.9692	0.166232

Continued on next page

Table 19: Final parameter estimates ML model - Choice question 'in case of delivery failure' (Continued)

Days before returned to sender (RTS)	0.03308	0.06224	0.5315	0.297553
Socio-demographic variables				
Education - SP	0.46797	0.2671	1.752	0.039885
Income - SP	-0.18662	0.09463	-1.972	0.024303
Eduation - PL	1.15283	0.3054	3.7749	8.00E-05
Urbanity - PL	-0.25756	0.08493	-3.0328	0.001211
Income - PL	-0.18408	0.10244	-1.7969	0.036179
Age - MOMENT	0.06372	0.01034	6.1646	3.53E-10
Female - MOMENT	1.41389	0.26213	5.3939	3.45E-08
Education - MOMENT	0.47052	0.11804	3.9861	3.36E-05
Availability at home - MOMENT	0.22825	0.09886	2.3089	0.010474
Full-time working - MOMENT	1.12268	0.27938	4.0184	2.93E-05
Income - MOMENT	-0.23512	0.05123	-4.5896	2.22E-06
Age - AHOUSE	0.0948	0.01068	8.8764	0
Female - AHOUSE	0.87447	0.26174	3.341	4.17E-04
Education - AHOUSE	0.67456	0.12222	5.5194	1.70E-08
Urbanity - AHOUSE	-0.25376	0.04751	-5.3407	4.63E-08
Part-time working - AHOUSE	-0.60744	0.28514	-2.1303	0.016572
Income - AHOUSE	-0.17618	0.04238	-4.1569	1.61E-05
Shopping characteristics				
Frequency of use SP - SP	0.33275	0.13767	2.417	0.007825
Shopping frequency - AHOUSE	0.22575	0.08757	2.5781	0.004968
Frequency of use SP - AHOUSE	0.24079	0.11921	2.0199	0.021699
Shopping frequency - MOMENT	-0.19014	0.09382	-2.0266	0.021351
Frequency of use SP - MOMENT	0.36124	0.11825	3.0548	0.001126
Attitudes				
Relative advantage - SP	1.18417	0.43505	2.722	0.003245
Relative advantage - PL	2.07277	0.47575	4.3569	6.60E-06
Degree of burden - SP	1.09642	0.27787	3.9458	3.98E-05
Degree of burden - PL	1.03889	0.29879	3.477	2.54E-04
Degree of burden - MOMENT	0.65606	0.12344	5.3149	5.34E-08
Degree of burden - AHOUSE	0.90956	0.12251	7.4242	5.67E-14
Shared error component				
SIGMA_SELFCOLL	3.00894	0.39101	7.6953	7.11E-15

To conclude this section, the most important findings are repeated. First, 'in case of delivery failure' the most important delivery attribute that influences the delivery choice decision is the distance to the pick-up location. The other delivery attributes have less influence on this decision, making the distance attribute dominant in the trade-off. Neighbour delivery is the most preferred delivery option 'in case of delivery failure', while the PL

is the least preferred option in most choice sets. The degree of burden consumers experience when picking up their parcel from a neighbour negatively impacts the utility for the Neighbour delivery alternative. Consumers who perceive more value in the Parcel Locker are more likely to choose the self-collection alternatives 'in case of delivery failure'. Second, 'at online checkout', the price of the delivery options, as well as distance to the pick-up location, day + evening delivery all week, and the RTS period significantly influence consumer choice for a delivery option. In this trade-off the price of HD is the most dominant delivery attribute. Here too, consumers who perceive more value in the Parcel Locker are more likely to choose the self-collection alternatives. What was surprising was the overall lack in increase of utility for the expansion of the delivery moment of HD, and the opening hours of both the SP and the PL. Lastly, both for 'at online checkout' and 'in case of delivery failure' a shared error component for SP and PL was found to be significant. This confirmed that these two delivery options are similar and that when a consumer chooses SP in one choice set, they are more likely to choose PL in a new choice set, and vice versa.

7 Market demand analysis

The former section interpreted the parameters for the two choice models that were estimated and provided insights into what these results mean in light of the aim of the paper. However, this does not provide much tangible information for policymakers about the actual impact a change in a delivery attribute has on the choice behaviour of the consumer. In this section, the estimated choice models will applied to estimate predicted choice probabilities for possible future policy scenarios. The predicted choice probability for a delivery alternative is then interpreted as the market share for that delivery option in a certain future scenario. By computing the market demand for the PL in different future policy scenarios, policymakers are provided with tangible information on the impact of PL-related delivery attributes on consumers' choice behaviour. This section therefore helps this research to translate the results of this research into more meaningful policy recommendations and to embed these policy recommendations on a more solid foundation.

In order to do this, the first step is to construct several policy scenarios for which the market demand will be computed. The construction of these policy scenarios is grounded in the delivery attributes that are included in the choice experiment and the interpretation of the model results. Such a policy scenario is a synthetic description of a choice scenario, similar to a choice task that was provided in the survey, in which the delivery attributes of the different alternatives take certain values in order to represent a policy measure.

Sample enumeration is applied to compute the market demand. Sample enumeration is applied to be able to account for the heterogeneity that is present in the sample. Because of this heterogeneity, the predicted choice probability is different for each individual. This means that to compute non-biased predicted choice probabilities that take into account the heterogeneity in the sample, predictions have to be made for each individual separately. The process of sample enumeration employed in this research is based on Molin (2022). First, a synthetic population is created. This synthetic population is created based on the distribution of characteristics of this sample. Two populations are created, one to predict consumer choices 'at online checkout' and one to predict consumers choices 'in case of delivery failure'. The size of these populations are 93,600 and 94,000. These are created by replicating the actual sample many times until a large enough population is created. A large population is needed in order to mitigate the impact of extreme values taken from the distribution of the error component and random parameters and assure stable predictions. Interactions are included in the choice model, so the next step is to adjust the parameters for each individual based on these interactions. Next, since a shared error component, as well as random parameters for delivery attributes are included, each individual is assigned a random value for these variables based on their assumed distribution. As the price parameters was assumed to be normally distributed for simplicity reasons, the very few positive values for individuals for this parameter were set to 0. With all these parameters now adjusted to each individual, the choice probabilities for each individual for each delivery alternative are computed by first calculating the utility for each alternative, and then compute the choice probabilities for each individual by applying the MNL model. The choice probabilities for all individuals for the delivery alternatives are then aggregated. These aggregated choice probabilities are interpreted as the market share for each delivery alternative.

Market demand for the PL will be computed in the context of anticipated failed delivery, as well as in the regular choice scenario at the checkout of ordering online. As two different choice models are estimated for the two different choice contexts, not every delivery attribute is significant in both models. It is illogical to vary delivery attributes that are found to have an insignificant impact on the utility of a delivery alternative. Additionally, the choice scenario for the anticipated failed delivery does not include the price parameter for the delivery options. Because of these two differences, two distinct sets of future policy scenarios will be designed. It should be noted that the market demand analysis performed in this section and its results only hold true for the experimental setting and the sample of respondents of this study, and are thus not directly translatable to the real world. Still, the results of the market demand analysis should provide valuable insight into the effect that several policy scenarios have on PL demand.

As the aim of this paper is to determine what influences the demand for PL and what this demand currently is, the policy scenarios will mainly revolve around varying PL-related delivery characteristics. First, possible policy scenarios will be constructed for the delivery choice experiment set at the online checkout. Then, future policy scenarios for the delivery choice experiment when delivery failure is anticipated are constructed. The different scenarios and the attribute values used to predict the choice shares 'at online checkout' are shown in Figure 36, along with the results.

7.1 Market demand analysis: delivery choice at checkout

Reference Scenario 1: Current market situation
First, a reference scenario is constructed that most accurately presents the current situation in the parcel delivery market. Presently, e-retailers do not offer different prices at checkout when choosing between Home Delivery, Service Point, or Parcel Locker. The price for these alternatives is therefore assumed to be the same. The context of the choice scenario presents the respondent with ordering a product at a value of 65 euros. As most retailers offer free delivery or free delivery when a certain shopping value is reached, the price for all three alternatives in the reference scenario is set to 0 euro. The delivery moment for HD is set at the reference level, 'Weekdays: delivery during the day', as this is the most common delivery moment used to deliver parcels by PostNL and DHL. These companies do offer delivery in the evening, however, this is often accompanied by an extra fee. No data could be found on the average opening hours of an SP or PL, so the website of PostNL is consulted to review the most common opening hours for SPs and PLs in the area of Rotterdam. The opening hours of the SP are also set to the least flexible level, 'Weekdays: open during the day'. The same is done for the PL alternative, so the level 'Weekdays and Saturday: daytime + evening, Sunday: daytime' is selected. For the distance of the Service Point, there is no data on what the average distance is now to a Service Point. Data analysed by the ACM in a market study on last-mile delivery from 2019 states that PostNL have a coverage of 52% within 500 meters, and if all service points of other companies are considered there is a nationwide coverage of 63%. In research by Radar (Dutch television programme that researches consumer affairs), two two-thirds of the respondents indicate having a SP within a kilometre of their house. A distance of 1 km to a SP is chosen. The same research by the ACM shows a low coverage of the PL network in the Netherlands in 2019, with 5% of the Dutch population having a PL within walking distance. Although more PLs have been placed since then, it is reasonable to assume that the network is not very dense at the moment and that for the majority of the Dutch population, one is not within walking distance. To this end, a distance of 2 km is chosen. This is a distance not within walking distance and far away enough to be considered unattractive, while also staying within the bounds of the distances that were varied in the experiment. Interpolation is seen as more reliable than extrapolation, i.e. choosing a value that lies outside of the values that were varied in the experiment, because no assumptions have to be made about the validity of the parameter outside of what was varied in the experiment. Finally, the RTS period is set at 7 days. PostNL uses a shorter period of 3 days. Both DHL and Budbee use a period of 7 days for the customer to pick up their parcel from the parcel locker. A period of 7 days is assumed to be the most common.

For the market demand analysis for the delivery choice at checkout, the attributes that will be varied in the policy scenarios are: HD Price, SP Price, PL Price, PL Distance and PL RTS. The price attributes will be varied because this is one common policy recommendation from other studies to motivate consumers to use self-collection alternatives, for example, Iannaccone et al. (2021) & Molin et al. (2022). PL Distance will be varied because it indicates the number of PLs that are placed. Policymakers can decrease the distance to a PL by placing more PLs. So a shorter distance in the scenario is interpreted as more PLs being placed. Lastly, the RTS period will be varied as it is an important attribute of the PL, especially for the parcel delivery companies, and is an attribute that they can directly influence. A longer RTS period is more costly for the parcel delivery companies since it affects the efficiency of the locker, so knowing how the length of the RTS impacts demand is very valuable. The other attributes are kept fixed throughout the analysis due to two reasons. First of all, when varying too many attributes at the same time, the impact of an individual attribute becomes blurred and hard to interpret. Secondly, the price attributes and the PL-related attributes are the most likely and obvious attributes to be used to shape policy around increasing PL demand among consumers.

Scenario 2 – Price incentive precedes PL network expansion
In the former scenario, the price incentive was already mentioned. This scenario therefore explores a policy scenario in the current market in which e-retailers and parcel delivery companies work together to offer differentiating prices for HD, SP and PL to their customers. A price incentive is given to use the self-collection alternatives SP or PL, by setting the price for HD at 2 euros. In this case, free delivery is still common in the current market and which customers are used to, is retained for the self-collection alternatives SP and PL. The distances to the SP and the PL are kept at the same level as in the reference scenario. This policy scenario will depict a future scenario where a small price incentive precedes the expansion of the PL network.

Scenario 3 – PL network expansion precedes price incentive
This scenario assumes that the PL network will be expanded before prices for the different delivery options are differentiated by e-retailers and parcel delivery companies. PL network expansion can be due to several projects that are either in their pilot phase or are being rolled out now. One such project is the pilot by EVAnet in

cooperation with the province of Zuid-Holland, where they have placed PLs at bus stops. Locating PLs at bus stops would greatly shorten the distance to a PL. Another project of interest is the cooperation between Albert Heijn (supermarket chain) and Budbee (PL provider), who agreed to place 700 PLs between 2022 and 2024 in the larger Albert Heijn stores (Albert Heijn, 2022). Projects such as these would shorten the distance from consumer to PL even more. Prices in this scenario are kept the same as in the reference level, as is the case for the RTS period.

Scenario 4 – Higher prices reference scenario
The fourth scenario introduces a scenario where the prices for all three delivery options increase. Last year, PostNL announced that they were inclined to increase their prices for parcel delivery (Stil, 2022). Rising inflation, increasing cost of fuel and electricity, and rising labour costs are the drivers of this increase. Although e-retailers are the ones who determine if and how they charge customers for delivery, it is not unlikely that eventually these costs will be passed on to the consumers. The prices for the three delivery alternatives increase in this scenario to 2 euros and stay equal among the delivery options. This scenario depicts the reference scenario but with increased prices. It explores what the market demand for PL will be if delivery is no longer free. There could be a difference with the reference scenario, as consumers might not feel inclined to use a self-collection alternative when they have to pay for this.

Scenario 5 - Price increase for all delivery services
The fifth scenario continues on this higher price reference scenario. So, in this scenario, e-retailers and parcel delivery companies do not offer differentiating prices for the delivery options and there is no price incentive to use the self-collection alternatives SP and PL. Prices are 2 euros for all three delivery options. In this scenario, as is the same in scenario 3, the distance to the PL is much shorter (500m). This is due to PL being placed at bus stops and within the larger supermarkets. The RTS period is set at 7 days.

Scenario 6 – Both incentive strategies at work
Scenario six explores the most optimal scenario for the PL that is still within possible bounds. In scenario six the two policies aimed at increasing the demand for PLs are both implemented. In this scenario, e-retailers and parcel delivery companies work together to provide differentiating prices at online checkout. Home Delivery is viewed as a luxury option and consumers pay an additional fee for this. HD Price is set at 6 euros. A price incentive is set to increase the use of self-collection alternatives SP and PL. SP Price and PL Price are set at 2 euros. Through the same policies as in scenarios 3 and 5, the network of PLs is expanded and they are located closer to the consumers at 500m. The last mile sector collaborates to provide the consumer with differentiating prices and a more dense PL network.

Scenario 7 – Extreme scenario, shortest distance possible
It was also chosen to calculate a scenario where the distance to a Parcel Locker is very small, 200m. A distance of 200m is the lowest attribute value experimented with in this study. A distance of 200m is very short, and probably not realistic or feasible for parcel carriers. The reason for computing a scenario with this distance is to provide insight into what the 'maximum feasible' demand for the PL would be. The other attributes are set to represent the optimal scenario for PL usage, as in scenario 6. This scenario explores what the maximum potential of market demand for PL is in a scenario where the 'inconvenience' of making the trip to the PL is limited by shortening the distance to 200 meters (or a 2 to 3-minute walk). Although 200m is a very short distance parcel delivery companies would collaborate and agree to open their lockers for each other, thereby creating a so-called white-label parcel locker network. This would further shorten the distance between the consumer and the PL.

Scenario 8 – Limiting the RTS period
In the former scenario, both the two policies to incentivize consumers to use the PL over HD are set in place. The former scenario should provide the last mile sector with a realistic scenario in which demand for the PL would be high. The price and distance attributes will be kept the same as in scenario 6. However, placing more PLs also comes with considerable cost. Shortening the RTS period is a measure that parcel delivery companies could take to increase the number of parcels that run through the locker, consequently increasing the economic efficiency of the locker. The RTS period is set at 1 day to determine what impact this would have on the demand for the PL alternative.

7.1.1 Result of the market demand analysis 'at online checkout'

Scenario	1 - Reference scenario	2 - Small Price change precedes closer PL	3 - Close but no price change	4 - Higher prices reference scenario	5 - Higher price, PL closer	6 - HD as 'luxury' + price incentive, PL close	7 - PL Extremely close	8 - PL with small RTS
HD Price	0 euro	2 euro	0 euro	2 euro	2 euro	6 euro	6 euro	6 euro
SP Price	0 euro	0 euro	0 euro	2 euro	2 euro	2 euro	2 euro	2 euro
PL Price	0 euro	0 euro	0 euro	2 euro	2 euro	2 euro	2 euro	2 euro
Delivery Moment	Weekdays: only day delivery	Weekdays: only day delivery	Weekdays: only day delivery	Weekdays: only day delivery	Weekdays: only day delivery	Weekdays: only day delivery	Weekdays: only day delivery	Weekdays: only day delivery
Opening hours SP	Weekdays: only daytime	Weekdays: only daytime	Weekdays: only daytime	Weekdays: only daytime	Weekdays: only daytime	Weekdays: only daytime	Weekdays: only daytime	Weekdays: only daytime
Opening hours PL	Weekdays and Saturday: day + evening, Sunday: day	Weekdays and Saturday: day + evening, Sunday: day	Weekdays and Saturday: day + evening, Sunday: day	Weekdays and Saturday: day + evening, Sunday: day	Weekdays and Saturday: day + evening, Sunday: day	Weekdays and Saturday: day + evening, Sunday: day	Weekdays and Saturday: day + evening, Sunday: day	Weekdays and Saturday: day + evening, Sunday: day
Distance SP	1 KM	1 km	1 km	1 km	1 km	1 km	1 km	1 km
Distance PL	2 KM	2 km	0.5 km	2 km	0.5 km	0.5 km	0.2 km	0.2 km
Days before returned to sender (RTS)	7	7	7	7	7	7	7	1
HD	71%	41%	61%	63%	53%	11%	9%	14%
SP	19%	41%	12%	25%	15%	32%	27%	52%
PL	10%	19%	27%	12%	32%	57%	64%	35%

Figure 36: Market demand analysis - Choice question 'at online checkout'

The above figure shows the predicted choice shares for the three delivery options 'at online checkout'. These choice shares are interpreted as the market shares for these delivery options in the parcel delivery market. The results of the different future policy scenarios will be interpreted and discussed in relation to each other. The reference scenario aims to represent the current last-mile delivery market as accurately as possible. It is clear that Home Delivery is the most preferred and dominant delivery option when consumers order a product online. Demand for the Parcel Locker is low, which can be attributed to the large distance between PL and consumer. From this scenario, it is evident that under current circumstances there is little demand for the Parcel Locker, and if policymakers want to increase its share they will have to make the PL more attractive to consumers. One way of doing this, as is shown in the second scenario, is for parcel delivery companies to increase the price of HD by 2 euros and for e-retailers to adopt this price into their delivery options. Such a price increase by the parcel delivery companies can be viewed as a price incentive for consumers to start using self-collection alternatives SP and PL more. From the results, it is clear that such a price increase yields the most benefits for the SP alternative, as it increases much more than the share of PL. The share of SP is now equal to that of HD (41%), while the share of PL is much smaller at 19%. This second scenario indicates that when a price incentive for self-collection precedes creating a denser PL network, most consumers will switch to the SP option. Therefore, if the aim is to increase demand for PLs, this strategy is not successful.

The third scenario turns this around. The scenario depicts a situation in which the PL network becomes more dense by placing more PLs, but no price incentive is adopted by the market. In this scenario, the demand for the PL increases to 27%, at the cost of both demand for HD (now 61%) and SP (now 12%). Compared to the reference scenario, demand for PL has almost tripled. However, in this case, HD is still the most preferred and dominant delivery option. Compared to increasing the price of HD first, shortening the distance to the PL does a better job of increasing demand for the PL. This could be expected, as shortening the PL distance is solely focused on PL, while the price increase of HD benefits both self-collection alternatives. What is also interesting from comparing the second and third scenarios, is that after the small price incentive HD is no longer the dominant delivery option, it is shared with SP. While shortening PL distance benefits the PL more, HD is still the most preferred delivery option. This leaves parcel delivery companies and policymakers with an important decision as to whether the aim is solely to increase PL use, or whether it is to lower the demand for HD and get more consumers to use self-collection in general.

The fourth scenario depicts a reference scenario with higher prices for all the delivery options. Higher pay for workers and rising energy cost makes delivery more expensive, and it is possible that this will eventually be recouped from the consumers. The scenario shows that a price increase of 2 euros for all three delivery options would lower demand for HD (now 63%), and increase demand for SP (now 25%) and to a small extent demand for PL (now 12%). The fifth scenario now depicts a situation in which all delivery prices are higher, and where PLs are located closer to the consumer. Compared to scenario 3, where the same decrease in PL distance resulted in a market share for PL of 27%, in this scenario the market share for PL increases to 32%. As was already clear from the market shares of the fourth scenario, increased delivery price of all options benefits self-collection. An equal decrease in PL distance has more impact on PL demand in a scenario of raised delivery prices. However, with a market share of 52%, HD is still the most preferred delivery option. While PL is now the second highest, to persuade the majority of e-consumers, shortening PL distance will have to be accompanied by a price incentive to use self-collection. Scenario six shows that when both PL distance is shortened, and HD price is increased to 6 euros, the PL becomes the dominant delivery option with a market share of 57%. Demand for HD is down to 11%, while SP demand is at 32%. So, turning HD into a luxury service and shortening the PL distance results in a last-mile delivery market in which self-collection is the dominant delivery option, and the PL in particular.

In the extreme scenario where the distance from consumer to PL is just 200 metres, its share increases to 64%, meaning that almost two-thirds of the online ordered products would be delivered to a PL. It showcases what is possible for the PL in the most optimal scenario. Finally, scenario eight depicts a situation in which parcel delivery companies and parcel locker providers limit the RTS period to one day, in order to increase the revenue of the PL to account for the cost of broadening the PL network. This scenario shows that this would significantly reduce the demand for the PL (now at 35%). Self-collection as a group is still very dominant over HD, however, the PL is no longer the most preferred delivery option. When the RTS period of the PL is lowered to 1 day, a large share of consumers would switch to the SP, although it is located much further (at 1 km) than the PL is (0.2 km).

To conclude, the results show that to boost PL use, decreasing the distance from consumer to PL has more impact than implementing a price incentive for self-collection alternatives. However, the market demand analysis for parcel delivery choice 'at online checkout' indicates that for the PL to become the dominant alternative in the delivery market, two policy interventions are necessary. So, decreasing the distance from consumer to PL has to be followed up by a price incentive for self-collection alternatives. The combination of both would result in PL being the dominant delivery choice.

7.2 Market demand analysis: alternative delivery choice for anticipated failed delivery

This section will introduce the future policy scenario for the market demand analysis for delivery choice in case of anticipated failed delivery. The future policy scenarios in this choice context are constructed based on the scenarios that have already been constructed for the market demand analysis for delivery choice at online checkout. Based on the parameters that were estimated in the final ML model for this choice context, there are three attributes that significantly influence the choice probabilities for the delivery choices: SP Opening hours, SP Distance and PL Distance. As was explained earlier for the former demand analysis, the future policy scenarios are shaped based on PL-related attributes. Demand for the PL is not influenced by the RTS period in this choice context, compared to the RTS parameter in the first choice context. This means that for future policies, only the distance to the PL will be varied, as this is the only PL-related delivery attribute that policymakers can change that (in the choice context of this experiment) impacts the demand for PLs. There are no PL-related delivery attributes that influence PL demand in case of an anticipated failure, that does not influence PL demand at online checkout. As a result, the future policy scenarios in this market demand analysis are fairly simple. The future policy scenarios in this case are taken from the scenarios that were constructed before, meaning that PL distance is varied in the same manner. In this sense, possible future policies for increasing PL demand in case of anticipated failed delivery are more of a direct result of the policies implemented for increasing PL demand for 'regular' online shopping and parcel delivery, than they are standalone policies. The different scenarios and the attribute values used to predict the choice shares 'in case of delivery failure' are shown in Figure 37, along with the results.

Scenario 1 – Reference scenario
In the second choice context/question, Home Delivery is excluded as an alternative. The price attribute is

also excluded as an attribute. The reference scenario in this market demand analysis uses the same levels for the delivery attributes as in the reference scenario for the former market demand analysis. SP Distance is set at 1 km and with opening hours of 'Weekdays: open during the day', as consumers would still have the same SPs in their neighbourhood to choose from. The same holds true for the PL delivery attributes. PL Distance is thus set at 2 km, with opening hours set at 'Weekdays and Saturday: daytime + evening, Sunday: daytime'. An RTS period of 7 days is selected as this does also not change between the two choice contexts.

Scenario 2 – PLs are located closer
In this second policy scenario, the PL network is expanded by the last mile sector in collaboration with municipalities and commercial partners. By expanding the PL network, the distance from consumer to PL is shortened and the network becomes more dense. As was explained earlier, several projects can make this expansion possible. The first is that PLs are placed at bus stops thanks to partnerships between municipalities and parcel locker providers. A pilot is now running where EVAnet and the province of Zuid-Holland have placed three PLs at bus stops. The second project has supermarket chain Albert Heijn and PL provider Budbee working together, placing 700 PLs in larger Albert Heijn supermarkets between 2022-2024. Such collaborations between other large supermarket chains and PL providers could significantly reduce the distance to a PL. PL distance is set at 500m, with the remaining delivery attributes set at their reference level.

Scenario 3 – PLs extremely close
In the third scenario, PLs are located extremely close to the consumer, at 200m. This policy scenario is not very realistic because it would necessitate the placement of a large number of PLs, which would come at a high cost. However, the policy scenario gives an indication of what is possible for PL demand in the most optimal scenario. This is still valuable information for policymakers as it provides insight into the maximum growth potential for the PL. The remaining delivery attributes are set at their reference level.

Scenario 4 – PL and SP at the same distance
The fourth scenario does not result from an earlier formulated policy scenario. This scenario explores what it would mean for PL demand when PLs and SP are located within the same distance from a consumer. PL Distance is set at 1 km. This means that the PL network has already undergone an expansion. This could be due to either of the two expansion projects, PLs at bus stops or PLs in larger supermarkets. The remaining delivery attributes are set at their reference level.
Scenario 5 - SP more distant, PLs located closer
From the model interpretation, it became evident that in case of delivery failure, the distance to the pick-up location is the delivery attribute that influences the consumers' decision in an alternative delivery option the most. The foregoing scenarios have only varied the distance to the PL, as this is the only PL-related attribute that policymakers can employ to stimulate PL use. Increasing the distance from the consumer to a SP would decrease its market share, but it could positively impact the market share of the PL. Since both delivery options are quite similar, it is expected that the market share of the PL would increase more relative to the other delivery options, as consumers who prefer self-collection would now opt for the PL instead of the SP. Service Points are often operated as a side business by private shopkeepers, but are reported to increase the workload while providing little revenue. So, it is possible that in the future Service Points will disappear due to this. These SPs could be replaced by PLs to increase the network density. PLs can also be located closer to the consumer by locating them at bus stops and within larger supermarkets. So, this scenario will explore to what extent it would be beneficial to PL use if there were fewer SPs.

7.2.1 Result of the market demand analysis 'in case of delivery failure'

Scenario	Reference scenario 1	Scenario 2 - PL Closer	Scenario 3 - PL Extremely close	Scenario 4 - PL and SP at same distance	Scenario 5 - Fewer SPs, PL closer
SP Opening hours	Weekdays: only daytime	Weekdays: only daytime	Weekdays: only daytime	Weekdays: only daytime	Weekdays: only daytime
SP Distance	1 km	1 km	1 km	1 km	1.5 km
PL Distance	2 km	0.5 km	0.2 km	1 km	0.5 km
PL Opening hours	Weekdays and Saturday: day + evening, Sunday: day	Weekdays and Saturday: day + evening, Sunday: day	Weekdays and Saturday: day + evening, Sunday: day	Weekdays and Saturday: day + evening, Sunday: day	Weekdays and Saturday: day + evening, Sunday: day
PL RTS - Days before returned to sender	7 days	7 days	7 days	7 days	7 days
SP	24%	17%	16%	20%	12%
PL	4%	15%	18%	10%	18%
MOMENT	12%	11%	11%	11%	12%
AHOUSE	26%	24%	23%	25%	25%
NEIGH	35%	33%	32%	34%	34%

Figure 37: Market demand analysis - Choice question 'in case of delivery failure'

The figure above shows the results of the market demand analysis 'in case of delivery failure'. Consumer choices were predicted, and these choice probabilities are interpreted as consumer demand for a certain delivery option when home delivery fails. The reference scenario is the same as 'at online checkout'. The results of the reference scenario show that when the PL is 2 km away and the SP is located at 1 km, demand for SP is at 24% and for the PL at just 4%. The most preferred alternative delivery option is delivery to a neighbour, and after that to leave the parcel at an agreed place around the house. It is obvious that under the current circumstances in the last-mile delivery market, consumers do not consider the PL to be a good choice. The SP is considered much more suitable at this stage. The second scenario moves PLs closer to the consumers, while the SP remains at the same distance to the consumer as in the reference scenario. Increasing the number of PLs and thereby shortening the distance has only a small impact on the demand of the PL in case of delivery failure. PL demand has increased to 15% in this scenario, which is almost four times more than in the reference scenario, but still low compared to the other options. Neighbour delivery remains the dominant delivery choice, while the demand for SP (now at 17%) has increased with the increase in PL demand. While shortening the distance to the PL to 0.5 km increases demand for the PL, its share is still relatively low. It also mainly affects the share of the SP, while shares of the other delivery options are largely unaffected. Further shortening the distance of the PL to just 0.2 km, as in scenario 3, only increases the demand for the PL by 3% to a total of 18%. The PL is now preferred over the SP (at 16%), but Neighbour delivery (32%) is still preferred over the PL. As well as leaving the parcel around the house (23%). Located at the same distance from the consumer, demand for the SP is twice as high as demand for the PL in case of delivery failure. This shows that in case of delivery failure, and with equal distance to the consumer, the SP is largely favoured over the PL. A possible explanation for this could be that consumers who favour Home Delivery in the first place, are more hesitant to use a new innovation such as the PL when a similar delivery option, the SP, exists that they are more accustomed to using. Finally, in a scenario where there would be fewer SPs, which are thus located further away from the consumer (at 1.5km), and the PLs are located at a shorter distance of 0.5 km, the analysis shows that demand for the PL is still relatively low (at 18%) compared to the other delivery options. In this scenario, Delivery to a neighbour (34%) and leaving the parcel at an agreed place around the house (25%) are preferred delivery options in case of a failed delivery.

To conclude, this analysis shows that there is limited demand for the PL in case of a failed delivery, even when the PL is located extremely close to the consumer. It is evident that by only being able to impact PL demand through distance, policymakers and parcel delivery companies are unable to reduce demand for the other delivery options. In case of failed delivery, and without a price incentive, the PL cannot compete with Neighbour delivery and Leave the parcel around the house.

8 Conclusion

This paper's research is concluded in this section, which will first briefly discuss the research approach. The key findings are presented and linked to the study's aim and research questions. These findings are compared to existing literature on the subject to determine the results that match what is currently known, which are contradicting, and what findings are new. Policy recommendations and implications are provided for various stakeholders in society. Additionally, some shortcomings and limitations of this study are discussed, as all studies have limitations due to their assumptions, making this a crucial step. Lastly, suggestions and potential directions for future research are discussed.

8.1 Research approach

The research approach employed a comprehensive examination of consumer parcel delivery preferences, conducting empirical data analysis through a discrete choice experiment and discrete choice modelling. The DCE is constructed based on a review of existing literature, to unravel insights into key behavioural factors influencing last-mile delivery choices. This study conducted the discrete choice experiment through an online distributed survey, which also collected data on neighbour relations, socio-demographic characteristics, as well as consumer attitudes regarding neighbour delivery, environmental sustainability of parcel lockers and home delivery, and finally the perceived advantage of parcel lockers over home delivery.

8.2 Important research findings

This section will discuss the most important results of this study in relation to the overall aim and research questions. This study aimed to investigate several things. First, to find consumers' preference for delivery methods in two distinct choice scenarios, when ordering a product online 'at online checkout', and in case of a failed delivery. Second, to find what factors influence the preference for a delivery method in these scenarios and how trade-offs are made between these attributes. Third, to investigate whether socio-demographic and shopping characteristics impact their preferences. Finally, to investigate how consumers perceive: neighbour delivery, the environmental sustainability of delivery methods, the advantage of parcel lockers relative to home delivery, and whether these perceptions influence their preference for delivery methods.

The addition of the second choice question 'in case of a failed delivery' is what constitutes the main addition of this study relative to others. The results of this study indicate that the PL is not considered by consumers as a good delivery option in case of a failed delivery. It is actually the least preferred option. The largest share of consumers prefer that the parcel is either delivered to their neighbours or is left at an agreed place around their house. That the parcel is to be delivered to a SP is the next most preferred. To reschedule the delivery to another moment comes next, while delivery to a PL in case of a delivery failure is the least chosen alternative. When picking an alternative delivery method, consumers are influenced by the opening hours of the Service Point, the distance to the Service Point and the distance to the Parcel Locker. Service Points also being open on Saturdays positively impacts the attractiveness of the Service Point. In the absence of price as a delivery attribute, distance to the SP or PL are the dominant in the trade-off between the attributes. It was expected that the absence of price would spur more trade-offs between the other attributes and that some of these would become significant. However, this was not the case and could be attributed to the overall preference towards the non-self-collection alternatives in the case of anticipated failed home delivery.

The market share analysis in case of failed delivery showed that in the current last-mile market, PL only has a share of 4%. Based on the findings of this study, it appears that there isn't much demand for the Parcel Locker when a delivery fails, even if the PL is located very close to the consumer. It's clear that policymakers and parcel delivery companies are limited in their ability to influence demand for the parcel locker solely based on distance. Without a price incentive, the PL cannot compete with neighbour delivery or leaving the parcel around the house in the event of a failed delivery.

To this researchers' knowledge, no other study has measured consumer preference for delivery options and attributes in case of anticipated delivery failure in the same manner as this study. However, this makes it difficult to compare the results of this study to others. Rai et al. (2021) in their study show that the majority of the respondents have the preference for a SP, and after that pick-up at neighbours is preferred. For all consumer segments they identified, only a small percentage preferred parcel lockers, in comparison to both neighbour delivery and SP. Three out of four segments preferred re-delivery at another moment over the parcel locker.

These results show some similarities with the results from this study, especially with regard to the small share of preference for the PL. As the consumer segments Rai et al. (2021) use are based on crowd logistic preferences, they, unfortunately, serve little value to this research. Otter et al. (2017) is another study that mentions similar results, stating that if someone is not present for an attended home delivery, people first prefer the parcel to be delivered to a reception box in the building within walking distance, next comes delivery to a SP one must travel to by car. From the results presented in the study by Otter et al. (2017) it is unclear whether consumers would still favour the reception box if an option for a SP very close to home was also included. The option of the reception box included by Otter et al. (2017) could be viewed as a Parcel Locker located very close to home. This allows for comparison between Otter et al. (2017) and this study. This study shows in the market share analysis that when a SP and a PL are located at the same distance from the consumer, demand for the SP as a delivery option is two times as high as that of the PL in case of a failed delivery. This study does find, in contrast to Otter et al. (2017), that consumers favour SPs above PLs if all is equal.

This study also investigated the social relationship with neighbours and the attitude of consumers towards parcel delivery to a neighbour. Most consumers have no extensive social bond with their immediate neighbours and indicate that contact is mostly limited to a greeting or short conversation in passing by. When it concerns neighbours who live a couple houses next to them, consumers mostly just greet them, without engaging in conversation. On average, consumers indicate to experience little restrictions when it comes to the delivery and collection of their parcels from their neighbours. However, there is also a group of consumers who perceive neighbour delivery as a burden and are concerned with the privacy of their online shopping. The degree to which consumers feel burdened to pick up their parcel from a neighbour positively impacts the choice for all other delivery options, and the self-collection alternatives SP and PL to the greatest extent. Whether neighbour delivery concerned delivery to an immediate neighbour or a distant neighbour led only to very small changes in consumers' attitudes towards it.

In the case of a failed delivery, the level of education of a consumer increases their utility for the PL as a delivery option. An increasing level of urbanity in their living environment, as well as an increasing level of income, decreases consumers' utility for the PL as a delivery option in case of delivery failure. As was expected, the value consumers see in the PL compared to Home Delivery, increases the probability that they are to prefer the PL delivery option to a great extent.

The results of the choice model for the first choice question 'at online checkout' showed us that Home Delivery has the largest share of choices, followed by the Service Point, and then the Parcel Locker. Home Delivery remains the preferred delivery method when ordering a product online. The market share analysis showed that in the current market situation, with PL being located at 2km and SPs at 1km, increasing the price of HD to 2 euros while delivery to an SP or PL remains free, would result in the HD and SP options both having a market share of 41%. So, even in the case of a price increase only for HD, it would still remain preferred among a large share of consumers. Consumers are influenced in their preference by the price of the delivery method, the distance to a Service Point or Parcel Locker, and the number of days a parcel is kept in a Parcel Locker. Consumers are less sensitive to price increases for SP and PL than they are for HD. The market share analysis indicated that when all aspects remain the same, except that all prices increase to 2 euros, the demand for HD would slightly decrease, while demand for both SP and PL would slightly increase.

Interestingly, and contradictory to results of other studies such as Iannaccone et al. (2021); Molin et al. (2022), this study finds no significant contribution, both 'at online checkout' and 'in case of delivery failure', to consumers' choice by an expansion of the opening hours of the Parcel Locker to being open all day all week (24/7). Unexpectedly, for the opening hours of the SP, every expansion on the narrowest opening hours 'Weekdays: during the day' proved to contribute negatively to the utility of the alternative. Every expansion was expected to contribute to utility since it provided them with more flexibility in picking up their parcel. So, the fact that every expansion actually decreases utility was highly unexpected and contradicts earlier findings from similar research byNguyen et al. (2019). The insignificance of delivery moment and opening hours contradicts the findings of other DCE studies on parcel delivery preference. This study uses almost identical attributes and levels as Molin et al. (2022), while their study found that opening hours and delivery moment do have significant and positive effects on preference. However, Molin et al. (2022) do find no significant increase in utility for further expansion of delivery moment after adding evening delivery. The insignificance and small impact of opening hours also differs from the findings Iannaccone et al. (2021), who find that 'opening hours' is highly significant. It must however be noted that the two levels of opening hours used in the study from Iannaccone et al. (2021) are wider apart. Concerning the distance attributes of SP and PL, the magnitude of their impacts are quite

similar compared to Molin et al. (2022) and Iannaccone et al. (2021) for a kilometre increase in distance, and a bit larger than what Ma, Teo, & Wong (2022) find.

The number of days before returned to the sender (RTS), was found to be significant but had the smallest relative importance. This relatively small importance is also found by Collins (2015), the only other DCE study to include this attribute. However, the attribute is significant for the PL alternative, while the opening hours of the PL are not. When looking at the results of the market share analysis, the impact that the RTS period can have becomes more clear. When the RTS period is shortened to just 1 day, instead of 7 days, the PL loses a considerable amount of market share to the SP alternative. So, especially when competing with the SP, the RTS period of the PL can have a significant influence on its usage.

The relative importance of the attributes shows that the price of HD is the most important attribute, followed by distance to a SP or PL. The price of Home Delivery is very dominant in determining consumers choice of a delivery option. The importance and dominance of the price attribute are not unexpected. Nguyen et al. (2019) find similar results, where the importance of the delivery fee overshadows the importance of other attributes such as time slot, daytime/evening delivery and delivery date.

In this scenario context, consumers who work, either part-time or full-time, find the self-collection alternatives more attractive compared to home delivery than non-working consumers. This is probably due to them having a busier schedule and less time on their hands, which makes the flexibility and level of control of the self-collection alternatives more attractive to them. More frequent online shoppers perceive Home Delivery as more favourable than self-collection. This is not unexpected. When the consumer has to perform a pick-up from a SP or PL more frequently, this might start to feel more of a burden. This finding is also in line with Ma, Teo, & Wong (2022), who found that more frequent online shoppers see less value in self-collection alternatives. Lastly, the results show that consumers who have used SP more frequently in the past tend to find the SP alternative, and to a smaller extent the PL, more attractive compared to HD. This is an encouraging finding for parcel locker companies, as this effect could mean that people who more frequently use SPs for their delivery are also more interested in adopting PL.

Lastly, this section will shortly discuss the results of the study, the perception of sustainability of home delivery and parcel locker, and of value of the parcel locker over home delivery. The majority of respondents perceive the parcel locker as environmentally sustainable and as a delivery option that is future-proof in that sense. Regarding the same questions for home delivery, the majority of the respondents do not view home delivery as a delivery option that can contribute positively to the environment or generate less carbon emissions. Respondents who to a greater extent perceive PL to be environmentally sustainable are more attracted to the PL alternative, while respondents who to a greater extent perceive HD to be environmentally sustainable are less attracted to the self-collection alternatives. An important side note is that this is only how respondents perceive the alternatives. It is not possible to brand one alternative more sustainable than the other, as the 'true' environmental sustainability of the delivery options depends on several things such as drop density, fuel type of the delivery vehicle or pick-up vehicle, the pick-up mode of the customer for self-collection and much more. The aim was to see whether the perception of it influences consumers' preferences. The results indicate that consumers let their choice be influenced by the degree to which they perceive a delivery option to be sustainable. The degree to which respondents see parcel lockers as advantageous over home delivery contributes to a great extent to how likely respondents are to choose a self-collection alternative. Most respondents see the possibility of collecting parcels at their own convenience as an advantage. The majority also agrees that it provides them with more control over the delivery process. However, these advantages do not make respondents agree with the statement that the PL improves their overall reception experience or makes it easier to receive parcels. A possible explanation for this could be that although the parcel locker offers the convenience of more control and collecting your parcel at your own convenience, this still does not weigh up to the convenience of Home Delivery and the inconvenience of the trip to the parcel locker.

8.3 Policy Recommendations and implications

This study has investigated what the preferences of consumers are regarding two distinct parcel delivery choice scenarios 'at online checkout' and 'in case of delivery failure', and has investigated how numerous types of factors influence their preferences. In this section, the results of the study will be translated into policy implications for stakeholders in the last-mile delivery market. The aim of the choice question 'at online checkout' was to determine what factors influence the choice of a delivery option, in order to identify how parcel locker use can be

more widely adopted. The objective of the choice question 'in case of delivery failure' was foremost to explore what consumers' preferences are and to see whether delivery attributes of self-collection alternatives influenced their preferences.

To the goal of the choice question 'in case of delivery failure', the following policy implication follows. The research shows that most consumers prefer their failed home delivery to be delivered to their neighbours or to a safe place around their house. Only a very small share of consumers prefer their parcel to be delivered to a PL. The study shows that the only delivery attribute that policymakers can employ to increase the demand for the PL is the distance to the pick-up location. However, it is evident that by only being able to impact PL demand through distance, policymakers and parcel delivery companies are unable to reduce demand for the other delivery options. Demand for the PL can be increased to a maximum of 18%. This raises concerns about the usefulness of the PL in case of a failed delivery. The study shows that demand for the PL could be raised by increasing the distance from the consumer to the SP, as this would leave the SP alternative less attractive. As other alternatives seem to be more attractive despite shorter distances for the PL, parcel delivery companies could also adopt a policy where the only option they offer in case of a failed delivery is the PL. However, this is not deemed realistic in light of the introduction of the notification, which is aimed at the consumer deciding where they want their parcel to be delivered when the delivery fails. Parcel delivery companies offer early notification of the delivery window, and combine this with the opportunity to choose an alternative delivery method if the consumer cannot attend the home delivery. By offering this possibility, the parcel delivery company tries to decrease the number of failed deliveries. Additionally, when consumers indicate that a parcel can be delivered to a SP or a Parcel Locker, this allows the parcel delivery company to consolidate these parcels and reap the benefits of this. Contrary, if consumers want their parcels delivered near their home, i.e. to neighbours or around the house as this research shows, this implies that the parcel delivery company still has to make a dedicated trip. In the absence of a price incentive, there is little demand for the PL as an alternative when home delivery fails.

Offering early notification and offering the possibility to choose an alternative seems to have potential, as several respondents indicated that they perceived this as very beneficial. This could be due to several reasons. Sometimes Home Delivery is the only option that is available, even though it might not suit you due to low availability at home and results in being forced to stay at home. On the other hand, initial delivery information is not always accurate, as between 13-22% of the parcels are delivered on the wrong day (Multiscope, 2023).

To the end of the choice question 'at online checkout', price and distance have the greatest impact on the choice of parcel lockers or service points. The further away a parcel locker is, the less likely a consumer is to use the parcel locker the next time they order a parcel. Closer distances to a parcel locker can attract more users to the alternative. Research by the Autoriteit Consument & Markt (2020) shows the parcel locker network in the Netherlands in 2020 only had a coverage of 5%, meaning that 5% of the households have a parcel locker with walking distance. This study has shown that more frequent users of PLs are less sensitive to this distance to a PL. So, once they are familiar with the benefits of the PL, distance matters less. The most forward policy recommendation therefore is to broaden this network of parcel lockers and increase its coverage. Placing more parcel lockers, these are then also closer to people their homes and increasing the PLs coverage, and they also become more visible as a delivery option. Consumers are also influenced by the price of a delivery method. When policymakers or parcel delivery companies introduce a price incentive in order to stimulate self-collection, similar to a price increase of just HD, the demand for self-collection alternatives would significantly increase and overtake HD as the dominant delivery alternative when ordering a product online. One recommendation is thus for parcel delivery companies and e-retailers to start offering differentiating prices for HD, SP and PL. E-retailers might be hesitant to introduce this and to ask for an extra delivery fee for home delivery in fear of dissatisfaction from their customers. So, future research could look into the acceptance of increased prices for home delivery.

Placing a Parcel Locker is accompanied by significant costs and these costs should be taken into consideration. For example, the province of South-Holland estimated the cost of a single parcel locker at 20.000 euros (M. van der Steeg, 2022). This is part of the pilot project by EVAnet and the province of South-Holland to place parcel lockers at bus stops to shorten the distance from consumer to locker and to also locate the locker at a convenient place. If at all 375 bus stops which are operated by the province of South-Holland a PL were to be placed, the costs of this would be substantial. This would have to be earned back through parcels that are being delivered and returned through the PL. The results of this study raise serious concerns regarding the profitability of the PL. In the current situation depicted in the market share analysis, for both 'at online

checkout' and 'in case of delivery failure' the demand for the PL is low. This indicates that first, the option has to be made more attractive before consumers start to use it. But to compete with HD 'at online checkout' shortening the distance is not enough, and a price incentive for the PL has to be agreed on to. Substantial costs have to be made before consumers will opt for the PL 'at online checkout'. The demand for the PL 'in case of delivery' shows that even when distances are shortened, the PL is unable to compete with delivery to a neighbour or to have the parcel be left at an agreed place around the house. The limited impact of RTS on choice for the PL leaves the opportunity for companies that own PL lockers to limit this period and by such increase the (economic) efficiency of the locker. However, these companies should be aware that shortening this period too much could push more consumers towards using the SP instead. One important note on the topic of locating parcel lockers more closely to the consumer is that a parcel locker is not always accessible for all delivery companies to deliver to. Lockers from PostNL and DHL are only available for parcels delivered by their own company. Having one type of locker closely located does not always mean that the consumers' parcels can be delivered to that parcel locker. This negatively impacts the coverage of the PL network. White-label parcel locker companies, such as DeBuren and Budbee, offer parcel lockers available to all parcel couriers. This expands the coverage of the PL network and would prevent the proliferation of parcel lockers only accessible for one parcel courier. It is recommended that parcel delivery companies open their lockers in order to open up the PL network. However, this would require the big parcel delivery companies to collaborate and deliver their own parcels into branded lockers of the competitor, which they are currently reluctant to do due to competition considerations.

The responsibility of placing additional parcel lockers primarily falls on the parcel delivery companies. Public stakeholders are mainly responsible for regulating this process, but as the collaboration between the province of South-Holland and EVAnet shows, public stakeholders can also take a more active role. However, installing parcel lockers in public spaces can be a challenging task due to regulations. Not everyone in the area might want a parcel locker placed in their street, due to a variety of reasons such as increased levels of traffic and noise, but also aesthetic reasons. Parcel lockers that are located in public spaces are usually open 24/7, compared to parcel lockers that reside in publicly available commercial buildings, which are limited to commercial opening hours. As this research shows, consumers are indifferent to the 24/7 opening hours compared to the opening hours of the PL in commercial buildings, as the latter seems to offer enough flexibility already. As the location of PLs in public spaces is more of a hassle, the second policy recommendation is to focus more on PL placement in commercial buildings. Cooperating with other commercial stakeholders to accomplish this also means that the costs of placing the PLs are shared.

As was earlier discussed, when consumers are more aware of PL and perceive the that use of PLs is beneficial over home delivery, they are more likely to choose the PL as their preferred delivery option. Consumers who work either part-time or full-time are more attracted to self-collection delivery options. Therefore, policymakers within the last-mile delivery sector can also focus on specifically targeting this group of consumers to increase their knowledge about the benefits that parcel lockers have to offer. Besides that, if parcel delivery companies can state with certainty that delivery to a parcel locker causes fewer emissions than the home delivery options, indicating this to the consumer will impact the likelihood of choosing the PL positively. However, this effect also works the other way around. When Home Delivery is perceived as more sustainable, this will make consumers more likely to opt for Home Delivery. The use of electric (smaller) vehicles in last-mile delivery impacts the sustainability of Home Delivery, among others, positively. So, in a future scenario where both Home Delivery and delivery to a SP or PL are performed by an electric vehicle, the advantage that self-collection has now with regard to sustainability compared to HD could be mitigated. As the sustainability of the delivery option contributed significantly to delivery choice in this study, further expansion of electric delivery vehicles could negatively impact the edge that PL currently has over HD.

Lastly, this research points out that currently, Dutch consumers favour the Service Point above the Parcel Locker as a delivery option, both 'at online checkout' and 'in case of delivery failure', when the distance to both pick-up locations is equal. While the number of parcel lockers is rising in the Netherlands, there are still more service points. It is difficult to predict how consumers feel about the parcel locker in a few years when the delivery option should become more common. Parcel delivery companies do however need to think about whether they want to promote self-collection in general, so both SP and PL, or whether they specifically want PLs to grow and take over a large share of parcels from the SPs. The large investment cost of parcel lockers would pose a problem when expanding the network, as PLs need to move closer to the consumer in order to be an attractive option, and as it stands now they would also need to be closer to the consumer than the SP. Otherwise, a large share of consumers would opt for the SP instead. Based on the results of this study, it is

unclear whether it would be worth it to expand the PL network to such a size.

8.4 Limitations of this study

The first limitation that impacts the results and limits generalizing the results to the population is the sample size and distribution. While the sample size of 208 respondents is considered sufficient for this research, it is not representative of the research population. There is an over-representation of people aged 21-30 and 51-60 and of academically schooled people. This is due to the fact that the survey of this research was distributed mainly in the close network of the researcher, and therefore represents a convenience sample. While it offered practicality and simplicity in finding a sufficient amount of respondents, convenience sampling can introduce bias, as it may not accurately represent the broader population. The design of the survey and the different choice scenarios in particular might have an impact on the validity of the results of the second choice question. First, for the second choice question, the distribution of the choice tasks that are shown is skewed, as this relied on respondents choosing home delivery in the previous question. Some choice tasks are reviewed more than others. Because one had to first choose Home Delivery over the SP and PL options, it is very likely that the choice tasks that were reviewed more in the second question were the choice tasks in which the PL and SP alternatives were less attractive. This then impacts what information is gathered in the second choice question and could be the possible reason why the shares for SP and PL are low. This could potentially influence the validity of the estimated model and could explain why some of the estimated parameters were insignificant. Also, the reasoning behind the specific wording in the second choice question might not have been clear. The researcher might have also misjudged the familiarity of the respondents with such a notification. When being presented with the opportunity of choosing an alternative delivery option, this means that the parcel courier is not yet on the road, implying that choosing SP or PL would mean that a trip is saved, and the parcel can be consolidated. From the researcher's point of view, this would have led to more people choosing the SP or PL.

Additionally, the shorter range that was chosen for the price of the SP and PL alternatives compared to HD, to mimic a price incentive to nudge respondents towards home delivery. This choice experiment thus relies for a large part on the assumption that in the future e-retailers and parcel delivery companies in the Netherlands offer differentiating prices for delivery options. However, not keeping the price range identical makes it harder to compare price sensitivity among the delivery alternatives and influences the relative importance of the attributes. As of now, parcel delivery companies do not offer different prices for HD, SP and PL, and therefore also does not represent the current market very well.

8.5 Future research

For further research, it is recommended to gather a larger sample of respondents. A larger sample is needed to validate the results of this sample. Additionally, this sample should be more representative of the population and not based on a convenience sample in order to get results that can be generalized over the population and contain less possible bias. Also, the description of delivery attributes should be re-evaluated, as this might have been a reason for the insignificance of this category of attributes. Future research should also utilize more advanced choice modelling techniques to estimate the data, such as Hybrid Choice Modelling or a Latent Class choice model. Hybrid Choice Modelling is a more advanced modelling technique that allows for more advanced modelling of latent psychological explanatory variables and segmentation based on these variables. Latent Class modelling can be used to more accurately find distinct groups in the population based on socio-demographic or background characteristics, and can therefore be used to more clearly research heterogeneity in the sample.

As several respondents indicated that it was a favourable option they would like to see in real life, research should be done into the effectiveness of sending messages that notify consumers on when the delivery is scheduled and allow them to choose an alternative location. Are consumers interested in such a system, and will they actually use it? This would also imply that parcel delivery companies will have to research how such a notification system could be designed best to reach the consumer and on what platform consumers can be reached.

This study found some surprising results concerning the delivery moment for HD. An earlier study by Molin et al. (2022) already found that after introducing evening delivery on weekdays, further expansions of the delivery moment did not lead to the expected increases in utility. In this research, not only an expansion of the delivery moment to include both weekend and night led to an increase in utility. This implies that what was thought to be straightforward, i.e. more options to choose the delivery moment from would always lead to extra utility for that option, is not so straightforward. The same holds true for the opening hours of the SP, which this

study found that further expansion from opening hours during the day on weekdays actually decreased utility. Future research is therefore required to determine whether consumers are still interested in such expansions on the delivery moment of HD and the opening hours of SP. It might be that, as a result of COVID-19, consumers work more from home and might fit delivery and pick-up better in this new schedule.

With respect to research on parcel lockers, it is advised to perform research that focuses not on consumers but on businesses in the Dutch e-commerce market. One aspect that is mentioned in this paper as well as many times in other scientific papers is the need, at this moment, for a price incentive to steer consumers towards parcel lockers or service points. These price incentives, or any difference in price that is related to the delivery method and not delivery speed, are not occurring in the Dutch delivery market. Research should therefore focus on whether parcel delivery companies and e-commerce companies are willing to adopt such an incentive that would steer away from home delivery, and what drives them in this belief. It should also cover how consumers would feel about such an increase in price for home delivery. This would provide a meaningful bridge between what scientific literature proposes and what the market is willing to do. Lastly, the current demand for PL in the Netherlands seems low and raising this demand would require a price incentive and the placing of more parcel lockers. Consumers sometimes are reluctant to the placement of a parcel locker and have concerns about how the locker would look in the street as well as concerns about an increase in traffic volume in their neighbourhood. Future research should investigate whether people would be open to parcel lockers in their neighbourhood or that they would prefer them to be located somewhere else.

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Appendix

Measuring socio-demographic variables

The table below shows how the different socio-demographic variables that are included in this survey are measured.

Table 20: Measurement scales of socio-demographic variables

Gender	Male
	Female
	Non binary / third gender
Age	Year of birth is requested
Education	Elementary school
	High school diploma or middle vocational (MBO)
	Higher professional education (HBO) or university without a degree
	Bachelor's degree (HBO or university)
	Master's degree
	Doctorate/PhD
Work status	Unable to work
	Student
	Unemployed / Retired
	Part-time working
	Full-time working
Income	10.000
	10.000 - 19.999
	20.000 - 29.999
	30.000 - 39.999
	40.000 - 49.999
	50.000 - 59.999
	60.000 - 69.999
	70.000 - 79.999
	80.000 - 89.999
	90.000 - 99.999
	100.000
Urbanity level	Rural
	Outside of centre of village
	Centre of village
	Outside centre of small city / town
	Centre of small city / town
	Suburb of big city
	Outside centre of big city
	Centre of big city
Availability at home	Rarely: I am rarely at home during the day.

Continued on next page

Table 20: Measurement scales of socio-demographic variables (Continued)

	Occasionally: I am at home during the day some days of the week.
	Sometimes: I am is at home during the day most days of the week.
	Often: I am at home during the day almost every day of the week.
	Always: I am always at home throughout the day.

Model estimation procedure

In this section, the model estimation procedure is presented in a more extensive manner. First, the model estimation procedure on the data of the choice question 'at online checkout' is described. After that, the model estimation procedure on the data of the second choice question 'in case of delivery failure' is described.

Estimating MNL model on data first choice question

First, a standard MNL model was estimated on the data of the first choice question (with alternatives HD, SP and PL), using only the associated attributes. This model includes 15 parameters. The final LL is -1816, with a Rho-square of around 0.20.

Next, all socio-demographic variables were added, as well as some interactions between socio-demographic variables and delivery attributes. For all three alternatives, an interaction between age and price was added. For the self-collection alternatives, an interaction between age and the distance to the pick-up point and an interaction between the level of urbanity and the distance to the pick-up point is included. Any variables from this step that are not significant are left out for the next step in the model development.

The socio-demographic variables are added to the utility functions of SP and PL. These are added with each variable with a different coefficient per alternative. By including the socio-demographic variables in this way, the coefficient (called BETA's) measure the impact of the socio-demographic variable on the utility of the alternative SP or PL with respect to the utility of the alternative of HD, where soc. dem. var. are not included in the utility function.

The model with socio-demographics included consists of 40 parameters and reports a final LL of -1704 and a Rho-square of 0.25. After excluding the insignificant parameters from the model, a new model with 29 parameters is estimated, reporting a final LL of -1717. Because the first basic model is nested within the more complex model with soc. dem. variables and interaction, a Likelihood Ratio Test can be performed to compare both models and determine the probability that the more complex model is a better fit due to coincidence.

The Likelihood Ratio Statistic (LRS) equals 2 times the difference in final LL. In this case LRS = 2 *99 = 198. The difference in model parameters equals the degrees of freedom (df), so df = 14. From the Chi-square table it can be concluded that the complex model outperforms the basic model at the conventional 95% significance level.

Age, gender, and level of urbanity were all found to be insignificant for the SP alternative (p-values > 0.05 and even 0.10). The level of education has a p-value of 0.06, slightly above the conventional threshold of 0.05, but is included in the next step of the model. With such a slight deviation, education may prove to be significant in the next iteration. For the PL alternative, age does prove to be significant (p-value = 0.02). Again, gender and level of urbanity are insignificant, with p-values well above 0.05. For the estimated interactions, the interaction between income and price of the HD alternative and the interaction between age and the distance to a parcel locker is significant, while the same interaction for the SP alternative is just above the 0.05 threshold (0.07). Therefore, this last interaction is also included in the next step. The interactions of the level of urbanity with distance are insignificant. The insignificant parameters are excluded from the MNL model for the next iteration. Parameters that were tested:

- Age
- Gender
- Income
- Education
- Working status
- Availability at home
- Urbanity of residence

Interactions that were tested:

- Age + price

Table 21: Coding of socio-demographic variables

Socio-demographic variable		**Coding**	
Gender	Male	0	0
	Female	1	0
	Non binary / third gender	0	1
Age	Real values used		
Education	Elementary school	1	
	High school diploma or middle vocational (MBO)	2	
	Higher professional education (HBO) or university without a degree	3	
	Bachelor's degree (HBO or university)	4	
	Master's degree	5	
	Doctorate/PhD	6	
Work status	Unable to work		
	Student	0	0
	Unemployed / Retired		
	Part-time working	1	0
	Full-time working	0	1
Income	10.000	1	
	10.000 - 19.999	2	
	20.000 - 29.999	3	
	30.000 - 39.999	4	
	40.000 - 49.999	5	
	50.000 - 59.999	6	
	60.000 - 69.999	7	
	70.000 - 79.999	8	
	80.000 - 89.999	9	
	90.000 - 99.999	10	
	100.000	11	
Urbanity level	Rural	1	
	Outside of centre of village	2	
	Centre of village	3	
	Outside centre of small city / town	4	
	Centre of small city / town	5	
	Suburb of big city	6	
	Outside centre of big city	7	
	Centre of big city	8	
Availability at home	Rarely	1	
	Occasionally	2	
	Sometimes	3	
	Often	4	
	Always	5	

Table 22: Coding of social relation with neighbours

(1)Take the immediate neighbour or neighbours (i.e., those who live right next to you)into consideration, whom you know the best. How well do you know these neighbours? **(2) When you think about the four houses on either side of your home, how well do you know most of these neighbours?**	**Coding**
Not applicable: I have no neighbours	0
I wouldn't recognize these neighbours on the street	1
I recognize these neighbours on the street, but I don't greet them or speak to them	2
I only greet my neighbours	3
I regularly have a chat with my neighbours	4
My neighbours and I sometimes visit each other	5
My neighbours and I engage in many activities together, such as drinking coffee, eating dinner or playing sports	6

- Income + price
- Age + distance
- Level of urbanity + distance

Third, shopping characteristics are added: frequency of online shopping, frequency of use of SP, frequency of use of PL, familiarity of PL, and familiarity of SP. Some interactions are also added. Interactions between frequency of SP use and both distance and price. For the PL alternative, similar interactions are added. This leads to the third iteration of the MNL model with 43 parameters. Of the new interactions, the interaction between the frequency of PL use and the distance to a PL and the interaction between the frequency of SP use and the price for the SP alternative are significant. Furthermore, soc. dem. variable 'Age' is no longer significant for the PL alternative. All the newly added background characteristics on shopping behaviour are significant at the conventional level of 0.05, except for Familiarity with SP in the SP alternative.

Because the second model is nested within the third MNL model with shopping characteristics, a Likelihood Ratio Test can be performed to compare both models and determine the probability that the more complex model is a better fit due to coincidence. In total 14 parameters were added to the third model, of which 3 were excluded because they were insignificant. The third model now reports a final LL of -1600. The Likelihood Ratio Statistic (LRS) equals 2 times the difference in final LL. In this case LRS = 2 *117 = 234. The difference in model parameters equals the degrees of freedom (df), so df = 11. From the Chi-square table it can be concluded that the complex model outperforms the basic model at the conventional 95% significance level.

Lastly, latent variables are added. It is decided to include the latent variables (LV) 'relative advantage' and 'perceived environmental sustainability'. This is the fourth and last iteration of the MNL choice model. The latter LV is measured for both PL and HD. Two interactions are also included: interaction between factor score on RA and distance to either the SP or the PL. A total of 8 new parameters are added in the fourth iteration of the MNL model. This includes adding the three LVs to both the utility functions of SP and PL and the interactions. Both interactions are insignificant (p-values of 0.35 and 0.17). The impact of PES PL on the utility of the SP alternative was also insignificant (p-value 0.07). The other LVs and their impact on the utility functions of SP and PL are significant at the conventional 0.05 threshold. Again, a Likelihood Ratio Test is performed to test the probability that this fourth iteration of the MNL model performs better than the previous MNL model. The fourth model reports a final LL of -1484 and a Rho-square of 0.35. The number of parameters included in the model is 41. Considering that for the third iteration model, the final LL was -1600 and the number of parameters was 40, this means that the LRS = 232 and df = 1. From the Chi-square table it can be concluded that the complex model outperforms the basic model at the conventional 95% significance level.

Estimating ML model on data of first choice question

Now a ML model is estimated on the data set of the first choice question. As was discussed earlier in section Methodology, the ML model has some advantages compared to a standard MNL model. The choice data con-

Table 23: Coding of shopping characteristics

Shopping characteristic	Coding
Frequency of online shopping	
Less than 1 time	1
1 time	2
2 times	3
3-4 times	4
5-8 times	5
More than 8 times	6
Use of Service Point	
Never	0
1-2 times	1
3-5 times	2
6-8 times	3
More than 8 times	4
Use of Parcel Locker	
Never	0
1-2 times	1
3-5 times	2
6-8 times	3
More than 8 times	4

sists of 10 choices per respondent, making it panel data. The ML model automatically accounts for this panel structure. In the same manner, as with the process of developing the MNL model, new variables will be added and parameters will be estimated iteratively.

In the first step, nesting effects are tested. Both the SP and the PL are self-collection alternatives. It is assumed that these two alternatives have more in common with each other than with the HD alternative. Some people may have a preference for a self-collection alternative over home delivery. If this preference is not measured through the attributes of the alternative, it ends up as unobserved utility in the error term of the utility function of these alternatives. It is then likely that the error terms of these alternatives are correlated. To account for this, a shared error component is added to the utility functions of the SP and PL alternatives. The shared error component is found to be significant (p-value = 0.0000). This implies there is shared variation in the error terms of SP and PL. The final LL reported is -1496, a large increase from the LL(0) of -2123. The parameter estimates for the delivery attributes and the shared error component that is added are shown in Table 24. With the added shared error component, the model includes 16 parameters. The parameters estimated for the delivery attributes of the choice experiment constitute the core part of the model, because these attributes define the different delivery options and represent policy levers that stakeholders can pull to influence consumers. Therefore both significant and insignificant parameters of the delivery attributes attributes are of interest, and all these parameters are included in the model at all times.

In the second iteration, all parameters for the delivery attributes were allowed to vary randomly. The results of the first step of the ML model estimation showed that the delivery attributes: *Delivery moment*, *Opening hours SP*, *Opening hours PL*, are not significant. By estimating a sigma, the possibility that the delivery attributes are insignificant is due to the large heterogeneity in the sample for these attributes and their levels that cancel each other out. For the other delivery attributes *price*, *distance*, *RTS*, sigma's are also estimated. While esti-

Table 24: First step ML model estimation: parameter estimates

	Estimate	s.e.	t.rat.(0)	p(1-sided)
Alternative Specific Constants (ASC)				
ASC_HD	0			
ASC_SP	-1.236	0.30317	-4.07694	2.28E-05
ASC_PL	-2.40426	0.53901	-4.46049	4.09E-06
Home Delivery				
Price	-1.01381	0.05418	-18.71253	0
Delivery moment (DM)				
DM0 - Weekdays: only day	0			
DM1 - Weekdays: day + evening	-0.14571	0.64907	-0.22449	0.4112
DM2 - Weekdays: day + evening, Weekends: day	-0.22028	0.40528	-0.54351	0.2934
DM3 - Whole week: day + evening	0.22829	0.23886	0.95574	0.1696
Service Point				
Price	-0.70357	0.07113	-9.89177	0
Distance	-0.77743	0.10103	-7.69487	7.11E-15
Opening hours (OH)				
OH0 - Weekdays: daytime	0			
OH1 - Weekdays: daytime, Saturday: daytime	-0.30942	0.30658	-1.00929	0.1564
OH2 - Weekdays: day + evening, Weekends: daytime	-0.18855	0.31257	-0.60324	0.2732
OH3 - Weekdays and Saturday: day + evening, Sunday: daytime	-0.10785	0.39657	-0.27197	0.3928
Parcel Locker				
Price	-0.67458	0.0669	-10.08316	0
Distance	-0.82487	0.13478	-6.1202	4.67E-10
Opening hours	0.01634	0.20795	0.07858	0.4687
Days before returned to sender (RTS)	0.21955	0.03305	6.64322	1.54E-11
Shared error component SP+PL				
SIGMA_SELFCOLL	2.84778	0.21885	13.01225	0

Table 25: Second step ML model estimation: parameter estimates

	Estimate	s.e.	t.rat.(0)	p(1-sided)
Alternative Specific Constants				
ASC_HD	0			
ASC_SP	-0.87954	0.24026	-3.6608	1.26E-04
ASC_PL	-2.04502	0.27355	-7.4759	3.83E-14
Home Delivery				
Price	-1.04691	0.06315	-16.5786	0
Delivery Moment (DM)				
DM0 - Weekdays: only day	0			
DM1 - Weekdays: day + evening	-0.29682	0.26834	-1.1061	0.134334
DM2 - Weekdays: day + evening, Weekends: day	-0.12899	0.24937	-0.5173	0.302487
DM3 - Whole week: day + evening	0.37675	0.19607	1.9215	0.027334
Service Point				
Price	-0.70389	0.06909	-10.1882	0
Distance	-0.77125	0.11984	-6.4358	6.14E-11
Opening hours (OH)				
OH0 - Weekdays: daytime	0			
OH1 - Weekdays: daytime, Saturday: daytime	-0.21924	0.14941	-1.4674	0.071129
OH2 - Weekdays: day + evening, Weekends: daytime	-0.06729	0.20361	-0.3305	0.370519
OH3 - Weekdays and Saturday: day + evening, Sunday: daytime	-0.11675	0.09986	-1.1691	0.121174
Parcel Locker				
Price	-0.72378	0.09151	-7.9091	1.33E-15
Distance	-0.98896	0.14719	-6.7189	9.16E-12
Opening hours	0.07844	NaN	NaN	NaN
Days before returned to sender (RTS)	0.19797	0.03486	5.6788	6.78E-09
Shared error component				
SIGMA_SELFCOLL	1.52129	0.25738	5.9107	1.70E-09
Sigma's				
HD Price	-0.31868	0.07978	-3.9945	3.24E-05
HD DM1	-0.24332	0.20976	-1.16	0.123028
HD DM2	-0.16971	0.38304	-0.4431	0.32886
HD DM3	0.09024	NaN	NaN	NaN
SP Price	-0.13031	0.08574	-1.5197	0.064293
SP Distance	-0.07323	0.15864	-0.4616	0.322193
SP OH1	0.18816	0.28624	0.6573	0.255482
SP OH2	0.24582	0.2741	0.8968	0.184911
SP OH3	0.23958	0.22535	1.0631	0.143857
PL Price	-0.13542	0.11732	-1.1543	0.124192
PL Distance	0.37465	0.17181	2.1806	0.014605
PL Opening hours	-0.1179	0.15637	-0.754	0.225425
RTS	0.14916	0.04967	3.0034	0.001335

mating a sigma only provides information on whether there is heterogeneity and no why this is so, the sigma's are still estimated because this does provide valuable knowledge for future research. If there is heterogeneity in the sample for one or more of the attributes, future research could focus on determining where this heterogeneity comes from in order to better grasp what consumer groups are for example (already) willing to travel longer distances to a PL or to pay more for using a PL. If there is no heterogeneity in the sample for a certain attribute, it could indicate that such research is not necessary and effort can be shifted towards other areas.

The estimated parameters are shown in Table 25. The results show that the sigma's for RTS, HD Price, and PL distance are all significant. The shared error component is also still significant. The insignificant estimated sigmas are excluded from the model, and the model is estimated again. This iteration results in a model that includes 19 parameters and reports a final LL of -1468 and Rhos-squared of 0.35. The first iteration of the ML model consisted of 16 parameters. A Likelihood Ratio Test is performed to determine the probability that the second iteration model performs better due to coincidence. The LRS equals 56 and df = 3. Based on this and the Chi-square table, it can be concluded that the probability that the second iteration model performs better than the first iteration model due to coincidence is smaller than 5%.

In the third and last iteration of the ML model, all parameters that were included in the fourth iteration of the MNL model are added. The parameter estimates are shown in Table 26. The parameters for education, availability at home, frequency of use of PL and the interaction between online shopping frequency and price were no longer significant for the SP alternative. For the PL alternative, availability at home, frequency of use of PL, and the sigma for the RTS parameter are no longer significant. These parameters are excluded from the model, and the model is estimated again. After this iteration, the frequency of use of PL is insignificant for the PL alternative and is excluded from the model. The model is estimated again, and this results in the final model. This model consists of 40 parameters and reports a final LL of -1333 and a Rho-squared of 0.41. A Likelihood Ratio Test is performed to determine the probability that the second iteration model performs better is due to coincidence. The LRS equals 270 and df = 21. Based on this and the Chi-square table, it can be concluded that the probability that the second iteration model performs better than the first iteration model due to coincidence is smaller than 5%.

Table 26: Third step in ML model estimation: parameter estimates

	Estimate	s.e.	t.rat.(0)	p(1-sided)
Alternative Specific Constants				
ASC_HD	0			
ASC_SP	-2.9066	1.020905	-2.8471	0.002206
ASC_PL	-9.7798	1.315485	-7.4344	5.25E-14
Home Delivery				
Price	-1.24968	0.097038	-12.8782	0
Delivery Moment (DM)				
DM0 - Weekdays: only day	0			
DM1 - Weekdays: day + evening	-0.27303	0.223582	-1.2212	0.111009
DM2 - Weekdays: day + evening, Weekends: day	-0.18732	0.205946	-0.9096	0.181526
DM3 - Whole week: day + evening	0.32398	0.185506	1.7465	0.040363
Service Point				
Price	-0.89009	0.152489	-5.8371	2.66E-09
Distance	-1.24598	0.194427	-6.4084	7.35E-11
Opening hours (OH)				
OH0 - Weekdays: daytime	0			

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Table 26: Third step in ML model estimation: parameter estimates (Continued)

OH1 - Weekdays: daytime, Saturday: daytime	-0.19343	0.151368	-1.2779	0.10065
OH2 - Weekdays: day + evening, Weekends: daytime	-0.06268	NaN	NaN	NaN
OH3 - Weekdays and Saturday: day + evening, Sunday: daytime	-0.05359	0.169758	-0.3157	0.376114
Parcel Locker				
Price	-1.16057	0.129067	-8.992	0
Distance	-1.81842	0.263119	-6.911	2.41E-12
Opening hours	0.02196	NaN	NaN	NaN
Days before returned to sender (RTS)	0.23407	0.030249	7.7382	5.00E-15
Socio-demographic variables				
Education - SP	0.16569	0.132332	1.2521	0.105274
Availability at home - SP	-0.10448	0.06623	-1.5776	0.057334
Part-time employed - SP	0.97341	0.362815	2.6829	0.003649
Full-time employed SP	1.02623	0.357483	2.8707	0.002048
Education - PL	0.31534	0.159437	1.9778	0.023973
Availability at home - PL	-0.04417	0.092249	-0.4789	0.316019
Part-time employed - PL	0.97578	0.44927	2.1719	0.014931
Full-time employed PL	1.13812	0.441266	2.5792	0.004951
Income SP	-0.14621	0.053245	-2.746	0.003016
Income PL	-0.1699	0.065822	-2.5813	0.004922
Interactions				
Age + distance - SP	0.01119	0.004566	2.4502	0.007139
Age + distance - PL	0.01739	0.005855	2.9697	0.00149
Income + price - HD	0.04126	0.014273	2.8907	0.001922
Income + price - SP	0.04895	0.021016	2.3292	0.009924
Income + price - PL	0.0753	0.022473	3.3508	4.03E-04
Shopping frequency + distance - PL	0.39229	0.154251	2.5432	0.005493
Shopping frequency + price - SP	-0.06584	0.051662	/1.2745	0.101236
Shopping characteristics				
Shopping frequency - SP	-0.50446	0.111012	-4.5442	2.76E-06
frequency use of SP - SP	0.61343	0.118212	5.1893	1.06E-07
frequency use of PL - SP	0.33977	0.243868	1.3932	0.081772
Shopping frequency - PL	-0.51176	0.137401	-3.7245	9.78E-05
frequency use of SP - PL	0.2855	0.138154	2.0666	0.019388
frequency use of PL - PL	0.52824	0.320914	1.6461	0.049876
Attitudes				

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Table 26: Third step in ML model estimation: parameter estimates (Continued)

RA - SP	1.05464	0.208443	5.0596	2.10E-07
RA - PL	1.73875	0.256688	6.7738	6.27E-12
PES PL - PL	0.73919	0.143088	5.166	1.20E-07
PES HD - SP	-0.61395	0.172193	-3.5655	1.82E-04
PES HD - PL	-0.44378	0.21398	-2.0739	0.019044
Shared error component				
self-collection	1.02832	0.234759	4.3803	5.93E-06
Sigma´s				
Price HD	-0.24171	0.071269	-3.3914	3.48E-04
PL Distance	0.35417	0.141124	2.5096	0.006043
RTS	0.05315	0.038412	1.3837	0.083228

In the estimation process of the ML model, the Apollo software raises a warning that states that some eigenvalues of the Hessian are positive, indicating convergence to a saddle point. This could mean that the optimization is stuck at a local maximum of the LL function. To try and steer away from this saddle point, three things can be done. The first thing that is tried is setting other starting values for the parameters. At the start, these are all set at 0. The estimates from the final iteration of the MNL model are used as the new starting values. Unfortunately, this still results in the same warning and the model still converges to a saddle point. Second, another optimizer can be set, to try and see whether another optimizer avoids the issue. Besides the standard option 'bfgs' Apollo also offers BHHH and NR as optimizers. Both were tried but encountered the same issues. The final option is to simplify the model that is to be estimated. The variance in the data could be too low to support the estimation of all model parameters. This is undesirable, as even insignificant parameters of delivery attributes are an important part of the model. In addition, the difference in the remaining estimated parameters before and after excluding insignificant parameters from the model has been investigated. This difference was small and the parameters remained in the same order of magnitude. Therefore, it is decided not to take any further steps to try and move towards a maximum.

Estimating MNL Model on second choice question data

First, the most basic MNL model was estimated on the data, only including parameters for the delivery attributes in the SP and PL alternative utility functions. As the other three alternatives in this second choice question were not depicted by any delivery attributes, only by a short description, the utility functions of these alternatives consist of just an alternative specific constant (ASC) to start with. An ASC was also added to the utility function of the SP and PL alternative.
In the estimation of the choice model on the data of the second choice question, it is decided to set the Neighbour Delivery as the reference alternative. It is done this way because Neighbour Delivery can be seen in the event of a failed delivery as the base alternative, the most common alternative delivery option in the Netherlands. If no one is home to receive your parcel, it is common practice to try and deliver the parcel to a neighbour instead. The ASC of Neighbour Delivery is fixed at zero, to clearly depict that it is the reference alternative. Since Neighbour Delivery serves as the reference alternative, this also means that to include socio-demographic variables or shopping characteristics, these variables will be added to all but the Neighbour Delivery utility function.

The first iteration, the base model, consists of 12 parameters and reports a final LL of -1203, a large increase from the starting LL(0) of -1304. In this first iteration, the parameters estimated for the distance to the PL, the distance to the SP, the first dummy category for opening hours of the SP (SP OH1), and the ASCs for PL, Another Moment (MOMENT), Around the House (AHOUSE) are significant at the conventional threshold of 0.05. As in the choice model estimation on the data of the first choice question, all delivery attributes are kept in the model at all times.

The next step, and the second iteration, is to include socio-demographic variables in the utility functions. As

was described earlier, the socio-demographic variables are added to all but one of the alternatives, leaving this alternative as a reference. All socio-demographic variables are added: age, gender, income, education, working status, availability at home, and urbanity level of residence. This means including 36 extra parameters in the model. The parameter estimates that resulted from this step are shown in Table 27 below. In the end, 19 parameters impact the utility functions significantly. These are included in the next step. This second iteration of the model includes 31 parameters and reports a final LL of -1052. To compare this second iteration to the first iteration, the Likelihood Ratio Test is used. The LRS equals 302 and the df equals 19. The probability that the second iteration model performs better than the first iteration model due to coincidence is smaller than 5%.

Table 27: MNL estimation second choice question: introducing soc-dem variables

	Estimate	s.e.	t.rat.(0)	p(1-sided)
ASC_NEIGH	0	NA	NA	NA
ASC_SP	-0.337053	0.778774	-0.4328	0.33258
ASC_PL	-2.164152	1.173659	-1.84394	0.032596
ASC_MOMENT	-5.5103	0.85637	-6.43448	6.20E-11
ASC_AHOUSE	-4.371335	0.785117	-5.56775	1.29E-08
BETA_SPDISTANCE	-0.881748	0.20722	-4.25513	1.04E-05
BETA_SP_OH1	0.852402	0.324585	2.62613	0.004318
BETA_SP_OH2	0.544192	0.3726	1.46053	0.072073
BETA_SP_OH3	0.301266	0.278308	1.08249	0.139517
BETA_PLDISTANCE	-0.870677	0.227051	-3.83472	6.28E-05
BETA_PL_OH	0.313099	0.28638	1.0933	0.137132
BETA_RTS	0.052657	0.060265	0.87376	0.191125
BETA_AGESP	0.014168	0.009807	1.44466	0.074276
BETA_GENDER1_SP	0.083885	0.231747	0.36197	0.358688
BETA_GENDER2SP	1.817648	1.228272	1.47984	0.069458
BETA_EDUSP	0.315111	0.114398	2.75451	0.002939
BETA_AVAILSP	-0.117276	0.10179	-1.15213	0.124633
BETA_URBANSP	-0.057369	0.054265	-1.05719	0.145213
BETA_EMP1SP	-0.254492	0.356989	-0.71289	0.237958
BETA_EMP2SP	0.221675	0.309772	0.71561	0.237117
BETA_INCSP	-0.204571	0.048937	-4.18031	1.46E-05
BETA_AGEPL	0.017271	0.013947	1.23827	0.107807
BETA_GENDER1_PL	-0.488071	0.337761	-1.44502	0.074226
BETA_GENDER2PL	-10.006654	481.343161	-0.02079	0.491707
BETA_EDUPL	0.7995	0.171106	4.67253	1.49E-06
BETA_AVAILPL	-0.218301	0.138858	-1.57212	0.057961
BETA_URBANPL	-0.220037	0.076701	-2.86876	0.00206
BETA_EMP1PL	0.55784	0.507185	1.09987	0.135693
BETA_EMP2PL	0.93372	0.450139	2.07429	0.019026
BETA_INCPL	-0.258272	0.063507	-4.06681	2.38E-05
BETA_AGEMOMENT	0.053644	0.009729	5.51364	1.76E-08

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Table 27: MNL estimation second choice question: introducing soc-dem variables (Continued)

BETA_GENDER1_MOMENT	1.350977	0.252903	5.34189	4.60E-08
BETA_GENDER2MOMENT	2.839736	1.473967	1.92659	0.027015
BETA_EDUMOMENT	0.522844	0.118257	4.42124	4.91E-06
BETA_AVAILMOMENT	0.285723	0.108476	2.63397	0.00422
BETA_URBANMOMENT	0.003997	0.054606	0.0732	0.470823
BETA_EMP1MOMENT	-0.704297	0.391055	-1.80102	0.03585
BETA_EMP2MOMENT	0.787698	0.323206	2.43714	0.007402
BETA_INCMOMENT	-0.210873	0.04833	-4.36321	6.41E-06
BETA_AGEAHOUSE	0.082234	0.009441	8.70987	0
BETA_GENDER1_AHOUSE	0.834073	0.235888	3.53589	2.03E-04
BETA_GENDER2AHOUSE	-8.567311	278.704845	-0.03074	0.487739
BETA_EDUAHOUSE	0.726428	0.116423	6.23955	2.19E-10
BETA_AVAILAHOUSE	-0.124728	0.09901	-1.25975	0.10388
BETA_URBANAHOUSE	-0.250123	0.050547	-4.94829	3.74E-07
BETA_EMP1AHOUSE	-1.088331	0.338634	-3.21388	6.55E-04
BETA_EMP2AHOUSE	-0.548309	0.316353	-1.73322	0.041528
BETA_INCAHOUSE	-0.130761	0.040946	-3.19346	7.03E-04

The third iteration includes shopping characteristics: shopping frequency, frequency of use of PL and SP. Again, these characteristics are included in all utility functions except the Neighbour delivery utility function. So, 12 new parameters are included in the model. The parameter estimates that result from this step are shown in Table 28. The impact of shopping frequency is significant for all alternatives except for PL. The frequency of use of a PL is insignificant for all alternatives. Lastly, the impact of the frequency of use of SP on the utility for PL is also insignificant. Insignificant parameters are excluded from the model. Thus, the model at the end of the third iteration includes 36 parameters and reports a final LL of -1027. To compare the performance of the third iteration model to the model of the second iteration, the Likelihood Ratio Test is used. The LRS equals 50 and the df equals 5. The probability that the third iteration model performs better than the second iteration model due to coincidence is smaller than 5%.

Table 28: MNL estimation second choice question: introducing shopping characteristics

	Estimate	s.e.	t.rat.(0)	p(1-sided)
ASC_NEIGH	0	NA	NA	NA
ASC_SP	-0.01294	0.485365	-0.02667	0.489363
ASC_PL	-1.85206	0.750725	-2.46703	0.006812
ASC_MOMENT	-4.939	0.740681	-6.66819	1.29E-11
ASC_AHOUSE	-5.49913	0.730802	-7.52478	2.64E-14
BETA_SPDISTANCE	-0.91555	0.213231	-4.2937	8.79E-06
BETA_SP_OH1	0.85366	0.33104	2.57871	0.004958
BETA_SP_OH2	0.49242	0.382384	1.28776	0.098914
BETA_SP_OH3	0.27341	0.284834	0.9599	0.168552
BETA_PLDISTANCE	-0.85026	0.22427	-3.79122	7.50E-05
BETA_PL_OH	0.30611	0.284529	1.07583	0.141001
BETA_RTS	0.04824	0.059488	0.811	0.208684

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Table 28: MNL estimation second choice question: introducing shopping characteristics (Continued)

BETA_EDUSP	0.16651	0.095902	1.73627	0.041258
BETA_INCSP	-0.09023	0.035894	-2.51391	0.00597
BETA_EDUPL	0.72497	0.157654	4.59847	2.13E-06
BETA_URBANPL	-0.20998	0.065846	-3.18893	7.14E-04
BETA_EMP2PL	0.67445	0.35822	1.88279	0.029865
BETA_INCPL	-0.16551	0.059245	-2.79366	0.002606
BETA_AGEMOMENT	0.04748	0.008749	5.42666	2.87E-08
BETA_GENDER1_MOMENT	1.32611	0.231118	5.73779	4.80E-09
BETA_EDUMOMENT	0.44431	0.110173	4.03288	2.75E-05
BETA_AVAILMOMENT	0.332	0.097083	3.41973	3.13E-04
BETA_EMP1MOMENT	-0.55665	0.364005	-1.52924	0.063103
BETA_EMP2MOMENT	0.68816	0.315583	2.18059	0.014607
BETA_INCMOMENT	-0.1567	0.048191	-3.25174	5.74E-04
BETA_AGEAHOUSE	0.07961	0.008689	9.16225	0
BETA_GENDER1_AHOUSE	0.73464	0.223305	3.28984	5.01E-04
BETA_EDUAHOUSE	0.70393	0.111283	6.32561	1.26E-10
BETA_URBANAHOUSE	-0.24468	0.045089	-5.42661	2.87E-08
BETA_EMP1AHOUSE	-1.32274	0.324968	-4.07037	2.35E-05
BETA_EMP2AHOUSE	-0.79138	0.29589	-2.67456	0.003741
BETA_INCAHOUSE	-0.08164	0.038963	-2.09523	0.018075
BETA_FREQ_SP	-0.26927	0.087885	-3.06394	0.001092
BETA_USESP_SP	0.42432	0.107604	3.9433	4.02E-05
BETA_USEPL_SP	0.32523	0.305995	1.06287	0.143921
BETA_FREQ_PL	-0.18865	0.115893	-1.62779	0.051785
BETA_USESP_PL	0.15428	0.145196	1.06257	0.143988
BETA_USEPL_PL	0.2123	0.413521	0.51341	0.303833
BETA_FREQ_AHOUSE	0.18344	0.081523	2.2502	0.012218
BETA_USESP_AHOUSE	0.25825	0.106833	2.41735	0.007817
BETA_USEPL_AHOUSE	0.17005	0.342443	0.49658	0.309744
BETA_FREQ_MOMENT	-0.25916	0.0926	-2.79876	0.002565
BETA_USESP_MOMENT	0.32529	0.112446	2.89286	0.001909
BETA_USEPL_MOMENT	0.30031	0.319053	0.94127	0.173284

Lastly, the latent variables are added to the model. The latent variables 'Relative Advantage' (RA), 'Perceived Environmental Sustainability PL' (PES PL), 'Perceived Environmental Sustainability HD' (PES HD), 'Privacy Parcel Delivery' (PRIVACY) are added to the model. In this step, the degree of burden that someone perceives from picking up a parcel at their neighbours is also added as 'BURDEN', which is the first question on attitudes towards neighbour delivery (see Table 8). The LV 'RA' was added to the SP and PL alternatives, as well as the LV 'PES PL' and LV 'PES HD'. The LV 'PRIVACY' and 'BURDEN' are added to the utility functions for all four alternatives. The parameter estimates that result from this step are shown in Table 29. The parameters for 'RA' on SP and PL are significant. 'BURDEN' also has a significant impact on the utility of all 4 alternatives. There was no significant impact measured of PRIVACY, PES PL or PES HD on the utility functions. In the end, 6 new parameters are added to the model. This fourth, and final, iteration of the MNL model consists of 41 parameters and reports a final LL of -974. The Rho-squared is 0.2525. To compare the performance of the fourth iteration model to the model of the third iteration, the Likelihood Ratio Test is used. The LRS equals 106 and the df equals 5. The probability that the fourth iteration model performs better than the third iteration model due to coincidence is smaller than 5%.

Table 29: MNL estimation second choice question: introducing attitudes

	Estimate	s.e.	t.rat.(0)	p(1-sided)
ASC_NEIGH	0	NA	NA	NA
ASC_SP	-2.233144	1.02148	-2.18619	0.014401
ASC_PL	-8.187396	1.46416	-5.59187	1.12E-08
ASC_MOMENT	-6.38297	0.831078	-7.68035	7.88E-15
ASC_AHOUSE	-7.452374	0.822915	-9.05607	0
BETA_SPDISTANCE	-1.001916	0.218539	-4.58462	2.27E-06
BETA_SP_OH1	0.918027	0.341494	2.68827	0.003591
BETA_SP_OH2	0.539938	0.392052	1.37721	0.084224
BETA_SP_OH3	0.295429	0.289382	1.0209	0.153652
BETA_PLDISTANCE	-0.954084	0.235594	-4.04971	2.56E-05
BETA_PL_OH	0.330589	0.296385	1.1154	0.132339
BETA_RTS	0.050295	0.06251	0.80459	0.210527
BETA_EDUSP	0.183255	0.103979	1.76242	0.038999
BETA_INCSP	-0.068399	0.036733	-1.86207	0.031296
BETA_EDUPL	0.792173	0.171357	4.62293	1.89E-06
BETA_URBANPL	-0.20211	0.069725	-2.8987	0.001874
BETA_EMP2PL	0.549648	0.366404	1.50011	0.066792
BETA_INCPL	-0.129843	0.060037	-2.16272	0.015282
BETA_AGEMOMENT	0.044719	0.008836	5.06102	2.08E-07
BETA_GENDER1_MOMENT	1.283904	0.232663	5.51829	1.71E-08
BETA_EDUMOMENT	0.421056	0.111256	3.78456	7.70E-05
BETA_AVAILMOMENT	0.261652	0.099314	2.6346	0.004212
BETA_EMP2MOMENT	0.983899	0.275567	3.57046	1.78E-04
BETA_INCMOMENT	-0.17404	0.047127	-3.69299	1.11E-04
BETA_AGEAHOUSE	0.076984	0.008935	8.61615	0
BETA_GENDER1_AHOUSE	0.655263	0.231663	2.82852	0.002338
BETA_EDUAHOUSE	0.665238	0.115265	5.77137	3.93E-09
BETA_URBANAHOUSE	-0.234147	0.046243	-5.06345	2.06E-07

Continued on next page

Table 29: MNL estimation second choice question: introducing attitudes (Continued)

BETA_EMP1AHOUSE	-1.018262	0.324145	-3.14138	8.41E-04
BETA_EMP2AHOUSE	-0.672818	0.311162	-2.16227	0.015299
BETA_INCAHOUSE	-0.085847	0.040782	-2.10504	0.017644
BETA_FREQ_SP	-0.190131	0.087788	-2.16581	0.015163
BETA_USESP_SP	0.400387	0.101991	3.92571	4.32E-05
BETA_FREQ_AHOUSE	0.2896	0.08067	3.58992	1.65E-04
BETA_USESP_AHOUSE	0.235629	0.102917	2.2895	0.011025
BETA_FREQ_MOMENT	-0.180969	0.08882	-2.03749	0.020801
BETA_USESP_MOMENT	0.341011	0.104916	3.25033	5.76E-04
BETA_PRIVACY_SP	-0.022369	0.170594	-0.13112	0.447839
BETA_PRIVACY_PL	0.346815	0.221091	1.56866	0.058364
BETA_PRIVACY_MOMENT	0.147027	0.148141	0.99248	0.160481
BETA_PRIVACY_AHOUSE	0.05631	0.150452	0.37427	0.354101
BETA_RA_SP	0.534544	0.169761	3.14881	8.20E-04
BETA_RA_PL	0.994288	0.264361	3.7611	8.46E-05
BETA_BURDEN_SP	0.724081	0.13126	5.51637	1.73E-08
BETA_BURDEN_PL	0.675252	0.183528	3.67928	1.17E-04
BETA_BURDEN_MOMENT	0.5883	0.125445	4.68971	1.37E-06
BETA_BURDEN_AHOUSE	0.803995	0.119851	6.70828	9.85E-12
BETA_PESPL_SP	-0.237571	0.182896	-1.29894	0.096981
BETA_PESPL_PL	0.102993	0.282142	0.36504	0.357541
BETA_PESHD_SP	-0.123139	0.146955	-0.83794	0.201032
BETA_PESHD_PL	0.007871	0.213892	0.0368	0.485322

Estimating ML model on second choice question

As for the data on the first choice question data set, the second choice question also consists of multiple choices per respondent. This however depends on how many times they have chosen Home Delivery in the first choice question. In total, 810 choices were made by 188 respondents. In the first step, nesting effects are tested. Similar to the estimation process of the ML model on the first choice question, a shared error term is estimated for the SP and PL alternatives. A shared error component is added to the utility functions of SP and PL, again called 'SIGMA SELFCOLL'. This shared error component is significant. The shared error component is found to be significant (p-value = 0.0000). This implies there is shared variation in the error terms of SP and PL. This first iteration of estimating the ML model, reports a final LL of -1081 and a Rho-squared of 0.17. The model consists of 12 parameters.

In the next step, the parameters for the delivery attributes are allowed to vary randomly. An explanation as to why this is decided is given in the ML model estimation process on the data for the first choice question. None of the random parameters that were estimated turned out to be significant. This leaves the model in this second iteration unchanged from the model of the first iteration. The parameter estimates that result from this iteration are shown in Table 30 below.

Table 30: ML model estimation second choice question: introducing a shared error component

	Estimate	s.e.	t.rat.(0)	p(1-sided)
ASC_NEIGH	0	NA	NA	NA
ASC_SP	-0.52166	0.24615	-2.1193	0.017034
ASC_PL	-1.46184	0.40692	-3.5925	1.64E-04
ASC_MOMENT	-0.73931	0.10791	-6.8509	3.67E-12
ASC_AHOUSE	-0.25079	0.09183	-2.731	0.003157
BETA_SPDISTANCE	-1.16587	0.22237	-5.2429	7.90E-08
BETA_SP_OH1	0.88333	NaN	NaN	NaN
BETA_SP_OH2	0.38929	NaN	NaN	NaN
BETA_SP_OH3	0.28833	NaN	NaN	NaN
BETA_PLDISTANCE	-1.01189	0.20543	-4.9258	4.20E-07
BETA_PL_OH	0.31428	0.28161	1.116	0.132208
BETA_RTS	0.02354	0.04112	0.5726	0.283462
SIGMA_SELFCOLL	3.47923	0.45334	7.6746	8.33E-15

In the third and last iteration of the ML model, all parameters that were included in the fourth iteration of estimating the MNL model on the data of the second choice question are added to the model. Of the parameters that were added in this step, only two parameters are insignificant: shopping frequency on the utility for SP, and full-time employment on the utility for AHOUSE. These parameters are then excluded from the model. This results in the final model estimation for the ML model, shown in Table 31 below. The final ML model for the second choice questions reports a final LL of -887 and a Rho-squared of 0.3198, and includes 40 parameters. To compare the performance of the final iteration of the ML model to the first iteration of the ML model, the Likelihood Ratio Test is used. The LRS equals 388 and the df equals 28. The probability that the fourth iteration model performs better than the third iteration model due to coincidence is smaller than 5%.

Table 31: Final parameter estimates ML model - Second choice question - Appendix

	Estimate	s.e.	t.rat.(0)	p(1-sided)
Alternative Specific Constants				
ASC_NEIGH (Reference)	0	NA	NA	NA
ASC_SP	-7.75174	1.98197	-3.9111	4.59E-05
ASC_PL	-12.44611	2.20716	-5.639	8.55E-09
ASC_MOMENT	-6.92044	0.88646	-7.8068	2.89E-15
ASC_AHOUSE	-8.05263	0.89719	-8.9754	0
Service Point				
Distance	-1.33199	0.29641	-4.4937	3.50E-06
Opening hours (OH)				
OH0 - Weekdays: daytime				
OH1 - Weekdays: daytime, Saturday: daytime	1.0559	0.44109	2.3938	0.008337
OH2 - Weekdays: day + evening, Weekends: daytime	0.51056	0.5093	1.0025	0.158057
OH3 - Weekdays and Saturday: day + evening, Sunday: daytime	0.27239	0.33257	0.8191	0.206377
Parcel Locker				
Distance	-1.18466	0.26529	-4.4655	3.99E-06
Opening hours	0.35005	0.36119	0.9692	0.166232
Days before returned to sender (RTS)	0.03308	0.06224	0.5315	0.297553
Socio-demographic variables				
Education - SP	0.46797	0.2671	1.752	0.039885
Income - SP	-0.18662	0.09463	-1.972	0.024303
Eduation - PL	1.15283	0.3054	3.7749	8.00E-05
Urbanity - PL	-0.25756	0.08493	-3.0328	0.001211
Income - PL	-0.18408	0.10244	-1.7969	0.036179
Age - MOMENT	0.06372	0.01034	6.1646	3.53E-10
Female - MOMENT	1.41389	0.26213	5.3939	3.45E-08
Education - MOMENT	0.47052	0.11804	3.9861	3.36E-05
Availability at home - MOMENT	0.22825	0.09886	2.3089	0.010474
Full-time working - MOMENT	1.12268	0.27938	4.0184	2.93E-05

Continued on next page

Table 31: Final parameter estimates ML model - Second choice question - Appendix (Continued)

Income - MOMENT	-0.23512	0.05123	-4.5896	2.22E-06
Age - AHOUSE	0.0948	0.01068	8.8764	0
Female - AHOUSE	0.87447	0.26174	3.341	4.17E-04
Education - AHOUSE	0.67456	0.12222	5.5194	1.70E-08
Urbanity - AHOUSE	-0.25376	0.04751	-5.3407	4.63E-08
Part-time working - AHOUSE	-0.60744	0.28514	-2.1303	0.016572
Income - AHOUSE	-0.17618	0.04238	-4.1569	1.61E-05
Shopping characteristics				
Frequency of use SP - SP	0.33275	0.13767	2.417	0.007825
Shopping frequency - AHOUSE	0.22575	0.08757	2.5781	0.004968
Frequency of use SP - AHOUSE	0.24079	0.11921	2.0199	0.021699
Shopping frequency - MOMENT	-0.19014	0.09382	-2.0266	0.021351
Frequency of use SP - MOMENT	0.36124	0.11825	3.0548	0.001126
Attitudes				
Relative advantage - SP	1.18417	0.43505	2.722	0.003245
Relative advantage - PL	2.07277	0.47575	4.3569	6.60E-06
Degree of burden - SP	1.09642	0.27787	3.9458	3.98E-05
Degree of burden - PL	1.03889	0.29879	3.477	2.54E-04
Degree of burden - MOMENT	0.65606	0.12344	5.3149	5.34E-08
Degree of burden - AHOUSE	0.90956	0.12251	7.4242	5.67E-14
Shared error component				
SIGMA_SELFCOLL	3.00894	0.39101	7.6953	7.11E-15

Final Survey Master Thesis

(This survey was exported from Qualtrics.com)

You can change the language in the top right corner of the screen / U kunt de taal van de survey veranderen in de rechter bovenhoek van het scherm

You are invited to participate in a research study with the purpose of gaining insights into the delivery preferences of consumers for products that are ordered online. The data and the responses gathered through this online study, are all part of my master thesis at the TU Delft.

The survey will take you approximately *10* minutes to complete.

Your participation in this study is entirely voluntary and you can withdraw at any time. You can do this by exiting this online survey.

By clicking through this opening statement and advancing to the online survey you agree in participating in this research. Giving consent to participate in this study means that the answers given by the participant will be stored as anonymous data for the duration of this master thesis and after that on the TU Delft data repository. The data will be used only for the purpose of this master thesis.

Thank you for taking the time to participate in this study. If you have any further questions or comments, you can reach me via this email address: ….@student.tudelft.nl

Have you ordered at least one (1) product online in the last 6 months?

- ○ Yes
- ○ No

Are you 18 years or older?

- ○ Yes
- ○ No

On average how often do you order a product online per month?

- ○ Less than 1 time
- ○ 1 time
- ○ 2 times
- ○ 3-4 times
- ○ 5-8 times
- ○ More than 8 times

How many times have you had a parcel delivered at a Service Point over the last year?

- ○ Never
- ○ 1-2 times
- ○ 3-5 times
- ○ 6-8 times
- ○ More than 8 times

How many times have you had a parcel delivered at a Parcel Locker over the last year?

- ○ Never
- ○ 1-2 times
- ○ 3-5 times
- ○ 6-8 times
- ○ More than 8 times

Take the immediate neighbour or neighbours (i.e., those who live right next to you) into consideration, whom you know the best. How well do you know these neighbours?

- ○ Not applicable: I have no neighbors
- ○ I wouldn't recognize my immediate neighbours on the street
- ○ I recognize my immediate neighbours on the street, but I don't greet them or speak to them
- ○ I only greet my immediate neighbours
- ○ I regularly have a chat with my immediate neighbours
- ○ My immediate neighbours and I sometimes visit each other
- ○ My immediate neighbours and I engage in many activities together, such as drinking coffee, eating dinner or playing sports

Answer the following statements based on your immediate neighbours.

To what extent do each of these statements apply to you?

	Does not apply to me at all	Does not apply to me	Partially applies to me	Applies to me	Applies completely to me
I feel burdened when I have to pick up a package from one of my neighbours	○	○	○	○	○
I don't like it when a package is delivered to one of my neighbours because I don't want them to know I ordered something online	○	○	○	○	○
I don't like it when a package is delivered to one of my neighbours because then they would know what I approximately ordered online	○	○	○	○	○
Since I also accept packages for neighbours, I don't mind picking up a package for myself from a neighbour	○	○	○	○	○
I prefer to have a package delivered to my neighbours rather than to a pickup center	○	○	○	○	○

When you think about the four houses on either side of your home, how well do you know most of these neighbors?

- ○ Not applicable: I have no neighbors
- ○ I wouldn't recognize these neighbors on the street
- ○ I recognize these neighbours on the street, but I don't greet them or speak to them
- ○ I only greet my neighbours
- ○ I regularly have a chat with my neighbours
- ○ My neighbours and I sometimes visit each other
- ○ My neighbours and I engage in many activities together, such as drinking coffee, eating dinner or playing sports

Answer the following statements based on the neighbours living in the four houses on both sides of your house.

To what extent do each of these statements apply to you?

	Does not apply to me at all	Does not apply to me	Applies partially to me	Applies to me	Applies completely to me
I feel burdened when I have to pick up a package from one of my neighbours	○	○	○	○	○
I don't like it when a package is delivered to one of my neighbours because I don't want them to know I ordered something online	○	○	○	○	○
I don't like it when a package is delivered to one of my neighbours because then they would know what I approximately ordered online	○	○	○	○	○
Since I also accept packages for neighbours, I don't mind picking up a package for myself from a neighbour	○	○	○	○	○
I prefer to have a package delivered to my neighbours rather than to a pickup center	○	○	○	○	○

The next part of the survey consists of a choice experiment.

You are asked to imagine the following situation: you have made a purchase of a product, such as sunglasses or clothing, valued at 65 euros. During the checkout process, you will be presented with multiple delivery options to choose from. The product is scheduled to be delivered on the following day.

Explanation of the different delivery options:

***Home delivery**:*

- *You choose to have the parcel delivered at home.*
- *Parcel is delivered at home*
- *Delivery moment indicates the specific day of the week and the time window within which delivery is possible.*
- *Day delivery is between 9-18, evening delivery is between 18-22*

***Service Point**:*

- *Choose delivery to a manned service point (e.g., supermarket, drugstore, bookstore).*
- *Pick up the parcel within the service point's opening hours.*
- *Daytime opening hours are: 9-18, evening opening hours are 18-22*

***Parcel Locker**:*

- *A parcel locker is an unmanned delivery point where the courier places the parcel in a locker (often located near public transport or at shopping locations)*
- *The customer receives a SMS or email when the delivery is made This message contains a code that can be used to open the locker and collect the parcel*
- *The parcel has to be picked up within the parcel locker's opening hours and before the specified maximum number of days has expired*
- *Daytime opening hours are: 9-18, evening opening hours are 18-22*
- *The parcel is kept for a maximum number of days in the locker (Days kept in locker). If unclaimed within this time, the parcel will be returned to the original seller.*

You will be presented with 10 different questions, each requiring you to select a preferred delivery option from various choices. Each question will feature a diagram similar to the one below, illustrating the available delivery options. Be aware that the characteristics of the options change.

Imagine that you have made a purchase of a product, such as sunglasses or clothing, valued at 65 euros. During the checkout process, you will be presented with multiple delivery options to choose from. The product is scheduled to be delivered on the following day. Examine the available delivery options and their respective attributes, and select the preferred option.

- ○ Home Delivery
- ○ Service Point
- ○ Parcel Locker

Based on your selection of Home Delivery in the previous question, consider a scenario where you receive a message from the parcel delivery company specifying a time window for their arrival, but you won't be able to be at home during that time. Within this message, you have the opportunity to choose an alternative option for the delivery process.

Note that three new options are added, that are not shown in the diagram.

- Delivery to Neighbour: You choose to have courier deliver the parcel to a neighbour
- Another Moment: You can choose another suitable moment for the delivery, and the courier will return to your home to deliver the parcel.
- Agreed Place Around the House: You can inform the courier about a specific location around your house where they can safely place the parcel.

Choose the option you prefer:

- ○ Service Point
- ○ Parcel Locker
- ○ Delivery to Neighbour
- ○ Another Moment
- ○ Agreed place around house

If the option 'Delivery at another Moment' is no longer available, which alternative among the remaining options do you prefer the most?

Choose the option you prefer:

- ○ Service Point
- ○ Parcel Locker
- ○ Delivery to Neighbour
- ○ Agreed place around house

Indicate to what extent you agree with the following statements.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Using a parcel locker would have a positive effect on environment and society	○	○	○	○	○
Using parcel lockers can generate less carbon footprint than other delivery methods	○	○	○	○	○
Using parcel lockers can be more sustainable in the long term	○	○	○	○	○
Using parcel lockers can create fewer negative externalities (e.g. noise or traffic congestion)	○	○	○	○	○

End of Block: Perceived environmental sustainability PL

Start of Block: Perceived environmental sustainability HD

Now answer the same questions but with home delivery in mind.
Indicate to what extent you agree with the following statements.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Using home delivery would have a positive effect on environment and society	○	○	○	○	○
Using home delivery can generate less carbon footprint than other delivery methods	○	○	○	○	○
Using home delivery can be more sustainable in the long term	○	○	○	○	○
Using home delivery can create fewer negative externalities (e.g. noise or traffic congestion)	○	○	○	○	○

Indicate to what extent you agree with the following statements.

Receiving parcels in a parcel locker would be better than home delivery, because using a parcel locker:

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Improves my overall reception experience	○	○	○	○	○
Makes it easier to receive my parcel	○	○	○	○	○
Allows me to collect my parcels at my own convenience	○	○	○	○	○
Offers me a more customised service	○	○	○	○	○
Offers me more control over the delivery process	○	○	○	○	○

What is your year of birth?

_____

What is your gender?

- ○ Male
- ○ Female
- ○ Non-binary / third gender
- ○ Prefer not to say

What is your employment status?

- ○ Employed full time
- ○ Employed part time
- ○ Unemployed / Retired
- ○ Student
- ○ Unable to work

What is your level of education?

- ○ Elementary school
- ○ High school diploma or middle vocational (MBO)
- ○ Higher professional education (HBO) or university without a degree
- ○ Bachelor's degree (HBO or university)
- ○ Master's degree
- ○ Doctorate/PhD

What is your yearly income?

- ○ Less than €10,000
- ○ €10,000 - €19,999
- ○ €20,000 - €29,999
- ○ €30,000 - €39,999
- ○ €40,000 - €49,999
- ○ €50,000 - €59,999
- ○ €60,000 - €69,999
- ○ €70,000 - €79,999
- ○ €80,000 - €89,999
- ○ €90,000 - €99,999
- ○ More than €100,000

How would you describe your living situation?

- ○ Rural
- ○ Outside of centre of village
- ○ Centre of village
- ○ Outside of centre of small city / town
- ○ Centre of small city / town
- ○ Suburb of big city
- ○ Outside centre of big city
- ○ Centre big city

How often are you at home during the day on weekdays?

- ○ Rarely: I am rarely at home during the day.
- ○ Occasionally: I am at home during the day some days of the week.
- ○ Sometimes: I am is at home during the day most days of the week.
- ○ Often: I am at home during the day almost every day of the week.
- ○ Always: I am always at home throughout the day.