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Crowdshipping: willingness to act as crowdshippers in Oslo

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Abstract

Crowdshipping as a concept has the potential to revolutionise the delivery industry. The success of crowdshipping depends on whether it can surpass traditional delivery's economic and environmental qualities. If crowdshipping was more beneficial to customers than conventional delivery, the demand for such a service and the supply of people willing to act as crowdshippers (commuters that go out of their way to perform delivery) would increase. This thesis is devoted to viewing crowdshipping through the eyes of crowdshippers and assessing the preferences they have when it comes to delivering a parcel. The study adopts stated-preference research design to determine its empirical results. Moreover, an extensive review of existing works builds the foundation for our findings. From the work done we outline the following. Potential crowdshippers are affected by remuneration, time period, remuneration frequency, delivery assignment process, and distance.

Keywords: Crowdshipping, Last-mile delivery, Stated preferences, Oslo.

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Chapter 1

1. Introduction

Making our world a world without emissions is unquestionably one of society's biggest challenges. The movement of becoming sustainable was initiated more than 30 years ago. The public is now recognising how serious the situation is. With authorities subsidising, companies implementing, and media talking about sustainability measures, environmental awareness is higher than it ever has been.

Amongst other things, this influences ideas in the start-up scene and the innovative landscape in general. Businesses increasingly act towards the preservation of the environment. They use new and inventive tools to optimise efficiency and at the same time cut down waste and emissions. Incentivised by premiums, companies become environmentally conscious on every step of the supply chain process.

Transportation, for example, is a field that is particularly important to consider. In 2018, the transport sector alone accounted for 24.6% of worldwide CO2 emissions (IEA 2020). Hence, it is imperative to find applications that curb the harm of transportation. The movement of passengers has already been transformed by services like Uber and Lyft. These companies encourage regular people to pick up passengers and drive them to a requested destination.

Crowdshipping is exactly that but for transporting goods. It is an alternative way of delivering any kind of item to a designated location. Members of the crowd, mostly commuters, deliver parcels on trips that they would take anyway. For crowdshipping to be accepted as a means of delivery, it has to provide more benefits to the customer than traditional delivery. Gatta et al. (2018) present empirical data on crowdshipping that depicts this new form of delivery as having not only environmental but also economic benefits.

1.1 Research problem

Although the evidence suggests that crowdshipping is on the brink of becoming mainstream, very little is known about its actual functioning, performance, impact, and the public's awareness (Ermagun, Shamshiripour, and Stathopoulos 2020). It seems as if crowdshipping companies have yet to discover the optimal way to reach the masses. And so, we decided to find out more about how crowdshipping delivery can be improved. As it turns out, a lot of research has already been conducted with regards to crowdshipping. However, most of it focusses exclusively on understanding its environmental and economic benefits.

The area of research that has not been covered yet are conditions to work as a crowdshipper. What does it take for a member of the crowd to pick up a parcel in a certain spot and deliver it to the final customer? When commuters are open to taking a detour on their way from/to work, study, etc., they are likely to have specific preferences. These preferences are subject to our research.

We expect commuters to only want to spend a short time delivering parcels. This is why crowdshipping is predominantly viewed as a method used on the last mile of delivery. Boyer, Prud'homme, and Chung (2009) explain that the final delivery to the customer is the most challenging part of logistics. Until goods reach consolidation centres, transport is relatively simple. Only when parcels go apart to be transported to a multitude of customers, it appears that shipping becomes exceedingly complex. This issue applies to crowdshipping as well.

Ballare and Lin (2020) point out that crowdshipping can only succeed if micro hubs are placed appropriately and crowd members are densely resident in the city where a crowdshipping system is implemented. If an area is sufficiently covered with people working as crowdshippers, it is likely for efficiency of delivery to increase.

Since the availability of commuters is of such high importance to the success of crowdshipping, the research conducted in this work focuses on the commuters' point of view and the associated preferences. The results will provide crowdshipping companies with essential information on their potential workforce. In addition, companies can use this information to determine the total cost of crowdshipping. Researchers may find this data helpful for further research.

The empirical data gathered is especially representative of crowdshipping in Oslo. All data were collected in the Norwegian capital. The city that is inhabited by close to 700,000 people is particularly suitable for our study. While Oslo has recourse to a highly functional public transport system, it also is the most populous city in Norway. Although our research is highly reliant on Oslo as a target area, still this work can exemplify the overall status quo in the field of crowdshipping.

1.2 Research question

The objective of this thesis is to, on the backdrop of existing research and literature, answer a research question. As we introduced in 1.1, crowdshipping is mainly applied on the last

mile of delivery. Also, we mentioned that crowdshipping particularly requires research that observes the viewpoint of people wanting to work as crowdshippers. Consequently, the problem that this work aims to investigate can be described as:

What are the factors that influence people's willingness to participate as crowdshippers in last-mile delivery in the city of Oslo, and how can these factors be measured appropriately?

Furthermore, and as part of this question, we intend to examine the desired benefits of crowdshippers in Oslo. Which conditions are favourable for a member of the crowd to engage in working for a crowdshipping service? Besides this, other relevant information is to find out the distance that crowdshippers are willing to go or how frequently they can operate. All of this is answered along the thesis, and more specifically in chapter 5.

As suggested by Robson (2002), we additionally formulate a research hypothesis. It is deduced based on the literature review, the specific case that we refer to, and the methodological approach that we use, and it can be expressed as follows.

Members of the crowd decide whether they want to work as crowdshippers based on the attributes remuneration, time, frequency, delivery assignment, and distance, which are further explained at a later stage of this work. The data proving this statement can be collected through an online questionnaire that includes choice experiments. Optimal results can be attained by analysing the data with the tools SPSS, Ngene, and Excel.

1.3 Structure

Before moving on to the findings, the reader of this thesis shall know their way around in this document. Part 2, which follows this chapter directly, contains a thorough review of the existing literature. The relevant aspects of crowdshipping are carefully illuminated. In chapter 3 we go over the case that this thesis revolves around. This section of the paper refers to the connection to the industry, more specifically how the so-called LEAD project intends to use crowdshipping as a basis for an updated transport system.

Subsequently, it is crucial to preface the actual findings with the methodology. Chapter 4 outlines the methods and models we applied to collect, process, and analyse the data. It is a testament to the validity of our results. Eventually, these results are depicted and discussed in chapter 5.

Chapter 2

2. Literature review

A literature review is incredibly useful in scientific work. It gives a balanced answer to a review question; more researchers tend to lead to a more balanced answer. A literature review builds an understanding of theoretical concepts and terminology. In addition, gaps in existing research can be identified (Booth, Sutton, and Papaioannou 2016). The literature review subtly discovers and leads up to the research topic, and eventually helps in interpreting the results (Rowley and Slack 2004).

This chapter gives a thorough overview of crowdshipping theory and essential related topics. We synthesise the works that are most relevant in understanding this field of research as suggested by Rowley and Slack (2004). First, it is vital to know about how freight transport infrastructure is developed, which we approach in chapter 2.2, and then explain its importance and intricacies. According to McKinnon (2016), crowdshipping is a recent approach that aims to extend transport infrastructure, as detailed in chapter 2.3. While in chapter 2.3 we especially define the overall concept of crowdshipping, chapter 2.4 is about the impact that this type of delivery has on its surroundings. Crowdshipping is specifically useful on the last mile (Le and Ukkusuri 2018), which is illustrated closely in chapter 2.5. To complete the picture, we discuss automated parcel lockers (2.6) and their connection to crowdshipping seeing their recent rise and potential usefulness.

2.1 Review methodology

The objective of this review is to comprehensively analyse the existing literature related to crowdshipping, especially with regards to last-mile delivery. The review question we intend to answer is: “How has crowdshipping been identified and defined in literature?” Also, we intend to list the benefits and challenges that are occurring in the existing empirical studies. The structure of this review stems from the works of Rowley and Slack (2004). Their article proposes the use of four different approaches when starting a literature review.

1. Citation pearl growing – research begins with few topic-related documents, consequently using keywords from these documents to retrieve other documents.
2. Briefsearch – is a good starting point; obtained results give a broad introduction to the topic and lay a foundation for further work.

3. Building blocks – the concepts considered are formulated as search statements, before additionally attaching synonyms and related terms.
4. Successive fraction – approach that reduces a large set of documents to only the essential documents.

After reading through a small number of relevant articles, it is recommended to formulate key concepts. In figure 1, we create a picture of our research territory, also known as a concept map. Concepts are illustrated by circles, and relationships are represented by lines. We used this map to find further search terms for the literature research and to better understand theory, concepts overall, and relationships between them.

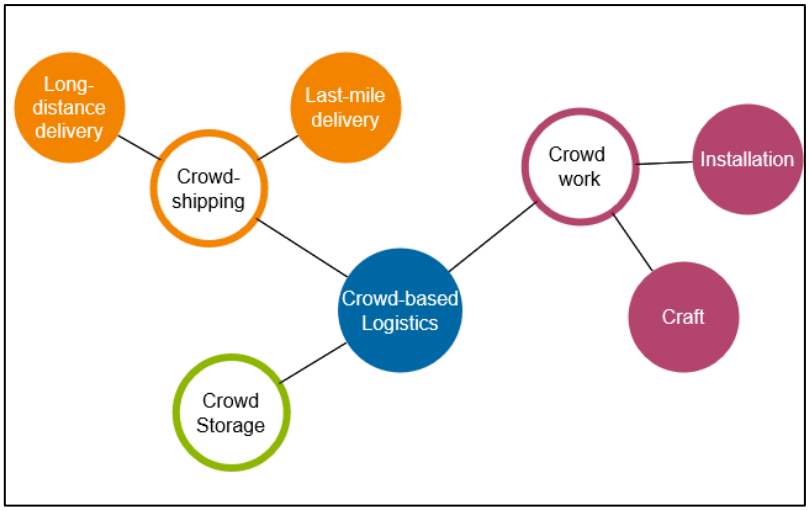

Figure 1: Concept map relating to Crowd-based logistics

The resulting search terms revolve around and include the key concepts. In the research process we entered keywords and their synonyms, sometimes stand-alone, other times connected through Boolean operators. The type of literature considered is journal articles, conference proceedings, books, web pages, and theses. Regarding the search engines, the ones used are University College Molde's own 'Oria', and Google Scholar. We frame the review according to what Carnwell and Daly (2001) consider to be the most popular approach: dividing the literature into themes and categories. With this, it is possible to include theoretical and empirical literature.

2.2 Developing freight transport infrastructure

The basis of everything transport-related is the infrastructure that it relies on. So for a crowdshipping service to succeed, it requires a city with fundamental infrastructure. Cui,

Dodson, and Hall (2015) describe that the setup of an efficient freight transport system also plays a primary role when designing modern urban areas. Before a freight transport system can be developed, it is necessary to observe the parties that are involved. Taniguchi and Tamagawa (2005) spot the following stakeholders:

- Freight carriers
- Shippers
- Residents
- Administrators
- Urban expressway operators

Every group of stakeholders has their interests and motivations – and will seek to address them. While congruent in some instances, other times their incentives are oppositional. If the latter is the case, designing a freight transport plan becomes increasingly difficult.

Besides this, there are other factors to consider. Stathopoulos, Valeri, and Marcucci (2012) state that it is important to know where economic activities are conducted, and what the patterns of urban land-use are. Depending on the city, freight flows are different from one another. There exist urban environments which are more novel than others. Because of this, the quality of infrastructure provision differs greatly among cities. Infrastructure also applies to the valid regulatory frameworks which can vary a great deal across countries.

Some urban areas are further ahead in creating city-specific initiatives regarding freight transport plans. However, Dablanc (2007) claims that the number of implemented initiatives overall does not match the demand, indicating the potential for improvement.

On the corporate level, freight transport used to pose few difficulties. Most businesses operating today have a bricks-and-mortar background. Generally, these businesses have goods delivered to their stores before selling them to customers in-store. With the ongoing pandemic and the continual shift toward e-commerce, it becomes more profitable for shops to add home delivery to their offer. This, however, causes additional expenses for picking online orders and covering the last mile (Hübner, Kuhn, and Wollenburg 2016). Companies that started out as e-commerce retailers, i.e. Amazon, benefit from their head start.

Compared to delivering products to retail stores, home delivery causes far more challenges as it exponentially increases the number of freight movements in the city. In addition, orders

from private customers are generally small, which increases the freight movements. This excessive freight transport potentially results in lower quality of life and less attractive urban areas for the population. Still, urban freight transport is required in some form to ensure that industrial and trading activities continue to thrive (Savelsbergh and Van Woensel 2016).

Being aware of these issues, governments impose rules that aim to benefit the quality of life. For instance, authorities implement restrictions that comprise time windows, vehicle weight, and size restrictions, low emission zones, and limited parking space (Anderson, Allen, and Browne 2005). Albeit well intended, many restrictions are one-sided as they achieve the goal of decreasing carbon emissions, while falling short on economic sustainability (Marsden et al. 2011). The challenges to come are exacerbated by increasing urbanisation. The urban population in Europe is expected to rise to 84% by 2050 (Verlinde 2015), hence increasing the challenges to planning efficient and sustainable urban freight transport.

Modern technology, however, can affect transport positively. Savelsbergh and Van Woensel (2016) reason that information systems will continue to improve, and thereby increase reliability, efficiency, and visibility of logistics operations. Assisting this is trending designs such as multi-echelon networks (Tsiakis, Shah, and Pantelides 2001), dynamic delivery systems (Savelsbergh and Van Woensel 2016), or pickup point networks (Cattaruzza et al. 2017). Savelsbergh and Van Woensel (2016) explain that dynamic delivery prioritizes same-day delivery and makes transportation as dynamic and responsive as possible.

Cattaruzza et al. (2017) depict that multi-echelon networks require distribution centres at the borders of a city, where deliveries are stored before being transported to the actual customer. This last part of the delivery, also known as the last mile, will then be performed using highly utilised vehicles. The most important elements to consider on the last mile are speed and cost. The goal is to maximize the former with the latter being at its minimum (Chen and Pan 2016). Efficiently fulfilling this task is difficult. A recent attempt to solve this problem is a method called Crowdshipping.

2.3 The concept of Crowdshipping

Crowdshipping, sometimes referred to as crowd logistics is defined by Rai et al. (2017, 5):

> *[…] [A]n information connectivity enabled marketplace concept, that matches supply and demand for logistics services with an undefined and external crowd that*

has the free capacity with regards to tone and/or space, participates voluntarily, and is compensated.

Crowdshipping is a growing industry with the advantage of lower shipping costs and a high potential of changing the delivery industry (Miller, Nie, and Stathopoulos 2017). It is perceived as an innovative solution that can be adopted in the last-mile common transport (Slabinac 2015). The objective of Crowdshipping is to achieve economic benefits by outsourcing logistics services to a crowd (Mehmann, Frehe, and Teuteberg 2015). A crowd can be defined as a network of volunteers (Estellés-Arolas and González-Ladrón-de-Guevara 2012).

Central to this is the shared use of excess capacity in vehicles (Cohen and Muñoz 2016). Uber and Lyft are well-known examples of how passenger transportation can be outsourced to a crowd. The transportation of goods using the crowd is less prominent. According to Pfenning (2014), the concept of crowdshipping leads to higher efficiency in last-mile delivery. The author highlights that both user and bringer profit from such a service. The user has access to a way of delivery that is more flexible than the traditional one. The supplier, on the other hand, benefits from having a new income source.

2.3.1 Requirements and categorisation

Frehe, Mehmann, and Teuteberg (2017, 90) say, that it is sensible to class crowdshipping among the sharing economy concept. Therefore, they argue, the *network* is vital for the success of a crowdshipping system. In a network there are two sides:

1. The customers, who are individuals or businesses, and
2. the carriers, who comprise freelancers, courier, express, and package (CEP) delivery providers.

CEP providers must only be considered when freelancers are not available in a certain area. The crowdshipping company, situated amid all this, takes on the role of the mediating force.

To gain more insight on the potential target group, Punel, Ermagun, and Stathopoulos (2018) measure how users of crowdshipping services can be differentiated from non-users. Their research reveals that men are more likely than women to use a crowdshipping service. Moreover, the authors argue that respondents show more interest in crowdshipping when they are working full-time.

Besides employing commuters, crowdshipping companies also employ bringers who explicitly take time to perform deliveries. In general, the order process begins with bringers receiving a list of delivery orders and their pick-up and delivery times. Subsequently, bringers select the requests they want to fulfill. In their research work, Rougès and Montreuil (2014) propose the use of matching algorithms to optimise the assignment of delivery orders to drivers. Such an algorithm could improve the efficiency of crowdshipping platforms by optimising matches and further automating the matching process (Soto Setzke et al. 2018).

Crowdshipping platforms are overall designed similarly. Their operability can generally be described in three stages. First, the person that requests delivery posts their shipment order on the platform's website/application. Information to be provided is the size of the package, pick-up, and drop-off location, as well as delivery time requirements. Second, the platform matches the person requesting a service and the bringer. There are multiple ways how this can be handled. Some platforms match the two parties centrally. Specific algorithms are used to optimise the probability of successful deliveries. In other cases, the sender selects from a list of bringers that are available (decentral approach). The third stage proposes the use of a bidding system. Here, bringers compete for deliveries they want to perform by communicating their conditions (Ermagun and Stathopoulos 2018).

2.3.2 Strategies and prospects

Now, crowdshipping is exclusively prevalent in major cities. However, this is expected to change with the proliferation of crowdshipping companies. Since this new system provides higher quality services at a lower cost than traditional logistics businesses, it will not be long until the industry is disrupted (Frehe, Mehmann, and Teuteberg 2017, 91).

A successful crowdshipping company must strategise considering three factors: the partnerships that it establishes (cooperation), the users that commit to it (marketing), and in which area the company operates (geographic scale); the latter being highly influential regarding the company's environmental sustainability. In addition to the scale on which a crowdshipping company operates, the composition of the transport fleet also plays an important role when considering its sustainability. It raises the question of how many of the members use environmentally friendly modes of transportation, such as public transportation and emission-free vehicles (Rai et al. 2017).

Savelsbergh and Van Woensel (2016, 585) consider crowdshipping useful in the realm of dynamic delivery routing problems. In addition to individual demand, some individual drivers appear on an *occasional* basis. With this turning into a reality, it will be essential to improve the anticipation of when orders and drivers arrive. Anticipating the exact arrival time could become much more important than it is today since the individual management of time increases in its importance.

2.3.3 Target regions and groups

Most crowdshipping start-ups have emerged in the United States (e.g. Postmates, Deliv, Roadie, Kaargo, UberRush), other crowdshipping platforms are distributed globally with examples in Australia (e.g. PostRope, Ppost), Colombia (Rappi), Nigeria (Max), China (Renren kuaidi), Europe (e.g. PiggyBee, Nimber in the UK and Norway, Trunkrs in the Netherlands, PiggyBaggy in Finland) or in all countries (Parcelio, Quincus). Despite the market in strong innovation, only a fraction of new crowdshipping companies manages to create a sustainable market over time by attracting and retaining users (Dablanc 2016).

The proliferation of the crowdshipping service is a response to the ever-changing demand of customers towards personalised faster and cheaper service delivery (Rougès and Montreuil 2014). The initial concept of crowdshipping started in the US but there are several platforms all over the world currently offering crowdshipping services (Punel and Stathopoulos 2017, Carbone, Rouquet, and Roussat 2017). All these service providers rely on the crowd as its key stakeholder (Rai et al. 2017). The crowd usually consist of students (Marcucci et al. 2017), taxi drivers (Chen and Pan 2016), pizza delivery (wo)men (Paloheimo, Lettenmeier, and Waris 2016), retailers, loyal customers (Dayarian and Savelsbergh 2020, Verheyen 2016), friends and acquaintances (Devari, Nikolaev, and He 2017), or migrants as new entrants/players who are looking for a way to earn a living in their new territory. Most platforms offer four main logistics services: crowd storage, crowd local delivery, crowd freight shipping, and crowd freight forwarding (Carbone, Rouquet, and Roussat 2017). Huang et al. (2020) combine the crowdshippers' motivations and categorise them. In table 1, these motivations are displayed.

Table 1: Factors influencing crowd workers' continued participation in crowdshipping

Types	Motivations/Influence Factors	Reference
Motivating factors	Monetary and non-monetary rewards	Horton and Chilton (2010), Rai et al. (2017)
	Intrinsic motivation values include the desire to experience something new, to share knowledge with others, and the enjoyment of the task itself; Extrinsic motivation values include the realization of common goals, the recognition of others, and satisfaction of the need for self-expression and uniqueness	Bayus (2013), Lusch, Brown, and Brunswick (1992), Mladenow, Bauer, and Strauss (2015)
Inhibiting factors	Extra charges, the absence of relevant laws, delivery delays and unclear distribution of responsibility	Mladenow, Bauer, and Strauss (2015)
	Financial insecurities, lacking social protection, isolation, and stress, blurring lines between the sphere of work and private life, high competition, and uncertainties due to short-term schedules	De Groen and Maselli (2016)
	Level of trust between crowd-sourcers and crowd workers	Rougès and Montreuil (2014)

2.3.4 Means to facilitate crowdshipping

By using a "local marketplace" approach, crowdshipping generates the necessary delivery frequency to establish a crowd. When combined with alternative forms of mobility such as (electric) bicycles, cargo bikes, etc., inner cities can be revived as well as relieved of traffic. This in turn increases their attractiveness by improving the quality of stay and accessibility. The crowd remains inactive until their action is required by a specific task. New technologies such as smartphones, the Internet, and the Web 2.0 thus play an elementary role in activating the crowd, as they are a prerequisite for broad involvement. As they are part of the crowd, the supplier can be a customer at the same time and vice versa. Due to the high number of bringers, bicycle logistics with bicycles or cargo bikes is especially suitable for crowdshipping, as no route planning or bundling is necessary (Dörrzapf et al. 2016).

Crowdshipping applies to people who use mobile technologies. Every person with a smartphone can be part of the system. The nature of crowdshipping is its decentralised approach to transportation, which mostly induces small-scale level use. However, as soon as enough people join, delivery coverage will be more efficient than before.

The key to the functioning of crowdshipping is to reach a critical mass. Only if there is a large number of suppliers, the concept can work and provide reliability. Complementary

professional suppliers and bicycle couriers can cushion this challenge somewhat (Dörrzapf et al. 2016). In reality, this problem is significant. Maintaining motivation among crowdshippers is a difficult task. One of the reasons why people are not willing to work in this field is its immaturity with regards to management, technology, and legality (Guo, Wang, and Yan 2019). Additionally, crowdshippers are required to spend time, energy, and money on equipment, which could prove to be too much of an effort for some (Afuah and Tucci 2012).

If there is access to a large number of drivers, transports are feasible with small detours. This possibly induces less mileage than the delivery tours of depot-supported parcel service providers. However, the density and availability of drivers that are required to ensure a sufficiently high coverage remain to be ascertained (Proff and Fojcik 2017). With a lot of workers, risk and safety issues become relevant. On a big scale, delivery delays, loss *of* and damage *to* goods, as well as traffic accidents are considerable problems, which affect trust between crowdshipper and platform adversely (Carbone, Rouquet, and Roussat 2017). Many platforms in the field of crowdshipping rely on community building to strengthen trust. This is achieved through a review system that allows users to create profiles and write reviews (Dörrzapf et al. 2016).

The users' credibility is ensured by asking the people providing the services to send in their drivers' license, insurance, and proof that there is a reliable vehicle at hand. Transportation types are as varied as they can be, including bike, cargo bike, car, van, truck, or even walk. Storage spaces are in no way inferior regarding their variety; considered are lofts, basements, spare rooms, garages, uncovered spaces, driveways, caravans, or motorhomes (Carbone, Rouquet, and Roussat 2017).

2.4 The impact of Crowdshipping

The impact or the overall effect of crowdshipping should be measured from the economic, societal, and environmental perspectives. Much emphasis has been on the environmental impact as the world is steadily moving towards total sustainability. However, literature shows that three factors determine whether crowdshipping has a positive or negative impact on the environment (Buldeo Rai, Verlinde, and Macharis 2018).

The crowd's transport behaviour is the first factor (Buldeo Rai, Verlinde, and Macharis 2018). Reducing empty kilometres results in less CO2 emissions (Li and Yu 2017), travel

levels, and resource use (Marcucci et al. 2017). Whether the crowd makes dedicated delivery or takes parcels along a trip they planned, consequently influences the impact of the crowdshipping (Wang et al. 2016).

Second is the consideration of parcels. Spare transport capacities are used by crowd logistic platforms for each parcel, traditional logistic service providers consolidated parcels or load full tracks before dispatching (Buldeo Rai, Verlinde, and Macharis 2018). Traditional logistic service providers such as Amazon offer crowd logistic service that makes use of dedicated vehicle trips because they can consolidate at least three to five deliveries per trip before a delivery vehicle leaves the urban warehouse (De Oliveira et al. 2017). Therefore, fewer vehicle trips are required as opposed to other retailers that use the crowd for only one parcel per trip.

The crowd's choice of transport is the final factor (Rai et al. 2017). Clean fuel vehicles are a possible solution (Lin, Zhou, and Du 2018) and many other concepts involve the use of bicycles, delivery on foot, and public transport (Buldeo Rai, Verlinde, and Macharis 2018).

2.4.1 Reduction of emissions

Crowdshipping reduces transport activities required for parcel delivery and accordingly promotes social, environmental, and economic sustainability (Allen, Thorne, and Browne 2007). However, the footprint of sustainability relies on several factors, including the crowd’s modal choice and consolidation of parcels (De Oliveira et al. 2017, Rougès and Montreuil 2014, Buldeo Rai, Verlinde, and Macharis 2018).

Most of the benefits derived from crowdshipping such as reduction in CO2 emissions or externalities reduction, reduction of traffic congestion, and resource use are linked to more efficient use of the loading space (Rai et al. 2017). Yet to be deduced is, if crowdshipping can also have a traffic-increasing effect. A successful crowdshipping system can lead to an increasing demand for transport services and thus additional traffic. Proff and Fojcik (2017) indicate that the acceptance of a crowdshipping service depends primarily on the cost-benefit ratio of individual participants or individual transactions. Consequently, questions regarding expected cost structures, fee models, and willingness to pay have to be answered.

According to Simoni et al. (2019), the total benefit of crowdshipping is still not clear. Private drivers and commuters using old or new routes can pick up packages and drop them off at designated locker stations.

A significant number of e-commerce deliveries are performed by couriers using city routes and it causes adverse conditions such as pollution and congestion. Crowdshipping will limit/reduce the movement of vehicles in the urban areas since a systematic delivery approach would be employed which will help reduce the number of deliveries performed by vehicles (Ryssel and Matuska n.d.).

Research conducted by Gatta et al. (2018) evaluates the environmental and economic impacts of crowdshipping for urban areas focusing on emission and traffic externalities. The research was conducted in the city of Rome and considered the environmentally friendly crowdshipping, using public transport service, crowd shipper's drop-off, and pick-up goods in automated lockers stationed in transit stations. Adopting discrete choice modeling, scenario analyses were performed to calculate the consequence of crowdshipping on the environment. The research suggests that implementing such a crowdshipping service in Rome produces total savings of 239 kg of particulates per year. Moreover, economic sustainability is reached only with public incentives justified by the reduction of externalities to the society that such a system can produce. The research also mentions that the biggest challenge that policymakers are likely to face is the redistribution of costs and benefits among stakeholders. Results from this research are useful to estimate the potential strategy for last-mile delivery.

2.4.2 Influence on user utility

Concerning the diversity of different sharing concepts, Proff and Fojcik (2017) raise the question of whether their combination creates synergy effects. These potentially increase user acceptance and thus also the impact on urban mobility. To be determined are the incentive measures that are compatible with different sharing concepts. Is it possible to strengthen user acceptance for *several* sharing approaches at the same time? By coupling previously separately viewed sharing concepts, sharing platforms can create systems that super-additively increase the customer's benefit. Synergies arising from the integration of two concepts arise, for example when combining crowdshipping and item-sharing. Unused

transport capacities in crowdshipping vehicles can be used for a particularly fast supply of shared goods.

Castillo et al. (2018) point out that while Crowdshipping fosters cooperation between a retailer, independent delivery company, and consumer, it also leads to competitive consumption. Now, retailers not only compete for customers but also for drivers. In addition, companies that use this approach face a certain degree of vehicle supply uncertainty. In a privately-owned fleet, this is not an issue. When drivers manage the schedules on their terms, the volatility in working time is decidedly higher. Companies that consider using crowdshipping have to closely investigate whether they are willing to put up with higher uncertainty for a lower cost.

Carbone, Rouquet, and Roussat (2017) state that crowdshipping benefits customers in that they receive deliveries quickly at low delivery costs. Platforms rake in value through commissions, fees, or advertisements. These benefits were echoed by Rougès and Montreuil (2014) as they explain the additional earnings of carriers compared to the users capitalising on tailored delivery, affordable cost, and transparency as a result of instantaneous tracking. They further explain that companies also benefit from crowdshipping as it is a cheaper means of delivery compared to generic logistics operators.

2.5 Delivery on the last mile

As crowdshipping impacts delivery itself, the question arises whether it can solve the issues on the last mile. Last-mile deliveries are some of the reasons for heavy congestion caused by commercial traffic in the bigger cities (Lemke, Iwan, and Korczak 2016) and it is the part of the supply chain considered the most inefficient, particularly because of its specificities (Slabinac 2015). Specificities such as “spatial distribution of small reception points, demand for frequent, but small shipments and time windows of delivery” makes it more difficult in delivering goods at lower costs and on-time (Slabinac 2015), and “this has become one of the biggest problems in the organization of the supply of goods to customers” (Lemke, Iwan, and Korczak 2016). The competitive market of logistic service has forced service providers to respond to demand regardless of the degree of use of their loading space (Lemke, Iwan, and Korczak 2016).

According to Sierpiński (2018), it is difficult to consolidate shipments in the last phase of transport because deliveries are composed of individual orders from different destinations that must be delivered to different addresses. This results in disproportionately high costs.

Boyer, Prud'homme, and Chung (2009) mentioned in their work, that different types of last mile can be used to deliver a product to the customer. Companies must find a perfect balance between the critical factors (customer convenience, delivery costs, efficiency, and capital investments) when choosing the time of the delivery option. In avoiding the main delivery issues presented by Gevaers, Van de Voorde, and Vanelslander (2009), which are delivering at home when customers are not at home, delivery to low-density areas, and the problem of empty returns, companies will have to choose the best option.

Infrastructure, new technologies, processes and business models must be developed and implemented to make the last mile more efficient (ERTRAC 2015). The delivery service where products are delivered to the home of customers is what is preferred by most customers, but the last mile of this service remains to be the most expensive of the delivery chain for retailers. Table 2 compares how delivery on the last mile can be approached.

Table 2: A comparison of last mile delivery systems (Allen, Thorne, and Browne 2007, 49)

	Attended delivery	Reception box / Delivery box	Controlled access system	Locker-bank	Collection point
Who covers the last mile?	Delivery company	Delivery company	Delivery company	Customer	Customer
Customer present?	Yes	No	No	No	No
Types of products	Any	Packages, groceries	Packages, groceries	Packages, groceries	Packages
Failed deliveries	High	Virtually none	Virtually none	Virtually none	Virtually none
Delivery window	Fixed delivery hours	Delivery company operating hours	Delivery company operating hours	Delivery company operating hours	CP opening times
Times at which goods can be collected	Not appropriate	24 hours	24 hours	24 hours	CP opening times
Retrieval time for customer	None	Very short	Very short	Short-Long	Short-Long
Drop-off time	Long	Short	Short	Very short	Very short
Initial investment	Low	High / Medium	Medium	Medium	Low / Medium
Delivery Costs	High	Low	Low	Lowest	Lowest

2.5.1 Changes due to e-commerce

With the increasing number of online purchases, retailers are under pressure to deliver products to customers rapidly and this has become one of the hurdles in Business to

Customer in the last mile delivery (Maes and Vanelslander 2012). A typical example is the year-to-year increase in e-commerce growth in the U.S from 2010 to 2020, as illustrated in figure 2.

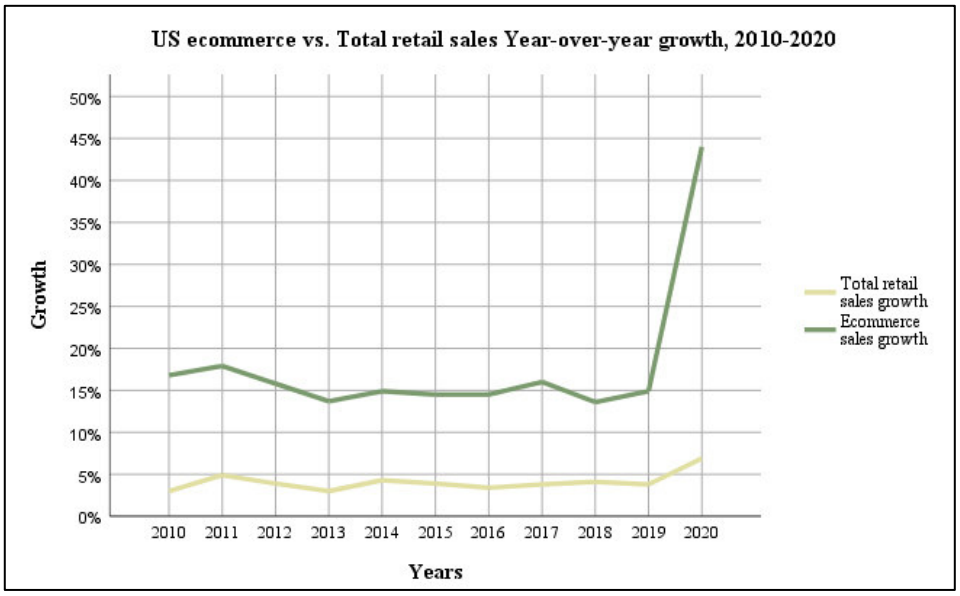

Figure 2: Comparing growth - US ecommerce vs. total retail sales (Digital Commerce 360 2021)

The total cost of last-mile deliveries within the supply chain has increased from 13% to 75% because of the growing importance of technology in the recent decade. Truthfully, the burgeoning of e-commerce has transformed the way we use home delivery (Slabinac 2015).

According to Leigh David Logistics (2019) on what is known about the last mile in the US and what it will look like in the future. There was a 33% increase in B2B last-mile delivery and a 67% increase in B2C last-mile delivery over 18 months in 2017-2018. Internet retail jumped from $290.4 billion to $1.6 billion between 2008 and 2018. The global last-mile delivery market was $30.2 billion and is projected to reach $55.2 billion based on the estimate of the expected world population of 11.2 billion by 2100 (UN Figures). Forty-eight percent of consumers are demanding next-day delivery and 23% are demanding same-day delivery. The maximum number of days people are willing to wait for delivery has dropped from 5.5 in 2012 to 4.1 days in 2018 even if free shipping is offered. Fifty-five percent of consumers surveyed think a 2-hour delivery option for the same-day world increase brand loyalty.

2.5.2 Means to bridge the last mile

The main item in the total cost of a supply chain is the delivery of products in an urban environment (Gevaers, Van de Voorde, and Vanelslander 2009) and as a result, many retailers are looking for alternative options in deliveries such products more efficiently (Serafini 2017). Another emerging alternative is that customers order online and pick up at local stores. On some occasions, customers do not even get out of their vehicles, they wait in their vehicles while shop employees load the products into their cars in a drive-through arrangement (Slabinac 2015).

Urban product delivery which is a crucial part of the product supply chain has become one of the bottlenecks of e-commerce and this can hinder the relationship between customers and retailers (Wang et al. 2016). Many companies are trying different means to reduce the cost of last-mile delivery while at the same time trying not to compromise the relationship with their customers. Last-mile delivery is eroding profits, businesses are charging less the cost of delivery and are taking the rest of the cost of delivery from the profit margins of sold products. Parcel lockers are becoming an efficient solution in reducing the cost of last-mile delivery and urban freight transport. Allen, Thorne, and Browne (2007) conclude the solution of this type, which we depict in table 3.

Table 3: BESTUFS good practice guide on urban freight transport (Allen, Thorne, and Browne 2007, 41-49)

Type	Description
Reception boxes	Permanently fixed to a wall outside the customer's home, to which access is possible using a key or an electronic code; customer can be alerted of the delivery by mobile phone or email; used mostly for parcels, but can be used for foods if the boxes are temperature controlled
Delivery boxes	owned by the retailer or delivery company; filled with the goods at the distribution depot, and then temporarily attached to the home via a locking device fixed on the wall in a secure place at the customer's home; empty boxes or boxes containing returned goods are then collected by the delivery company either as a separate collection round or as part of the next delivery
Controlled access systems	provide the delivery driver with a means of gaining access to a locked area to leave the goods in; a key may be sealed inside a unit, which is mounted in a location where delivery staff can access it; the driver enters an access code into the sealed unit to release the key and open the nominated delivery location to leave the goods

Collection points	based on the use of locations other than customers' homes to which goods are delivered (the nearest Post Office, convenience store or a petrol station; often have long opening hours. Goods are delivered by the retailer or their carrier to the collection point and the customer is informed that their order is ready for collection. Customers may arrange with the collection point for the goods to be delivered to their home. Collection points result in fewer delivery locations and improved drop density
Locker-banks are groups of reception box units (lockers)	Like collection points although not sited at each customer's premise but sited in apartment blocks, workplaces, car parks, railway stations etc. Customers are not usually assigned to their own locker to optimize usage (lockers have electronic locks with a variable opening code and can be used for different customers on different days). They may be dedicated to one delivery company or used by many. Customers may be notified by message about when their delivery has arrived, the box number and location, and the code to open the box. Locker-banks require the customer to make the final leg of the journey. However, locker-banks are located to make the deviation in customers' journeys as short as possible. Example of this type of solution is Packstation by InPost.

There are many economic benefits in the transport business. The last mile transport activity has a more negative effect on the environment because of the various externality effects to deliver in an urban environment (Slabinac 2015). According to Serafini (2017), using vehicles for transporting goods has operational, economic, and social impact on the already unbearable urban transport infrastructure. Crowdsourcing as a solution for freight transport problems in urban areas is currently being explored (Mehmann, Frehe, and Teuteberg 2015).

2.6 Automated parcel lockers

Lemke, Iwan, and Korczak (2016, 5) point out:

> *The most important aim of parcel lockers' implementation is to reduce the number of deliveries in the city area, including failed deliveries and the subsequent return of goods by couriers and postal services. It helps to reduce unnecessary vehicle mileage with associated energy use and congestion impacts.*

The growth in e-commerce in the last decade has resulted in the growth of parcel lockers. This new means of parcel delivery has the potential to change the traditional parcel delivery model significantly (Zurel et al. 2018). Parcel lockers are installed in either public or private spaces, such as gas stations, supermarkets, parking sites, or outside private enterprises in city centres. Parcel lockers are either electronic or mechanical. Currently, most parcel lockers are stationary, mobile parcel lockers will likely be introduced soon (Joerss, Neuhaus, and

Schröder 2016). Suggestions of moving vans stopping at destinations for customers to access and pick their parcels.

Ballare and Lin (2020) investigated the performance of the micro-hub delivery paradigm in combination with crowdshipping by comparing it with the traditional delivery service paradigm. They used total vehicle miles traveled, the number of trucks and crowdshipping dispatched, total daily operating cost, and the total fuel consumption as performance parameters for comparison. The study also considered the time window for customer demand and the costs of a central hub and micro-hubs and concluded that micro hub and crowdshipping prove to significantly reduce the number of trucks, vehicles, miles traveled, total daily operating costs, and total fuel consumption in comparison with the hub-and-spoke delivery model for the same demand. In conclusion, the research also stated that the success of micro hubs and crowdshipping paradigm depends on the abundant availability of crowd shippers willing to complete the delivery requirement.

Lemke, Iwan, and Korczak (2016) in analysing parcel lockers' efficiency as the last mile delivery solution mentioned that for parcel lockers to be highly efficient in their utilization, internet retailers must be willing to deliver goods to parcel locker locations, and internet purchasers must be willing to receive their goods from parcel lockers. The strengths, weaknesses, opportunities, and threats of parcel lockers are perfectly presented by Torrentellé, Tsamboulas, and Moraiti (2012) using a SWOT analysis shown in table 4.

Table 4: SWOT analysis of parcel lockers (Torrentellé, Tsamboulas, and Moraiti 2012, 127)

Strengths	Weaknesses
• Customers have the possibility to access to their packages 7 days per week and 24 hours per day • Customers are informed of deliveries via SMS or e-mail • Reduction of freight transport trip km in comparison with attended delivery, thereby reduction of emissions, noise, and energy consumption • Low delivery costs	• Parcel lockers are a private action, and the public authorities do not have information about the impacts • The final leg of the journey has to be made by the customers
Opportunities	**Threats**
• Efficiency gains for logistic providers • Transferable to other cites	• E-commerce is expected to grow further in the future, and this can cause a higher freight mileage due to high number of parcel lockers

2.6.1 The public's awareness of parcel lockers

A study by IPC (2018) indicated that 11% of parcels are delivered to a parcel locker while 9% of returned parcels are delivered to a parcel locker as well. Parcel lockers are most popular in Finland (43%), Denmark (41%), and China (33%). It has been revealed by a study conducted in Poland that young adults like parcel lockers. 55% of them like parcel lockers because of it 24 hours availability, 32% like it because it reduces the total cost of delivery, and only 1% percent like it because of its environmental effect (externalities) (Moroz and Polkowski 2016). Other reasons stated were delivery speed and brand confidence. Bengtsson and Vikingson (2015) found out that 93% of its respondents in their master's thesis did not know what a package vending machine was but all participants thought that retrieving and returning packages will be an easy process to perform. A 2017 consumer study in Belgium by BIPT (2017) reported that parcel lockers are relatively unknown to postal users due to parcel lack of locker visibility and acquaintance. However, many stated that they would be willing to use these lockers in the future as they thought the lockers are useful.

In a 2014 pilot survey by GRASS in Poland Szczecin, respondents were asked for overall ratings of parcel lockers, reasons for parcel lockers utilization, expectations regarding the location of parcel lockers, and rating of the current locations of parcel lockers in Szczecin. The most important reason for using a parcel locker is the price with 27% of internet shoppers rating the lockers with 10 points on a 10-point scale, with 1 being the worst value. The second and third most important reason is 24hrs availability (23%) and localization (22%). Twenty-eight percent of respondents were satisfied with the utilization of parcel lockers, with an average rating of 8.8 points.

2.6.2 Automated parcel lockers in Europe

DHL started a pilot project in Germany in 2001 for Packstations where end-users can send and receive parcels and oversize letters. In its 2017 annual report, DHL said that it operates 3200 Packstations in Germany with over 250,000 compartments ((DHL 2018, Zurel et al. 2018). Aside from the Packstations and Packetboxes which DHL provides for sending parcels, DHL also provides private parcel lockers that can be used for sending and receiving parcels at private premises (Zurel et al. 2018).

In Spain, Corres in collaboration with KEBA offered two types (HomePaq and CityPaq) of parcel lockers, starting with around 500 lockers in Madrid and expanded steadily to other

areas in Spain. HomePaq lockers are private lockers in local communities placed in apartment entrance halls, whiles CityPaq lockers are parcel lockers placed in public spaces such as train stations and supermarkets. Amazon is also active in Spain with automated parcel lockers in 30 cities in 26 provinces (Zurel et al. 2018).

Swedish incumbent, PostNord, started automated parcel lockers in 2014 on a pilot project of 10 parcel lockers stationed at public transport nodes across Sweden, Norway, and Finland. Due to lack of demand, PostNord no longer provides this service but aims to re-enter soon (Zurel et al. 2018). Unlike PostNord, Bring, a subsidiary of Norwegian postal operator Posten Norge entered Stockholm in 2015 after partnering with a public transport company SL. In 2016, less than one year of entering the market, Bring has 11 locker locations particularly at public transport stations, making it easier for commuters to pick and drop off their packages on the go. DP/DHL is another player in the Swedish market, partnering with Danish firm Swipbox, who together have installed over 60 automated parcel lockers at various locations throughout Sweden.

In Belgium, Bpost started commercialising parcel lockers in 2014 and established 125 locker locations near well-attended places by the end of that year. These lockers were accessible at any time, day or night. In 2016, Bpost took a majority interest in De Buren, a network of independent parcel locker providers. Bpost rebranded these lockers to “Cubee” and had over 450 lockers in Belgium by the end of 2018. These lockers are currently opened to operators like GLS, UPS, and DPD as it is now an open network of lockers (Zurel et al. 2018).

DHL is another parcel locker provider in Belgium, but these lockers can only be used for sending parcels as of 2018.

2.7 Theoretical framework

This subchapter reasons the validity of our research. In the first step, we examine the concepts in empirical research that have been applied. After displaying these concepts, we present our approach and show how and why it is different from other authors’ works. Due to the novelty of the crowdshipping concept, there does not exist *one* accepted method how to determine and measure factors that influence participation in the service. Methods used in our research are drawn from a selection of acclaimed papers.

It was in June 2016 when Punel, Ermagun, and Stathopoulos (2018) started surveying people regarding their attitudes and preferences toward crowdshipping. The researchers' approach involved a web-based questionnaire, which was disseminated on Amazon's Mechanical Turk (MTurk) platform. The survey application Qualtrics was used to design the form. Punel and his co-authors decided to use the MTurk platform because of its reputation to attract large numbers of people in a short period. Generally, users of the platform request a crowd of workers to perform tasks against payment.

Huang et al. (2020) present their *research process*. It includes five steps: 1) Questionnaire design, 2) questionnaire pre-test, 3) data collection and control variables selection, 4) data analysis, and 5) identification of factors influencing continuous participation intention. The process supports the purpose of investigating factors that influence crowd workers' continuous engagement in crowdshipping. The actual questionnaire design in Huang et al. (2020) is separated into two parts: demographic information on the respondents and validated scales for the seven key variables. The variables had answer options in form of five levels, indicating agreement or disagreement. Ermagun and Stathopoulos (2018) received a considerable amount of information from one of the leading crowdshipping companies in the United States. Therefore, they had access to first-hand information about the industry.

Our research, just as the work of Punel, Ermagun, and Stathopoulos (2018) makes use of a web-based questionnaire. Especially because of the ongoing pandemic, face-to-face meetings with a high amount of people are not feasible. The dissemination of the questionnaire is performed through multiple platforms, social media groups, and print media. To generate the questionnaire, we use an application called "Nettskjema". Brought into being by the University of Oslo, it is used among all Norwegian universities. "Nettskjema" is an application that is known to residents of Norway and is associated with functionality and competent management of personal data. Since our research is exclusively targeting people commuting to or residing in Oslo, we saw Nettskjema as the optimal software to create the survey with. We go closely into describing the applied methods in chapter 4.

In our research process, we adopted the approach of Huang et al. (2020). After designing the questionnaire, we tested it within the scope of a pilot survey. The data that was collected provided information regarding the validity of the parameters and gave us insight into how to change those parameters. The main questionnaire that resulted from these changes was

disseminated. The analyses and findings of this are depicted in chapter 5. First, however, it is relevant to put forth the case under observation.

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Chapter 3

3. Case description

Vividly explained in the literature, crowdshipping is becoming an acceptable means of transporting parcels. It is seen as a means of reducing traffic congestion and externalities, while it makes last-mile delivery more efficient. Crowdshipping provides economic benefits to both the online shopper and the online seller. Previous research on crowdshipping shows that online shoppers are willing to use crowdshipping services to receive or send parcels, with the crowd/a commuter willing to act as a crowdshipper. What is not yet known is, under what conditions is a member of the crowd willing to participate as a crowdshipper. This has motivated the need for scientific research to investigate its acceptability in Oslo city and the conditions that will motivate a member of the crowd to act as a crowdshipper.

3.1 E-commerce in Norway

Norway is the 23rd largest market for e-commerce with a revenue of US$ 6 billion in 2020 (ecommerceDB 2021) and it is projected to reach US$ 6.85 billion in 2021 (Statista 2020). The Norwegian e-commerce market contributed significantly to the worldwide growth in 2020 with a 26% growth rate (ecommerceDB 2021). Revenue is expected to show an annual growth rate of 3.24% between 2021 and 2025, with a projected market value of US$ 7.782 billion by 2025. Included in the e-commerce revenue figures is online sales of physical goods to private end-users (B2C). This definition comprises purchases via desktop computer and purchases via mobile devices (Statista 2020, ecommerceDB 2021). Excluded from this definition are digital distributed services, digital media download and streams, dedicated B2B online stores, and online sales between private individuals (Facebook market, Finn, etc.). Figure 3 shows the turnover in the Norwegian e-commerce market from 2012 to 2019.

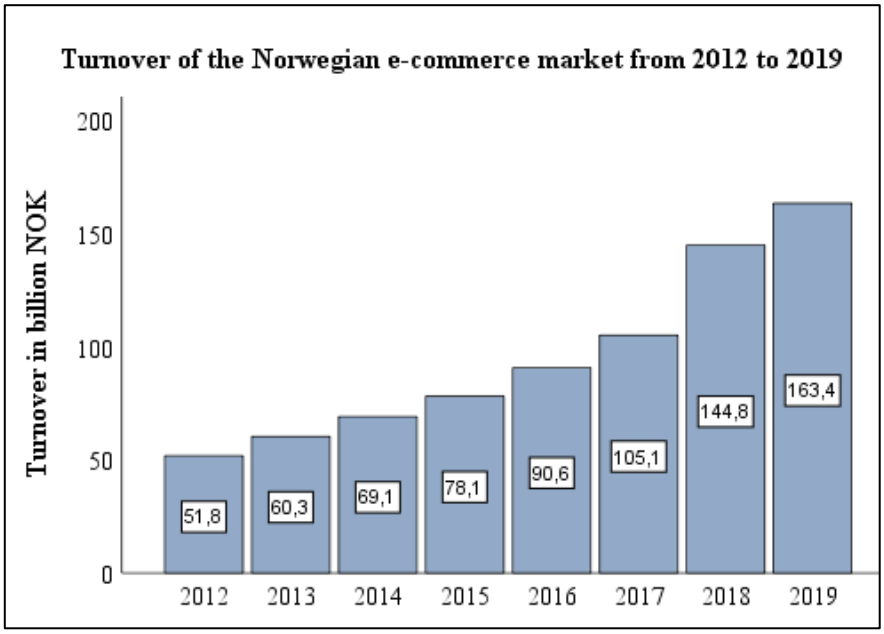

Figure 3: Turnover of the Norwegian e-commerce market from 2012-2019 (Statista 2020)

E-commerce user penetration was 81.3% in 2020 (Edwards 2020) and is expected to hit 85.2% by 2025 (Statista 2020). Most Norwegians shop online as it is perceived a more convenient way of shopping than going to a physical store. Men rather than women shop online, a trend that is expected to remain the same for the next five years. The average online purchase of a consumer is 3-4 times in a month with an average amount of €220 per month. 79% of the population was buying online at least once in 2020 (ecommerceDB 2021). More than 40% of Norwegians make a cross-border purchase with China, UK, US, and Swedish online stores.

Elkjop, Komplett, and Zalando are the biggest players in the e-commerce market in Norway. These three have a combined total of 10% on online revenue in 2020 in Norway.

According to ecommerceDB (2021) as shown in figure 4, fashion is the most significant segment and it accounted for 29% of the e-commerce revenue in 2020. This is followed by electronics and media with 23%, toys, hobby, and DIY with 20%, food and personal care with 17%, furniture, appliances, and others with 12%. With existing and emerging new markets, there is a potential for further development. This development also brings impact in the cities, with more people buying, and more freight circulating.

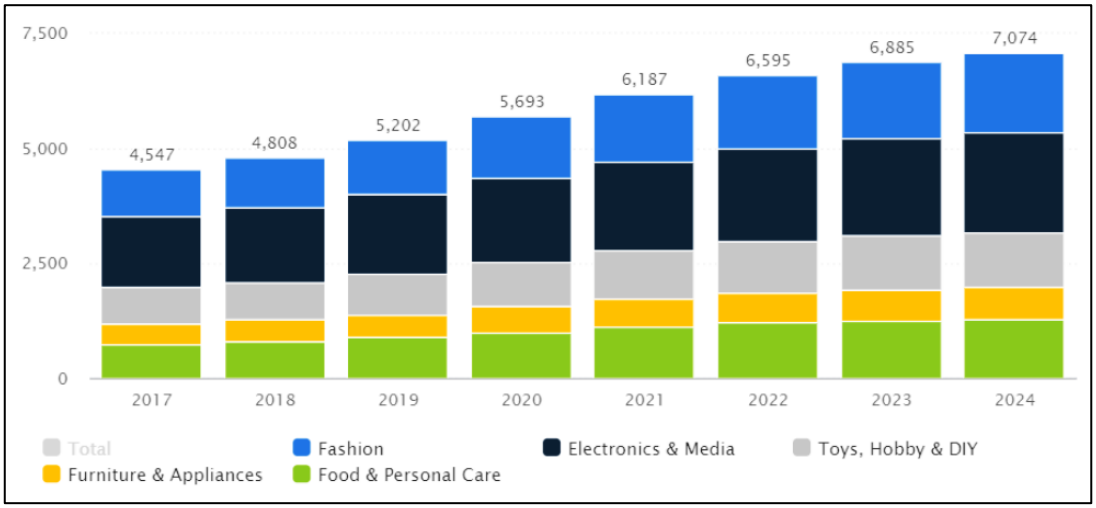

Figure 4: E-commerce revenue (in USD Million) in Norway from 2017-2024 (est.) (Statista 2020)

3.2 Freight traffic at Oslo airport

Increasing urban population results in increase in demand for goods and services that must be distributed in densely populated cities. The total capacity of urban freight continues to increase as urban population increases. This has resulted in difficulties in logistics operations. In Norway, Oslo Airport is the busiest airport and the leading airport in freight handling, with 6410 freight operations in 2019 and 7226 operations in 2020. Figure 5 shows the total freight movement in Oslo airport.

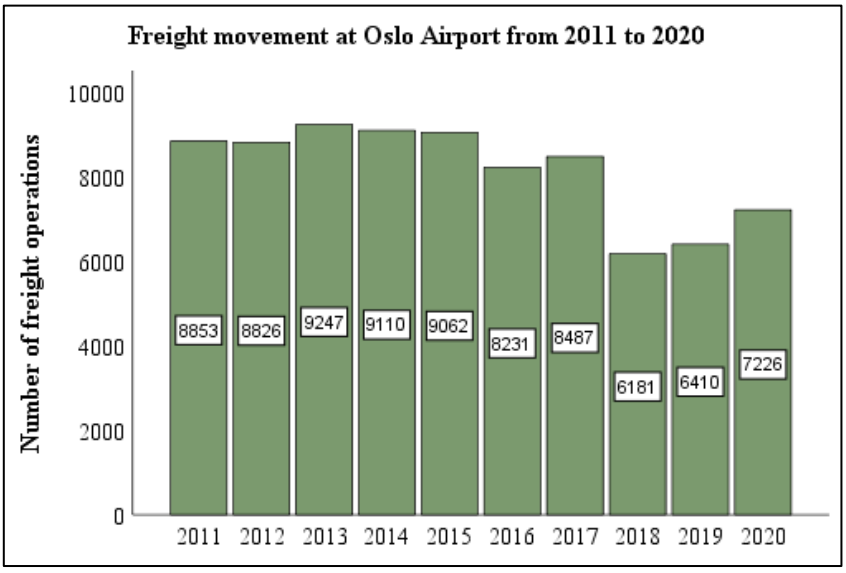

Figure 5: Freight movement at Oslo Airport from 2011 to 2020 (Avinor 2021)

3.3 Public transport in Oslo

More people have been traveling with public transport than by car in Oslo city in recent years. Public transport comprises a network of trains, trams, subway, buses and boats with almost 24 hours travel possibilities within the city of Oslo. The subway and the train move the biggest numbers of travellers within the city, mainly underground. Buses and trams are the main modes of on-the-surface transport, while the boats carry the commuter on sea/fjord.

Due to long-term comprehensive investment and predictable funding, the number of trips made by public transport has increased by 63 percent, from 228 million to 371 million between 2007 and 2017 (Oslo Kommune 2018).

According to Oslo Kommune (2018), public transport does not only offer solutions to challenges of how to ensure efficient accessibility to the population, but also they contribute to the reduction of emissions from the public transport space. By 2028 all public transports in the Oslo metropolitan area must be emission-free as it is seen to be beneficial to public health. Currently, the trams and subway are powered by renewable energy. The electrification of buses and boats is underway. It is expected that by the end of 2021, all ferries serving the inland in the inner Oslo fjord will be electric and all buses running on the Ruter lines will be emission-free by 2028.

With everyday supply and demand on the rise in cities, public transport can be adopted in delivering goods in the cities as it will be cheaper compared to traditional delivery (Galkin et al. 2019).

3.4 The LEAD project

“LEAD” is a thirty-six-month project in ten countries with funding from the European Union Horizon 2020. The project aims to provide low-emission adaptive last-mile logistics supporting *on demand economy* through digital twins. The project has twenty industry partners, six living labs in six cities (Madrid, Oslo, Budapest, Porto, The Hauge, Lyon) with 60+ models.

According to Lead Project EU (2020), the rise of on-demand logistics puts serious strain on last-mile delivery systems and this requires responsive logistics, greener options, agile warehousing and resilience to new technologies. The project will create Digital twins of

urban logistics networks in 6 cities to test and represent different innovative solutions for city logistics to address requirements of on-demand economy.

The objectives and strategies of LEAD are displayed in table 5, while the objectives of digital twins are shown in table 6.

Table 5: Objectives of Lead concepts (Lead Project EU 2021)

Concept	Objectives
Value Cases and Co-Design	To develop a contextual framework to support the design and implementation of cost-effective sustainable integrated city logistics systems, by involving stakeholders in the co-creation of innovative last-mile solutions and services that address the needs of the on-demand economy
Digital Twinning tools	To design and develop a simulation-based assessment environment and a Digital Twin Model for evaluating alternative city logistics strategies, measuring the impact of interventions, and supporting well-informed data-driven decision and policymaking.
Validation in Living Labs	To demonstrate and validate project concepts and tools in six intervention areas (Madrid, The Hague, Lyon, Budapest, Oslo, Porto) with heterogeneous urban, social, and governance conditions and logistics profiles, representative of the European diversity, involving all actors in exploring combinations of different measures toward implementing optimal logistic solutions.
Scale-up	To formulate a Roadmap towards PI-inspired zero-emission city logistic consolidating project experiences from the living Labs, accelerate take-ups of sustainable solutions through stakeholder engagement and capacity building and provide practical guidelines on the use of LEAD tools and Digital Twins in SUMPs (Sustainable Mobile Mobility Plan) and SULPs (Sustainable Urban Logistics Plan) process steps.

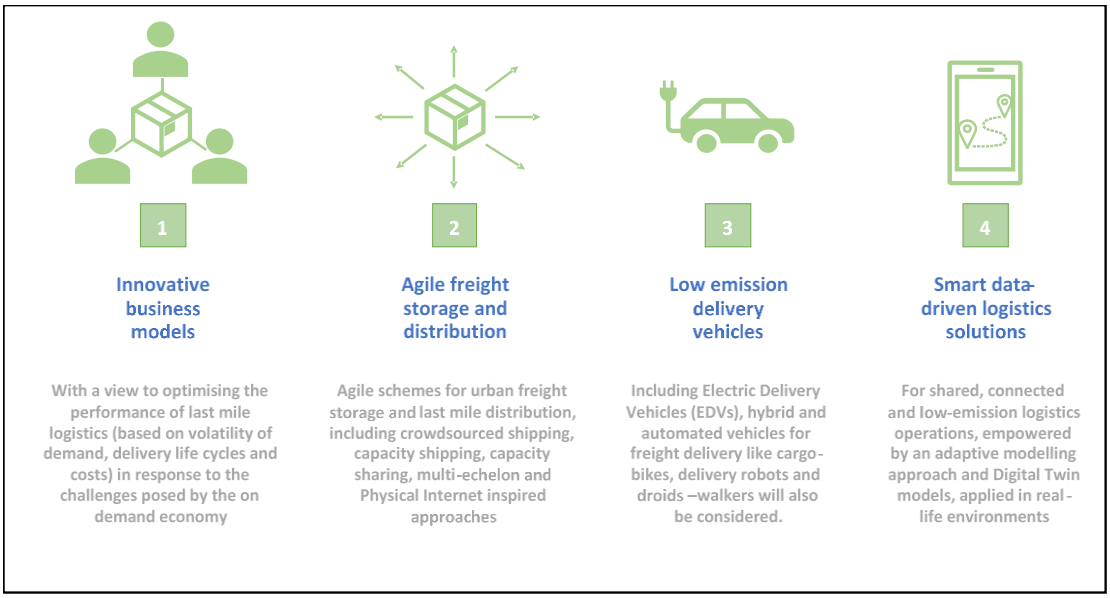

Figure 6: Lead strategies (EU 2021)

Table 6: Objectives of digital twins (Lead Project EU 2021)

Objectives	Description
Efficient Operations	The ultimate objective of introducing Digital Twins in last mile logistics is to improve the operations and efficiency of parcel delivery, reduce costs and externalities through forecasting and prediction of future states and support advanced decision making through the entire logistics lifecycle, while also fostering stakeholder participation via reliable information
Data-driven Decisions	Technology enablers for building Digital Twins include modelling, predictive analytics and decision-making methods, and the use of lifecycle-oriented knowledge with historical and real-time operational and city-data. A Dynamic Data-Driven Application System (DDDAS) will manage the real-time coordination of models and data, interfacing to digital platforms, APIs and sensors and integrating city data in the models.
Co-Design	The Digital Twins will enable the co-design of value cases by suppliers, shippers, policymakers and urban planners, and the development of solutions for the integrated systems of logistics/fright operations in urban, metropolitan, and peri-urban areas, introducing low-emission connected/automated delivery vehicles.

Oslo Living Lab

A Living Lab is an arena for innovation where structural framework, experiences, routines, and conditions are integrated into research and innovation processes within a public and private-people partnership. Feurstein et al. (2008) describe a living lab as an innovative approach in an environment in which all participating agents in a product, service, or application participate directly in the development process.

The Oslo Living Lab concentrates on Business to Consumer, home deliveries representing the most preferred option from a consumer's perspective. It considers establishing its Living Lab at Lysaker with four different scenarios with a predetermined sequence of operators, namely: commuters, Nimber community members (bringers), and regular logistic operators (trade-offs between cost and reliability issues). The following elements will be explored:

- Business models financially viable and beneficial from a social and environmental perspective
- A concept for senders'/bringers'/receiver's preferences for alternative delivery service
- The interplay between demand and relevant supply design of energy-friendly dedicated crowdshipping services
- The role of parcel lockers to enhance delivery/pick up flexibility.
- The economic, financial, and environmental potential for a green dedicated crowdshipping service
- The integration of data modelling with real-market data to support a Digital Twin approach.

3.5 Description of the service

The specific case we are investigating is linked to the 2020 LEAD horizon project. The Norwegian component includes the University of Molde as the research partner, Nimber as the industrial partner, and Oslo Kommune as the public administration.

Nimber's current modus operandi is directly linked to crowdshipping and Nimber has already developed a pilot with Ikea. That is, people buying from Ikea will have the option of getting their goods delivered to their house through Nimber. The LEAD-Nimber project will have a consolidation hub close to a public transport station downtown that will be used by

Nimber in providing crowdshipping service from Ikea to the hub and then from the hub to people's homes. Introducing a hub gives us four basic options.

1. Delivery from the hub with Ikea items to the residence of customers,
2. delivery from the hub with Ikea items plus other boxed items from the hub to the residence of customers,
3. delivery from the hub with Ikea items plus food to the residence of customers,
4. delivery from the hub with Ikea items plus other boxed items plus food to the residence of customers.

In doing so, we are making a hypothesis with respect to different transportation modes that are going to be used. The leg between Ikea and the consolidation hub will be performed using regular vans. Nimber is interested in trying out the use of electric vans. From the consolidation hub, we are interested in looking into the delivery performed by commuters using public transport or their own vehicles which are non-dedicated trips. We would like to find out if this is technically feasible, economically and financially viable.

The company "Nimber"

The platform Nimber was created to match spare capacity with deliveries. The idea is to hire bringers who utilise their spare capacity to solve the challenges of delivery.

From a humble beginning, Nimber has become the first choice of delivery for over 100,000 businesses. Nimber is currently operating in three cities in Europe. London, Greece, and Oslo.

Chapter 4

4. Methodology

This part of the paper describes how we conducted our research. It lays the foundation and is important with regard to the empirical data that was collected. The structure of this chapter is based on Saunders, Lewis, and Thornhill (2015). In their publication, the authors analyse different research methods. Some of those methods are applied in this work.

4.1 Research philosophy

It is important to illustrate the fundamental philosophy used in any research conducted (Saunders, Lewis, and Thornhill 2015). The research onion diagram in figure 7 shows the different philosophies that are adopted in the research. Saunders, Lewis, and Thornhill (2015) display several concepts of how research can be approached. Research is inseparably connected to knowledge. Epistemology addresses the question of when knowledge is acceptable and when it is not. Within epistemology, there come multiple philosophies. They all start with a distinct supposition and lead to a different result. In the following, the four main philosophies (positivism, realism, interpretivism, and pragmatism) adopted in most research are introduced briefly.

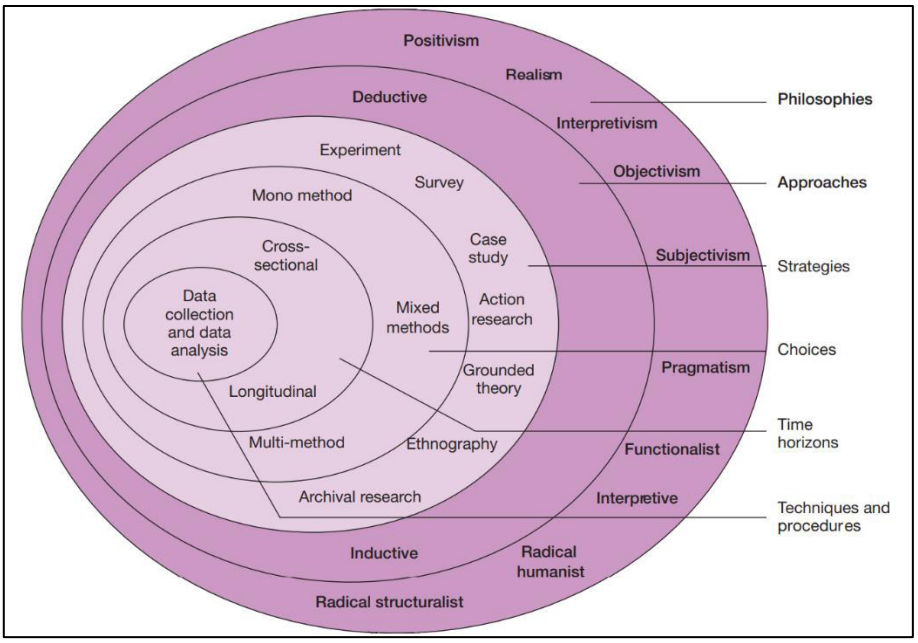

Figure 7: The research 'onion' (Saunders, Lewis, and Thornhill 2015, 132)

1. Positivism is a philosophy characterised by the notion that produced data can only originate from observable phenomena. In general, data is generated using hypotheses that are either accepted or dismissed during the research process.
2. The proposition of Realism is to consider everything truthful that the senses classify as real. In this context, reality is not only detected by the mind, but also through the senses. The concept of Realism is very close to Positivism.
3. Opposed to these approaches is Interpretivism. This theory argues that compared to physical sciences the real world is too complex to be described by definite rules. In this case, the research process is influenced by empathy for the subjects. Interpretivism aims to understand reality from the subjects' point of view.
4. Pragmatism is not committed to a specific philosophy, rather it highlights the importance of the best possible tools to investigate a phenomenon by approaching research from a practical point of view, where the knowledge is constantly questioned and interpreted by being subjective in drawing conclusions based on participants responses and decisions.

Besides these concepts, more philosophies belong to other schools of thought. Ontology is one of these. Instead of questioning the validity of knowledge like epistemology, it questions the nature of reality. Saunders, Lewis, and Thornhill (2015) analyse several aspects of ontology, such as objectivism and subjectivism. In their work, they discuss further philosophies, which are not included here. However, we display an overview of the most important concepts in this next illustration.

The philosophy adopted in this research is positivism; this philosophy is employed because it explains that knowledge can only be acquired through empirical research, which is based on measurement and observations, not reliant on human reasoning but instead knowledge that is gained from research. The results of this research will be based on empirical research; i.e. collecting a sizable amount of primary data for analysis and interpretation.

4.1.1 Approach

The research approach is the broader method to be used for research. According to approaches to research, deduction and induction are the approaches on the second layer of the research onion. It is important to identify the research approach as it will form the basis for data collection and analyses of the data. The deductive approach entails developing a

theory and hypothesis through academic literature and designing a research strategy to test the hypothesis, i.e. starting with a theory and building on it. The inductive approach entails collecting data and developing a theory as a result of analysing the data. It involves generating theories from research rather than starting with a theory as a foundation.

Research approaches are mostly based on research philosophies. Positivism philosophy usually adopts a deductive approach and it is mostly used among researchers with traditional natural scientific views whiles the inductive approach is usually based on interpretivism (Saunders, Lewis, and Thornhill 2015).

For this thesis, we want to find out through stated preference method and experimental design, what conditions are favourable for a member of the crowd to act as a crowdshipper. A deductive approach is the most suitable approach for this thesis as it involves collecting primary data to test the hypothesis of whether the attributes have an impact on the utility.

Robson (2002) lists five stages through which deductive research will progress:

1. Deducing a hypothesis**.**
2. Expressing the hypothesis in operational terms (that is, indicating exactly how the concepts or variables are to be measured), which propose a relationship between two specific concepts or variables.
3. Testing this operational hypothesis.
4. Examining the specific outcome of the inquiry.
5. If necessary, modify the theory in light of the findings.

Using a deductive approach, we made a hypothesis concerning the different transportation modes that are going to be used in finding out if using the crowd to deliver parcels will be technically feasible, economically and financially viable, and environmentally sustainable.

4.1.2 Strategy

The third layer of the research onion is the research strategy. The research strategy describes the methods of research used, with regards to collecting data for the research in question. The strategy is the link between the research philosophy and data collection. The methods for collecting data include archival research, ethnography, grounded theory, action research, case study, survey, and experiment. A deductive approach was used for this research, for this reason, experiment and survey strategy were used for this research.

The experiment strategy was used as it provides the links between the dependent and independent variables and answers the questions how and why. Experiment research involves manipulating one variable to observe a change in another variable. We manipulated the levels using efficient Bayesian design to design different choices and kept the attributes the same to see how it will influence commuters' desire to work as a crowdshipper. This is an unlabelled experiment because the alternatives have no intrinsic value. The independent variables are the attributes and the dependent variables are the choices or preferences.

A survey often results from a deductive approach, this gives researchers a better process of collecting large amounts of data to answer what, who, where, when, and how of any researched topic (Saunders, Lewis, and Thornhill 2015). The first set of data were collected from a pilot study. The data collected from the pilot study were cleaned, using the data to estimate a new model and used the estimated co-efficient as input for the new experimental design and then used the new design to develop a different set of questionnaires for the second wave.

4.1.3 Choices

This layer of the research onion is about deciding how many data types (qualitative and quantitative) should be used in research. There are three options, it can be mono, mixed, or multi-method. A mono method is making use of only one data type – either qualitative or quantitative. The mixed-method is taking both approaches in research, both qualitative and quantitative. Multi-method means making use of two qualitative methods (interviews, focus group) and then additionally make use of one quantitative method (correlation, regression) to analyse the data, or vice versa.

Qualitative research can be ambiguous. The term “qualitative research” is used differently depending on the setting that it is used (Strauss and Corbin 1998). However, some researchers have been able to draw a clear definition of qualitative research. One of the definitions that encompass several other definitions is the one by Denzin, Lincoln and Aspers. Aspers and Corte (2019) and Denzin and Lincoln (2005). They defined qualitative research as follows:

> *Involving the studied use and collection of a variety of empirical materials through a case study, personal experience, introspective, life story, interviews, observation,*

> *historical, interactional, and visual texts – that describe routine and problematic moments and meaning in individual lives.*

Quantitative research is described as "empiricism" by Leach (1990) and "positivism" by Cormack (1991).

> Quantitative methodologies test theory, deductively from existing knowledge, through developing hypothesized relationships and proposed outcomes for study, qualitative researchers are guided by certain ideas, perspectives or hunches regarding the subject to be investigated (Cormack 1991).

From the above definition, it is clear that the quantitative approach is the better approach to use when it involves collecting data from many respondents (Saunders, Lewis, and Thornhill 2015).

For this research, we used a multi-method choice. That is both qualitative and quantitative methods. We used the quantitative research method to analyse and draw meanings from the data collected and we used the qualitative research method (interviews and focus group) in trimming down our list of attributes and setting the levels for the various attributes.

4.2 Data collection

Data is either primary or secondary. Primary data is data that is collected directly from main sources while secondary data is data that has already been collected and made readily available for researchers to use in their work. Hox and Boeije (2005) defined primary and secondary data as displayed below.

> Primary data is data that is collected for a specific research goal, while secondary data is information that was originally collected for a different purpose than the study at hand and reused for another research question.

Both primary and secondary data were utilized in this research. The data collection method used in this study is based on stated preferences.

4.2.1 Primary data

A questionnaire, interviews, and focus group were used as a method for collecting primary data. Interviews and focus groups were used to understand the most relevant attributes that

should be used for the experimental design. Further data were collected for this study using a questionnaire. The data was collected during May 2021, through the publication of a structured questionnaire and administered online. The administration was carried out largely through publishing the questionnaire in student and employee groups, notices on student campuses and student hostels. A third part of the investigation was carried out “face to face” on student campuses, student hostels, train and tram stops, and bus stations. The “face to face” was done by asking the respondents to scan a bar code that gives them the link to answer the questionnaire online.

Pilot survey

A pilot study is a test version of the main questionnaire, this is done to reveal a likely problem that could be faced when the main questionnaire is administered (Hassan, Schattner, and Mazza 2006). Research is not considered good research if it is not piloted. Saunders, Lewis, and Thornhill (2015) maintained that a pilot study helps researchers to know the validity and reliability of the data to be collected.

For this research, an experimental design was used in designing the questionnaire. The questionnaire was first piloted and disseminated to 30 individuals. This was done to ascertain which attributes and levels are important when commuters act as crowdshippers. Data collected from the questionnaire was cleaned, new coefficients estimated, new choices were developed and used to develop a new set of questionnaires.

Questionnaire

It is easy to collect large samples of data using questionnaires as each respondent answers the same set of questions. For this questionnaire, all questions were the same except for the choices. According to Saunders, Lewis, and Thornhill (2015) as shown in figure 8, there are three types of questionnaires, namely self-completed, interview completed, or a mixture of both.

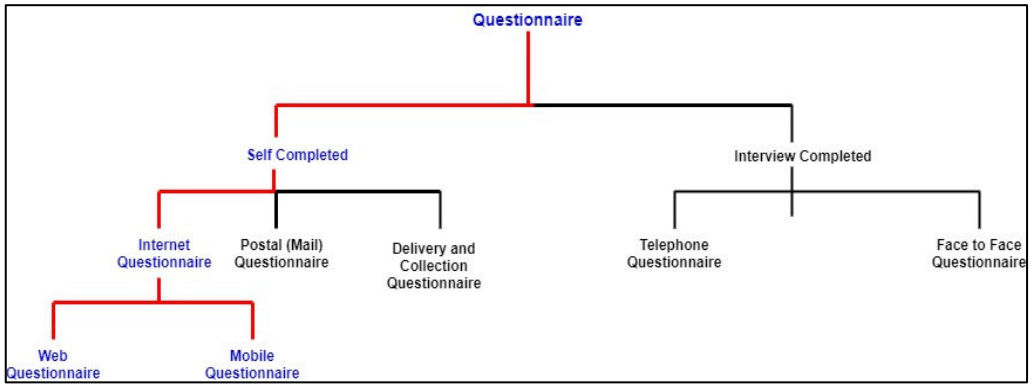

Figure 8: Questionnaire types (Saunders, Lewis, and Thornhill 2015)

Due to Covid-19, we used a self-completed type of questionnaire which was administered online using Nettskjema. Nettskjema is an online platform used for developing and distributing questionnaires. The platform easily exports data into Excel files to avoid mistakes in transferring data.

The questionnaire consists of five blocks: 1) pre-interview questions, 2) stated preference choice sets, 3) environmental consciousness questions (sustainability), 4) post-interview questions, and 5) sociodemographic and socioeconomic questions.

4.2.2 Secondary data

The secondary data for this research was obtained from other research papers on literature, books, journals, articles, government reports, statistics reports, and conference proceedings. Reliable websites were also used as a source of reference for this research. The attributes for this research work were all obtained from secondary data.

4.3 Data analysis

Quantitative data in its raw form gives very little meaning to most people, to give meaning to raw data, it must be analysed to critically answer the research question (Saunders, Lewis, and Thornhill 2015).

For this research, to analyse and understand the data, we used IBM SPSS. SPSS is a tool with advanced statistical procedures used to analyse and understand complex data sets to ensure high accuracy and quality decision making.

4.3.1 Stated preference analysis

Stated preference surveys are important tools that help in forecasting decisions, suggesting to respondents questions about their possible choices in hypothetical situations given a specific set of conditions created thanks to experimental design. (Petrik, e Silva, and Moura 2016, Gatta et al. 2019)

The level of distinctiveness of the alternatives is nothing more than the representation of goods or services that differ from each other (Gatta et al. 2019). Alternatives are offered to individuals, and they are asked to express their choices by declaring their preferences. According to Gatta et al. (2019), there are three systems for expressing your preferences: sorting the alternatives (ranking), assigning value to the various alternatives (rating), or simply choosing the preferred alternative (choice).

Stated preference technique was used in collecting data for this thesis by submitting hypothetical alternatives of choice to individuals. After getting the attributes and levels from the literature and reducing it through interviews and focus group discussion, an experimental design was used to generate 18 choice situations. Each choice situation has three alternatives: option A, option B, and neither one nor the other.

4.3.2 Experimental design

The aim of generating an experimental design is to help construct a stated choice experiment. Ngene (2018) points out:

> An experimental design may be viewed as a set of matrix values that are used to determine what goes where in a stated choice survey, where the values that populate the matrix represent the attribute levels that will be used in the stated choice survey, whereas the columns and rows of the matrix represent the choice situations, attributes, and alternatives of the experiment.

An experimental design describes which hypothetical choice situations the respondents are faced with in the stated choice experiment, therefore the experimental design chosen by a researcher or an analyst may play a significant role in stated choice studies (Ngene 2018). According to Ngene's user manual and reference guide, creating a stated choice experiment requires taking three main steps.

1. A complete model specification with all parameters estimated must be determined.
2. An experimental design must be selected and the design can be generated.
3. A questionnaire is then created based on the underlying experimental design.

To specify the model specification, one needs to address the following choices: which alternative needs to be included and which attributes to include for each alternative. For this thesis, we included all attributes for each alternative because the alternatives have generic parameters, which are unlabelled (option A and option B).

It is important to know and understand that there are many experimental designs available. The aim is to select the one that fits our case best. Before the selection process, some design decisions need to be made (Ngene 2018). These include:

- Should the design be labelled or unlabelled?
- Should the design be attribute level balanced?
- How many attribute levels are used?
- What are the attribute level ranges?
- What type of design to be used?
- How many choice situations to use?

Several design types can be considered. Full factorial or fractional factorial are the two most common types used. For a practical study, the number of choice situations for a full factorial design is too large, so we opted for a fractional factorial design as it consists of choice situations from a full factional design selected in a structured manner. It is also faster and cheaper to run.

The most well know fractional factorial design is orthogonal design, but more recently several researchers have suggested efficient designs as it aims to find designs that are statistically as efficient "as possible in terms of predicted standard errors of the parameter estimates" (Ngene 2018). Efficient designs will be able to outperform the orthogonal designs as long as prior parameters are estimated (Ngene 2018). The efficient design was used in generating the choices for our questionnaire, specifically Bayesian efficient designs, which are further described in the next chapters.

4.3.3 Discrete choice modelling

Microeconomic consumer theory considers the individual demand of a consumer to be characterised by the maximisation of the utility function. Traditionally, these functions are constructed with *continuous* decision variables. Selecting fractional quantities is, however, not at all realistic. Hence, researchers started investigating a discrete choice model (Wrigley 1982).

The setup of a discrete choice model allows researchers to accurately determine the respondents' preferences. In this context, "discrete" means that the choices are binary. The respondents can decide between predefined options. Every option is expressed by multiple attributes. An attribute is a factor that influences the respondent's decision process. Attributes, in turn, have a certain number of characteristics also known as levels.

Cantillo and Ortúzar (2006) point out, that respondents are expected to select the option that maximises their net utility. Depicted in equation (1) is the utility function (U_{jq}) that results from this. It includes the possibility that information collected by the researcher is not complete. Besides a systematic part (V_{jq}), this function also contains a random part (ε_{jq}), ensuring that unobserved characteristics are covered as well.

$$U_{jq} = V_{jq} + \varepsilon_{jq} \tag{1}$$

i/j: alternative q: individual

When confronted with two alternatives, Cantillo and Ortúzar (2006) expect the individual to select based on the value of U_{jq}. If it is higher than U_{iq} (utility function for another alternative), it is assumed that the individual selects the alternative with the higher utility value. On this note, Kitamura (1990) made an interesting observation. Choice processes are complex in their structure. Not only can they be dynamic, but they can be perceived and assessed differently depending on the individual.

The challenge that derives is formulating models that take this into account. What distinguishes a model from reality is that the former does not cover the whole truth. A model rather simplifies the truth. One essential trait of a good model is that it is easy to understand and at the same time covers a sufficient part of the truth. A method that is regularly used to ensure this is an orthogonal design.

4.3.4 Orthogonal design

As opposed to a full factorial design, implementing an orthogonal design does not require the consideration of *every* choice situation. In the case of five attributes (5), four with three and one with two levels (3, 3, 3, 2, 3), and two alternatives (2) as displayed in table 7, a full factorial design would produce $(3 \times 3 \times 3 \times 2 \times 3)^2 = 162$ combinations. With even more attributes or more levels, this number increases exponentially. If one respondent were asked to answer 162 or more choice situations, they would quickly discontinue. Therefore, a full factorial design is only useful in a situation where there are few attributes and levels (Ngene 2018).

Table 7: Alternatives, attributes, and levels

	Alternative 1	Alternative 2
Attribute 1	Level 1 Level 2 Level 3	Level 1 Level 2 Level 3
Attribute 2	Level 1 Level 2 Level 3	Level 1 Level 2 Level 3
Attribute 3	Level 1 Level 2 Level 3	Level 1 Level 2 Level 3
Attribute 4	Level 1 Level 2	Level 1 Level 2
Attribute 5	Level 1 Level 2 Level 3	Level 1 Level 2 Level 3

Orthogonal design falls into the category of fractional factorial designs. The respondent is required to only answer a subset of choice situations. To avoid biased selection of the choice situations adequate for the subset, orthogonal designs do not select randomly, but rather use a methodical approach. For a design to be orthogonal, it needs to achieve an attribute level balance, and all parameters must be independently estimable. This is true when the levels of an attribute are uncorrelated. Mathematically, this translates into the following expression.

$$\sum_{s=1}^{S} x_{j_1 k_1 s} \times x_{j_2 k_2 s} = 0 \qquad (2)$$

$\forall (j_1 k_1) \neq (j_2 k_2)$ j: alternative k: attribute

Equation (2) defines that the sum of the inner product of any two attribute columns is zero. To clarify, we depict an example of an orthogonal design in table 8. In the said example there are four choice situations (S), three attributes (A, B, C) with two levels each (-1, 1). Taking A and B, we see that the sum of the inner product equals zero (Ngene 2018).

Table 8: Orthogonal design (Ngene 2018, 60)

s	A		B	C
1	-1	×	-1	-1
2	-1	×	1	1
3	1	×	-1	1
4	1	×	1	-1
		$\sum = 0$		

In the case that single attributes are removed, orthogonality is preserved. Solely if a *choice situation* is cut out, the levels are no longer uncorrelated. Say we erase choice situation 4. Then, the sum would not be zero, indicating a non-orthogonal design.

As this subchapter explained, orthogonal designs result in fewer choice situations than full factorial designs. Nonetheless, for a large experimental design, it can still add up to a high number of choice situations. Considering a respondent prefers to spend as little time as possible on answering a survey, orthogonal design introduces a technique called “blocking”. This method divides the design into several smaller designs. Orthogonality is not achieved by one block itself, but by the combination of all blocks. If there were nine choice situations in total, a reasonable blocking strategy would be to split the choice situations in three blocks, with three choice situations each. Instead of nine, a single respondent only has to answer three scenarios (Ngene 2018).

4.3.5 Efficient design

An efficient design is a variation of an orthogonal design. Besides having the least possible correlation between levels, efficient designs additionally aim to create parameter estimates with a minimised standard error. This is possible with the help of the asymptotic variance-covariance (AVC) matrix. The roots of the diagonal of this matrix are the asymptotic standard errors. However, the only way to attain the AVC matrix is if the parameters are known. Generally, such information is not available since finding out the parameters is exactly the objective of a choice experiment. In the occasion that such data is at hand, it usually comes in the literature or as part of a pilot study (Ngene 2018).

There exist several ways how to generate an efficient design. Sándor and Wedel (2001) propose the use of a Bayesian approach. This implies that a design is tested multiple times based on the estimated parameters, which were defined *a priori*. The resulting efficiency of the design comes as the expected value of the respective measure of efficiency. A Bayesian approach is always implemented by running simulations. This method approximates expected values for differing designs as well.

The Bayesian approach is mostly used in D-optimal efficient designs. D-optimal signifies the fact that it maximises the determinant of the AVC matrix. The D-optimal design needs to be generated with the help of an algorithm. A software that is appropriate for constructing such a design is Ngene. Applying such a design benefits the experiment because it allows the researchers to measure the effect that each attribute has on total utility (Burgess and Street 2005, Ngene 2018).

When deciding whether to choose orthogonal design or efficient design for a research approach, a few factors come into play. When any information about the parameters is known, an efficient design is regularly performing better than an orthogonal design. The possibility to adjust parameters leads to an optimised design. It maximises the information that is gathered from the choice situations (Ngene 2018).

4.4 Forming the choice experiment

The first step when surveying respondents with choice experiments is to examine the literature for adequate attributes. Attributes in the field of crowdshipping generally belong to two different categories.

1. The demand side: The factors that influence the decisions of consumers of crowdshipping services.
2. The supply side: The factors that influence the people who offer crowdshipping services.

We identified thirteen attributes on the supply side, and seven on the demand side. Table 9 below displays the list of attributes in the early stages of our work.

Table 9: Demand attribute review

	Literature
Shipping fee The price that customers are willing to pay for delivery of their items.	Punel, Ermagun, and Stathopoulos (2018), Gatta et al. (2019)
Delivery lead time The time that it takes from ordering the delivery to receiving it.	Punel, Ermagun, and Stathopoulos (2018), Gatta et al. (2019), Marcucci et al. (2017)
Tracking services Customers may want to locate their parcel at any given time. Reasons include insurance and safety issues in case a parcel goes missing.	Punel, Ermagun, and Stathopoulos (2018), Gatta et al. (2019)
Safety With high value items customers may want to be protected in case of missed deliveries, if their product is broken, or when personal data is infringed.	Marcucci et al. (2017)
Additional Services The needs of customers can be more complex than just delivery. Additional services such as installation of delivered devices might provide extra value to customers.	Frehe, Mehmann, and Teuteberg (2017, 15-16)
Transport Modes Customers may have preferences regarding the type of vehicle the parcel is delivered with. This is traceable to environmental or safety concerns of customers.	Frehe, Mehmann, and Teuteberg (2017, 17)
Bringer's expertise Some customers might only be comfortable with professional or semi-professional bringers being responsible for delivering their parcel.	Ermagun and Stathopoulos (2018), Marcucci et al. (2017)

For the choice experiment to contain only the most relevant attributes we condensed the original list. One-on-one interviews and focus groups helped us in detecting which attributes to eliminate. To integrate the crowdshipping industry into the process, we communicated with Oslo-based crowdshipping company "Nimber" for their preferences with regards to the attributes. The attributes that remain are x_1: Shipping fee, x_2: Delivery lead time, and x_3: Tracking services. Equally if not more important is the list of attributes collected for the supply side. These attributes are depicted in table 10 below.

Table 10: Supply attribute review

	Literature
Frequency of remuneration The frequency that bringers are willing to be paid in. Per single delivery, per 10 deliveries, weekly, etc.	Nguyen et al. (2019)
Remuneration The price that bringers are willing to accept for their services.	Gatta et al. (2019), Ermagun and Stathopoulos (2018)
Delivery assignment How is the delivery assigned?	Gatta et al. (2019)
Time of delivery The time when a parcel is delivered.	Nguyen et al. (2019)
Distance Distance between origin and destination.	Punel, Ermagun, and Stathopoulos (2018)
Estimated delivery time The time that a bringer is willing to spend for delivery. For commuters it is the time for detour from their normal route.	Devari, Nikolaev, and He (2017)
Hub location The hub is located at an accessible point for bringers.	Gatta et al. (2019), Ermagun and Stathopoulos (2018), Marcucci et al. (2017)
Services What services bringers are willing to offer.	Frehe, Mehmann, and Teuteberg (2017, 15-16)
Parcel value The value of the parcel that a bringer is willing and able to transport.	Kin et al. (2018)
Parcel size The size of the parcel that a bringer is willing and able to transport.	Kin et al. (2018), Ermagun and Stathopoulos (2018)
Parcel weight The weight of the parcel that a bringer is willing and able to transport.	Kin et al. (2018)
Working days Which days of the week will a bringer offer delivery services?	Nguyen et al. (2019)
Transport modes Bringers may have preferences regarding the type of vehicle they want to deliver the parcel with. This is traceable to their environmental or safety concerns.	Frehe, Mehmann, and Teuteberg (2017, 17)

The attributes on the supply side undergo the same procedure as the attributes on the demand side. The result is a list that involves x_1: Remuneration, x_2: Time of delivery, x_3: Frequency of remuneration, x_4: Delivery assignment, and x_5: Distance. After determining the attributes for supply and demand, we realised that the choice experiment would become too complex for one survey alone. Therefore, the focus in this work is solely on the supply side. The levels, which represent the attributes' characteristics, need to be set in the following. They are essential when conducting a choice experiment. The research for levels is performed by deriving data and information from various industry-related sources. Eventually, we conclude two levels for the attribute x_4: Delivery assignment, whereas the remaining attributes are assigned with three levels each.

4.4.1 Design put into effect

When formulating a design, the number of attributes and levels is one factor in the scale of a design. Another factor is whether a full factorial design or a fractional factorial design is applied. As described in chapter 4.4.4, a full factorial design would produce an excessive amount of choice situations considering the number of attributes and levels that we have; unrealistic for one respondent to complete. After testing several designs in the Ngene software, we opted for an efficient design with three choice situations per respondent.

Specifically, the design relies on the Bayesian approach and is performed under conditions of a D-optimal design. This specific set fits our case especially since the objective of this work is to find out to which extent certain attributes influence the behaviour of the target group.

The Bayesian method is suitable for working with a multinomial logit model. Parameters are estimated using the maximum likelihood function. According to Koppelman and Bhat (2006) the maximum likelihood estimation procedure involves two steps:

1. development of a common probability density function of the observed sample, known as the probability function, and
2. estimating parameter values that maximise the probability function.

The likelihood function for a sample of "Q" people with "J" alternatives is defined in equation 3:

(3)

$$L(\beta) = \prod_{\forall q \in Q} \prod_{\forall j \in J} \left(Prob_{jq}(\beta)\right)^{\delta_{jq}}$$

δ_{jq}: If chosen by the individual (=1), if not (=0)

$Prob_{jq}$: Probability that individual q chooses alternative j

To find out the parameter values that maximise the likelihood function, we commonly determine the first derivative of the likelihood function and set it to zero. Differentiating the log of a function brings the same result and proves to be easier to calculate in this case. Consequently, the log-likelihood is maximised instead of the likelihood function itself.

4.4.2 Construction of the pilot survey

In this subchapter, we explain how the pilot survey was approached. We start with the attributes' levels, which undergo close observation regarding their difference in utility. Even without prior knowledge, for some levels, it is clear they have a positive or negative impact on total utility. To illustrate this issue, this next table 11 shows the attributes and levels of the supply side equipped with their utility expectations.

Table 11: Supply attributes and levels

Attributes	Levels	Utility expectation
Remuneration (kr)	150 250 350	Positive
Time (hrs)	Morning (07:00-12:00) Afternoon (12:01-17:00) Evening (17:01-22:00)	Neutral
Frequency (number)	Single delivery Per 5 deliveries Per 10 deliveries	Negative
Delivery assignment	Company Self-select	Positive
Distance (km)	0-5 5.1-10 10.1-20	Negative

At this point, attributes and levels are substituted with numerical values. This facilitates the transfer of data in Ngene as well as in Excel. To maximise the number of people that respond to our questionnaire we used the "blocking" technique (see chapter 4.3.4). With as complex

situations as we designed, the choice situations in each block were set to three. There are six blocks, that is 18 choice situations in total.

4.4.3 Analysing validity and reliability

Whether data is valid and reliable is an important aspect to examine. Heale and Twycross (2015) refer to this as the "rigour" with which the researcher aims to gather data. Rigour in this context can be understood as a measure to enhance the quality of research. The authors further define the concept of validity. It is seen as "the extent to which a concept is accurately measured in a quantitative study."

The survey included in our work intends to discover the preferences of people that provide crowdshipping services. The utility connected to single attributes and overall utility plays an important part in the search for respondents' preferences. Our goal is to measure the trade-off between the attributes by confronting the participants with choice situations. The types of validity that have to be considered, according to Heale and Twycross (2015), are:

1. Content validity
2. Construct validity
3. Criterion validity

Content validity looks at the instrument that is used, in our case the survey. It further seeks to find out if the instrument covers the ground that it should be based on the variable that was set beforehand. A tool that allows researchers to find out whether their studies are valid or not is *face validity*. This requires the gathering of first-hand information through communicating with people competent in the respective field of study. Their opinion concerning the quality of the instrument has a high significance. In our survey, this was achieved by conducting one-on-one interviews with people working in the transport industry, and by hosting focus groups where potential respondents would have discussions about details in the survey, before proposing improvements.

On the other hand, there is construct validity. Heale and Twycross (2015) define this concept as "whether you can draw inferences about test scores related to the concept being studied." One way of determining a project's construct validity is by assessing its convergence. When the instrument in use shows similarities with other instruments, this convergence displays

construct validity. Our experimental design follows Gatta et al. (2019), which has a similar topic, where only the attributes and levels vary from our work.

Third, we look at criterion validity, which expands the concept of construct validity. It describes the extent to which the instrument correlates with other instruments. A prominent way to attain this data is by computing the correlation between the attributes.

Furthermore, data must be reliable. Heale and Twycross (2015) define reliability as the "consistency of a measure." If an individual participant were to answer the same questionnaire multiple times, in each iteration the answers should be approximately the same. Reliability cannot be calculated exactly. Generally, however, it can be estimated relying on the following attributes in table 12.

Table 12: Attributes of reliability (Heale and Twycross 2015, 67)

Attributes	Description
Homogeneity (or internal consistency)	The extent to which all the items on a scale measure one construct
Stability	The consistency of results using an instrument with repeated testing
Equivalence	Consistency among responses of multiple users of an instrument, or among alternate forms of an instrument

4.5 Econometrics

It is known from previous chapters that this work depends on disaggregating behavioural patterns. The behaviour of individuals is viewed through the lens of hypothetical choice situations. Then, utility is used to predict the behaviour of other individuals. Since we work with utility functions and behavioural patterns, certain assumptions on the questioned individuals must be made.

1. The respondent acts and answers rationally and is always looking to maximise their utility.
2. Alternatives available to respondents differ from one another. Not every respondent has access to all alternatives.

3. The respondent can assign their own customised utility to each alternative that they are presented with. Based on this utility they make their choice.
4. Total utility is derived from a set of attributes, each having a distinct impact on total utility.
5. Utility can be measured in quantitative terms. It relies on the attributes that are selected and is calculated using a scalar, expressed by a mathematical function (Louviere, Hensher, and Swait 2000).

If the following utility inequality is met, individual q will select alternative j. The statement $\bar{A}(q) = \{A_1, \dots, A_j, \dots, A_M\}$ depicts the choice set that a participant q faces. The superset of participants is expressed by Q with $q \in Q$, while the total number of alternatives is $\bar{A}$ with $\bar{A}(q) \in \bar{A}$.

$$U_{qj} \geq U_{qi} \qquad (4)$$

$$\forall i \mid A_i \in \bar{A}(q) \qquad i \neq j$$

Equation (4) should not distract from the fact that utility is not a deterministic value. Utility certainly and primarily affects the decision process. However, each of us as individuals has preferences that are not based on utility. This is the reason why human behaviour is not entirely rational. Utility is hence regarded as a stochastic or random variable, and it is approached based on random utility models (Tversky 1972).

Partially revising our previous assumption, a respondent will not always give the same answer if they were to repeatedly answer a questionnaire. All the while respondents might have the same sociodemographic characteristics but still, answer differently. Furthermore, the utility cannot be reproduced in a model. It will always only show a part of the truth. Factors that influence the decision of a respondent most likely have an element that is not covered in the developed survey (Manski and McFadden 1981).

Consequently, we can solely make statements on the probability of individuals' behaviour. This issue is depicted by equation (5).

$$Prob_{qi} = prob\left(U_{qj} \geq U_{qi}\right)$$

$$\forall i \mid A_i \in \bar{A}(q) \qquad i \neq j$$

(5)

As discussed, it is not possible to cover individual behaviour by utility alone. Therefore, we introduce another component. As a result, the two components that constitute utility are a systematic component V_{qj} and an additive component ε_{qj}. The systematic component represents the attributes, alternatives, and characteristics of the individual respondent. The additive component identifies the variables that cannot be observed with the attributes at hand. Mathematically, this can be illustrated as follows in equation ((6)

$$U_{qj} = V_{qj} + \varepsilon_{qj} \quad (5)$$

Equation (7) shows that the systematic component or systematic utility consists of the vector of measurable attributes X_{qj}, and the vector of unknown parameters β, or the weight that the attributes have on total utility. The value of β can be positive or negative. Either the attribute has positive or negative impact on utility.

$$V_{qj} = f(X_{qj}, \beta) \quad (7)$$

All of this is incorporated in our discrete choice model, which in our case additionally required the use of multinomial logit (MNL) models as well as mixed logit (ML) models.

4.5.1 The multinomial logit model

Whether a discrete choice model is an MNL model or not mainly depends on the assumptions that are made about the additive component. According to Koppelman and Bhat (2006) the assumptions that lead to the MNL model are:

1. Additive components are extreme-value (Gumbel) distributed
2. Additive components are allocated across alternatives in an independent and identical fashion.
3. Additive components are allocated across observations in an independent and identical fashion.

Koppelman and Bhat (2006) further point out that these three assumptions when combined make the foundation of the MNL model. This model is designed to give each alternative a choice probability as part of the systematic component of the utility function. Choosing an alternative $i(i = 1,2, \dots, J)$ is commonly expressed as displayed in equation (8).

(8)

$$Prob(i) = \frac{exp(V_i)}{\sum_{j=1}^{J} exp(V_j)}$$

$Prob(i)$: probability of decisionmaker choosing alternative i

V_j: systematic component of utility of alternative j

What becomes apparent is that the MNL model is depicted with exponential functions in this equation. The following figure 9 shows how $exp(V_i)$ is always positive, and how it constantly increases with V_i.

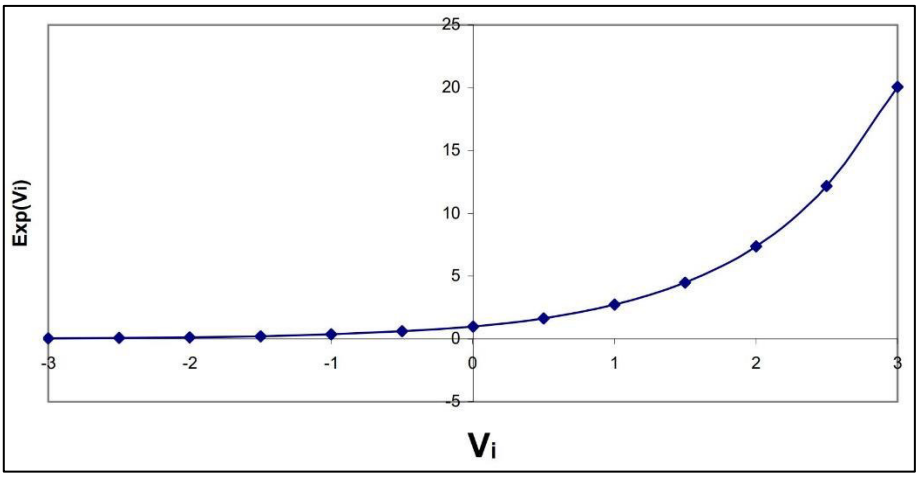

Figure 9: Relationship between $exp(V_i)$ and V_i (Koppelman and Bhat 2006, 29)

Now we start introducing alternatives. The next equation shows that as soon as one alternative is selected, the systematic utility of this alternative increases. It decreases when the systematic utility of the other alternatives increases. This issue is depicted by equation (9). i represents the alternative that has been selected and is under observation.

$$Prob(i) = \frac{exp(V_i)}{exp(V_1) + exp(V_2) + exp(V_3)} \qquad (9)$$

If $exp(V_i)$ increases, the overall probability increases. If $exp(V_1)$, $exp(V_2)$, or $exp(V_3)$ increases the overall probability goes down. Further important properties of the MNL model include its sigmoid or S shape, as well as the fact that the volatility in systematic utility influences the choice probabilities.

4.5.2 Model estimation

The development of the logit model is performed by defining model requirements. In addition, numerical values of the parameters must be estimated for every attribute. This is achieved by adjusting the MNL model in such a way that it matches the observed choice data. The key elements of this process are selected based on some statistical measures (Koppelman and Bhat 2006).

The MNL model above can be used to create a stated choice experiment. In this next expression, the attribute levels are represented by x, the sequence of choice situations S, and the respondent q. The vector of choices made by each respondent can be denoted as $y_q \in R^{SJ}$. If the respondent selects alternative j in choice situation s, $y_q = 1$, if not $y_q = 0$. With these results, the parameters β can be estimated. More specifically, they are estimated through maximising the log-likelihood function, which is depicted in equation (10) (Bliemer and Rose 2013).

$$\ell_Q(\beta|X_Q, Y_Q) = Y'_Q \log Prob_Q(X_Q|\beta) \tag{10}$$

$$X_Q = \begin{pmatrix} x_1 \\ \vdots \\ x_Q \end{pmatrix} \qquad Y_Q = \begin{pmatrix} y_1 \\ \vdots \\ y_Q \end{pmatrix} \qquad Prob_Q = \begin{pmatrix} Prob_1 \\ \vdots \\ Prob_Q \end{pmatrix}$$

As for the experimental design, Bliemer and Rose (2013) state that it is helpful to generate a matrix of attribute levels. Based on their depiction, equation (11) shows this issue. This matrix of attribute levels is the experimental design for one respondent q. In addition to previous variables, there are K attribute values.

$$x_q = \begin{pmatrix} & & & \\ x_{q111} & x_{q112} & \cdots & x_{q11K} \\ \vdots & \vdots & \vdots & \vdots \\ x_{q1J1} & x_{q1J2} & \cdots & x_{q1JK} \\ x_{q211} & x_{q212} & \cdots & x_{q21K} \\ \vdots & \vdots & \vdots & \vdots \\ x_{q2J1} & x_{q2J2} & \cdots & x_{q2JK} \\ \vdots & \vdots & \vdots & \vdots \\ x_{qSJ1} & x_{qSJ2} & \cdots & x_{qSJK} \end{pmatrix} \tag{11}$$

For generating the complete design, we are strongly oriented towards the work of Bliemer and Rose (2013, 147-148). They provide a clear guide on how to estimate parameters and how to use them in the experimental design.

Chapter 5

5. Findings

To obtain data, we developed a questionnaire or a series of questions that are directed towards individuals to gather information from them. The eventual product is a survey, which is both the questionnaire and the method used in collecting and analysing the data. A survey is a tool that facilitates interaction between the researcher and the target respondents.

A survey, therefore, allows for observations to be standardised so that every part of the questionnaire is the same for each respondent besides being easy to compare. A survey can be carried out in several forms: face to face, via telephone, online, and/or by mail. Due to how COVID-19 has drastically changed the nature of social interaction, the questionnaire was administered online to avoid unnecessary human interaction.

The questionnaire is divided into five parts. Each question in each part is well explained using simple words that are easy for every respondent to understand and work through. The questionnaire follows a chronological order. Each step of the questionnaire was supervised and approved by the thesis supervisor. Before the final approval and piloting of the questionnaire, a presentation was made to industry experts in transport economics for their input and contribution towards the design of the questionnaire. Their contributions were thoroughly discussed in the meeting together with the supervisor and necessary corrections were made to the questionnaire.

The questionnaire is designed neatly, having only a few questions on one page, in order not to overburden a respondent. The questionnaire is precise so it can be answered within 5-7 minutes. Very sensitive and personal questions like income were placed in the last part of the questionnaire. This is done so the respondents will not be put off at the initial stage of the questionnaire or to avoid a high rate of unfinished questionnaires.

The first page of the questionnaire introduces respondents to the questionnaire and explains the purpose and significance of the questionnaire. The first part of the questionnaire has pre-interview questions. An initial question of whether a respondent lives in or commutes to Oslo is asked to filter for only eligible respondents. We only want data from these groups of people as the case study is a case currently been piloted by Nimber in the city of Oslo. This pre-interview entails respondent days of travel to Oslo, the purpose of this trip, what time of the day do they travel to Oslo and return, what modes of transport do they usually use, and

respondents' prior knowledge of crowd shipping. These questions are asked as they will give the case company valuable information on how to tailor the service they offer.

The second part investigates attributes that affect people's desire or willingness to act as a crowdshipper using choice scenarios.

The third part consists of Likert questions, which investigate the behaviour of respondents regarding sustainability. This is important as it provides information as to whether a respondent is likely to act as a crowdshipper or not. We expect a sustainability proponent to be more likely to participate in crowdshipping.

The fourth part is post-interview questions. Attributes that were eliminated during interviews and focus group discussions but considered necessary are asked as post-interview questions. It entails questions about the size and weight of parcels crowdshippers are willing to carry, the maximum length of detour crowdshippers are willing to make when delivering a parcel, the services they are willing to offer as crowdshippers, and which days of the week crowdshippers are willing to work.

The final part of the questionnaire is socio-demographic/economic questions such as gender, age, educational level, occupational status, and annual income.

Data limitations

The sample size for the survey was random, small, and asymmetric for statistical measurement. The sample size lopsided towards a youthful population, students, commuters who frequently use public transport. Even though the results give an interesting finding, a more refined sample structure that represents or cuts across the entire populace in Oslo city will provide a better result.

5.1 Descriptive statistics

This section contains descriptive statistics of the data obtained from the survey. The survey had 27 valid responses for each block, giving a total of 162 interviews. Two respondents do not live in or commute to Oslo. For this reason, no data was received from them.

5.1.1 Occurrence of most frequent trips

Figure 10 shows that 87% of the respondents travel frequently during weekdays and 13% travel frequently during weekends or on holidays.

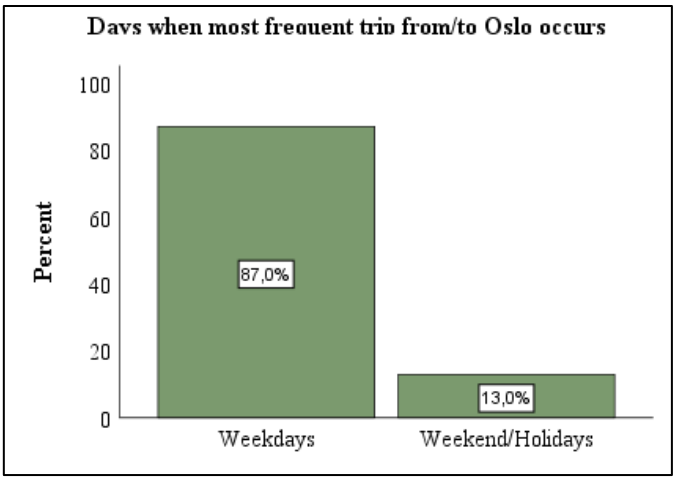

Figure 10: Days when most frequent trip from/to Oslo occurs

5.1.2 Purpose of trip

The respondents were further asked what the main motivation for their trips is, or the main motivation for traveling. Figure 11 shows that sixty-three and six-tenths percent (63.6%) take trips purposely for work, 26.5% take trips purposely for study, 3.1% take the trip for shopping and 6.8% take the trip purposely for leisure activities.

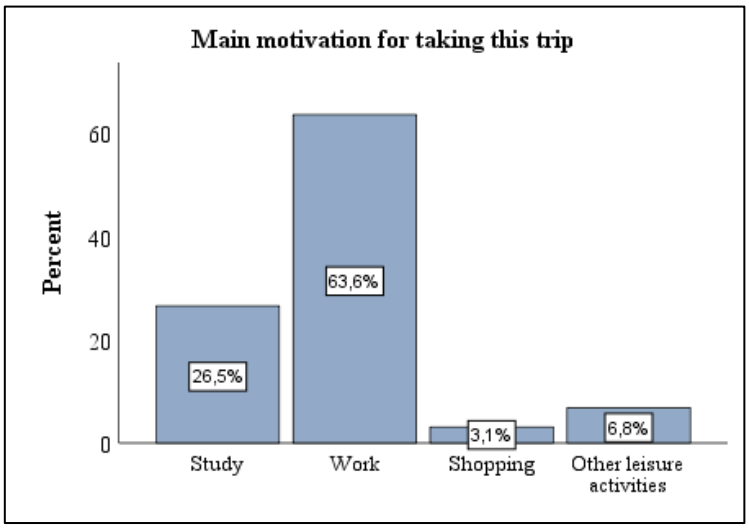

Figure 11: Main motivation for taking this trip

5.1.3 Usual trip time

Respondents were further asked what the usual time of their outbound and return trip is.

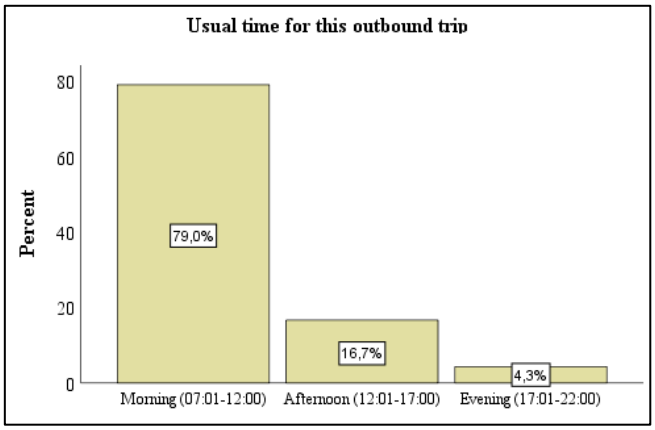

Figure 12: Usual time for this outbound trip

Figure 12 shows that 79% of respondents usually take their outbound trip in the morning, 16.9% in the afternoon, and 4.3% in the evening.

Figure 13 depicts the time of respondents' return trips. Three and seven-tenths percent (3.7%) of them take their return trip in the morning, 53.1% in the afternoon, 29% in the evening, and 14.2% in the night.

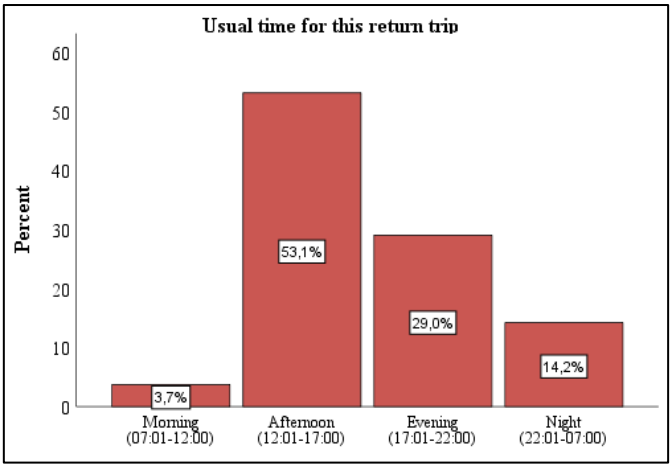

Figure 13: Usual time for this return trip

5.1.4 Trip duration

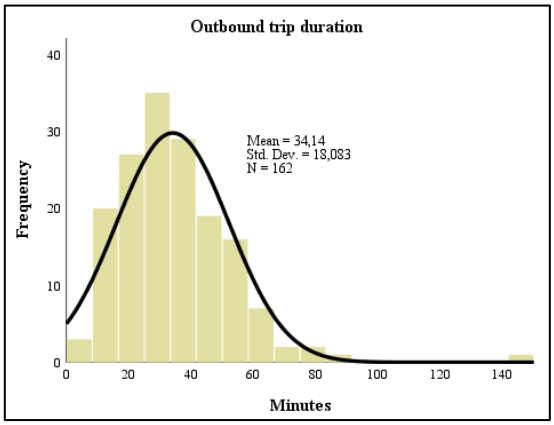

Figure 14: Outbound trip duration

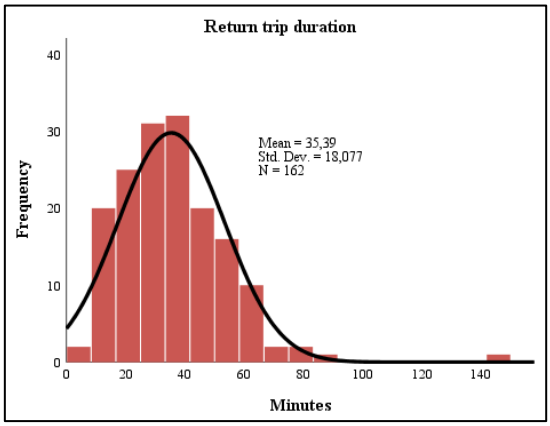

Figure 15: Return trip duration

As can be seen in figures 14 and 15, the average trip time of respondents' outbound trips is 34.14 minutes and 35.39 minutes for return trips. The minimum travel time for both outbound and return trips is 1 minute and the maximum travel time is 145 minutes (2hr:25m).

5.1.5 Crowdshipping awareness

From figure 16, 116 of the respondents, representing 71.6% of the total respondents have not heard of crowdshipping. This also means they have neither used a crowdshipping service or ever worked as a crowdshipper before answering the questionnaire. Only 46, representing 28.4% have heard of crowdshipping before answering the questionnaire.

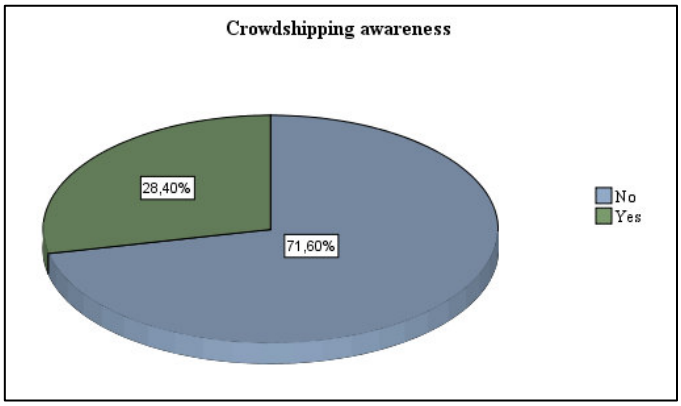

Figure 16: Crowdshipping awareness

5.1.6 Worked as a crowdshipper in the past

Figure 17 shows how many respondents have ever worked as a crowdshipper. After explaining crowdshipping, respondents are asked if they have ever worked as a

crowdshipper. One hundred and forty-three (143), representing 88.3% have never worked as crowdshippers, 14 of the respondents, representing 8.6% have offered a crowdshipping service in the past and 5, representing 3.1% are unsure whether they have ever worked as a crowdshipper.

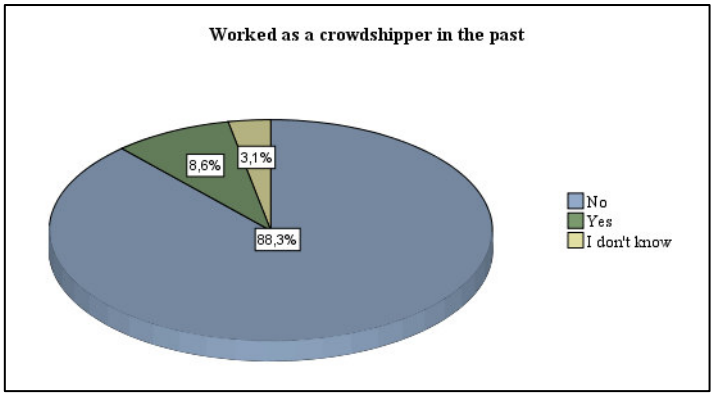

Figure 17: Worked as a crowdshipper in the past

As displayed in table 13, only five (5) out of the 14 respondents who have ever worked as a crowdshipper worked with or for Nimber[1], one (1) worked with or for TravelPost, and eight (8) worked for or with other crowdshipping companies. Notable among the other crowdshipping companies is Posten.

Table 13: Crowdshipping companies that respondents have worked for

	Frequency	Percent	Cumulative percent
Nimber	5	35.8	35.8
TravelPost	1	7.1	42.9
Other	8	57.1	100.0
Total	14	100.0	

5.1.7 Work as a crowdshipper in the future

The respondents were asked if they would consider working as crowdshippers in the future. Figure 18 depicts the answers to this question. Sixty-four (64) of the respondents, representing 39.5% said they would consider working as a crowdshipper in the future, with 24, representing 14.8% saying they would not want to work as crowdshippers in the future.

[1] Nimber is the case company

Seventy-four (74), representing 45.7% are undecided as to whether they would consider working as crowdshipper in the future.

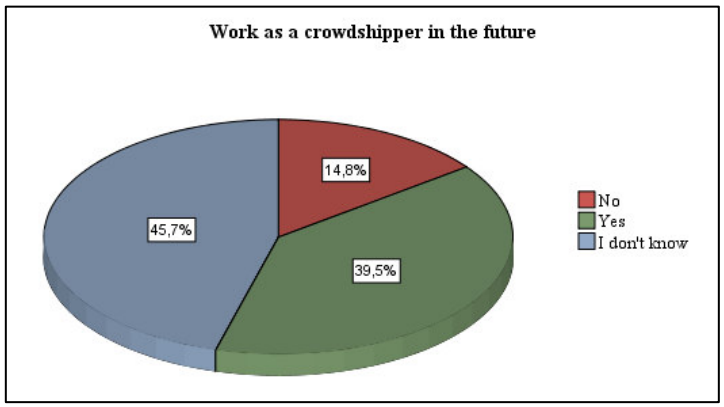

Figure 18: Work as a crowdshipper in the future

5.1.8 Maximum length of detour

Next, the respondents are asked to again think of the trip that they take most frequently. Firstly, we want to know the detour that respondents would be willing to take. Suppose their usual route goes from home to work and back. The detour describes the deviation from this original route. This question is asked to have an idea about the area in Oslo that could be covered by a crowdshipping system.

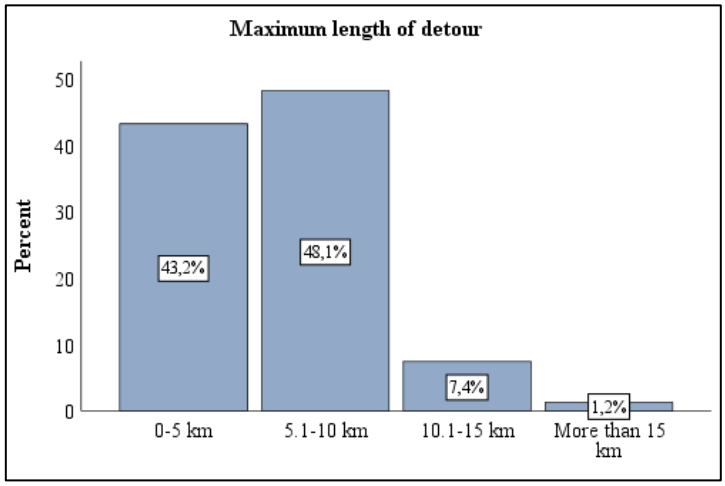

Figure 19: Maximum length of detour

Figure 19 shows that 48.1% of respondents would deliver a parcel on a detour that is 5.1 to 10 km long. Most people, in fact, more than 90%, would take a detour from their original route that is not longer than 10 km. While short deviations are well covered, detours of more

than 10 km are represented with less than 10%, indicating that customers that are close to people's most frequently taken routes can be supplied with a much higher probability.

5.1.9 Case experiment: Delivery options

The next question closely revolves around the specific case that we are examining. In this case, the plan is to place a hub or consolidation centre in Lysaker, a part of the greater Oslo area. Respondents are asked whether they would prefer delivering 1) Ikea items, 2) Ikea items + other boxed items, 3) Ikea items + food, or 4) Ikea items + other items + food. In figure 20 we display where the hub would be situated.

Figure 20: Lysaker hub (Google 2021)

This hub location was selected, amongst other reasons, because the Ikea Slependen subsidiary is based in the vicinity. Ikea plays an important part in the LEAD project that the reader can learn more about in chapter 3.6. The intention behind this question is to gain insight into the preferences of the respondents with regards to the services they are willing to offer and the items they are willing to deliver.

We display the answer to this issue in figure 21. The option that people mostly selected is the delivery with Ikea items + food. Closely behind there is the delivery with Ikea items only, and the delivery with Ikea items and other boxed items. Way behind is the fourth option: Only 7.4% are willing to deliver Ikea items, other boxed items, and food.

This answering pattern is most likely a result of the multitude of services a potential crowdshipper would have to provide. It shows that this option overexerts most respondents. Many are not inclined to offer three services at once.

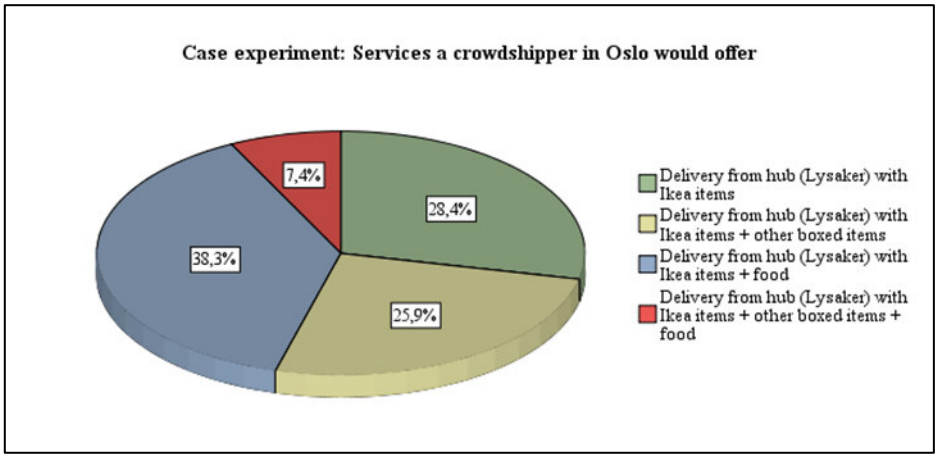

Figure 21: Case experiment: Services a crowdshipper in Oslo would offer

5.1.10 Influence of parcel size

In addition, the survey participant is requested to state whether they see the size of a parcel as a reason to act or not act as a crowdshipper. This information is insofar relevant as it will help us in understanding which market segments can be addressed. As expected, displayed in figure 22, most people see parcel size indeed as a factor that influences their desire to work as a crowdshipper. Only about 12% of respondents would deliver a parcel independent of its size.

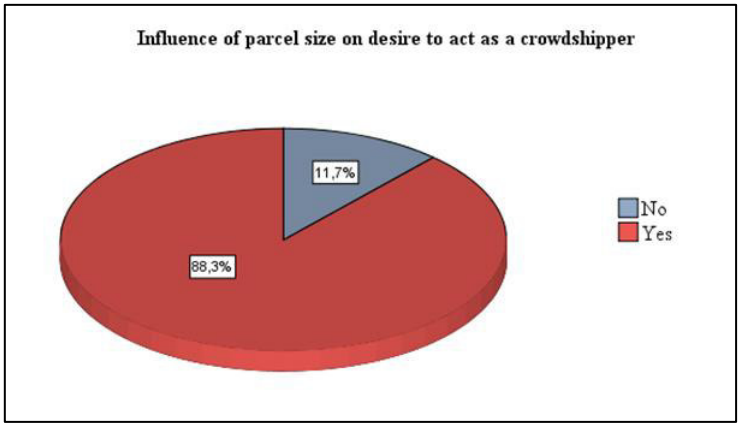

Figure 22: Influence of parcel size on desire to act as a crowdshipper

Following up, the respondents that answered affirmatively were asked to state the maximum size a parcel may have. As depicted in figure 23, the majority opts for small- or medium-sized items. 48.8% of respondents would only deliver small parcels. 35.2% can picture themselves delivering medium-sized parcels. People that fall into these categories

presumably lack the means of transportation where medium- or large-sized items can be stored. Consequently, just 3.7% of respondents would consider the delivery of large parcels.

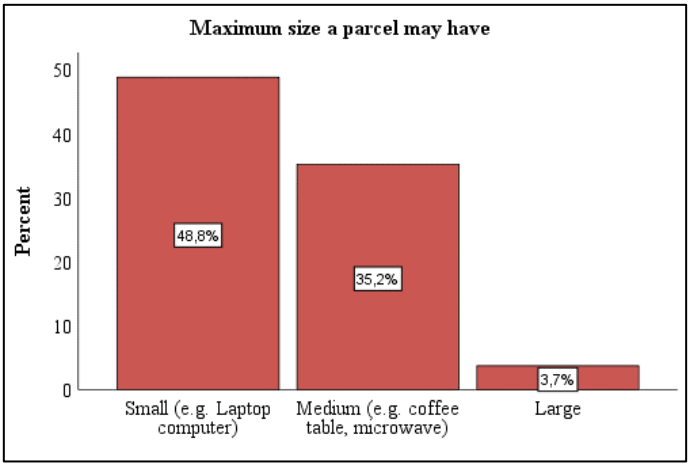

Figure 23: Maximum size a parcel may have

5.1.11 Influence of parcel weight

The same question was asked with regards to the weight of a parcel. This question serves a similar purpose as investigating the maximum size that a parcel may have. It distinguishes the type of product that can be supplied in a crowdshipping system. The answers on this, displayed in figure 24, clarify that people are influenced by the weight of a parcel comparably to the size of a parcel. 87% of respondents selected "Yes" as an answer, thereby expressing their desire to deliver a parcel very much depends on its weight. On the other side, 13% of people indicate that the weight of a parcel is not an issue.

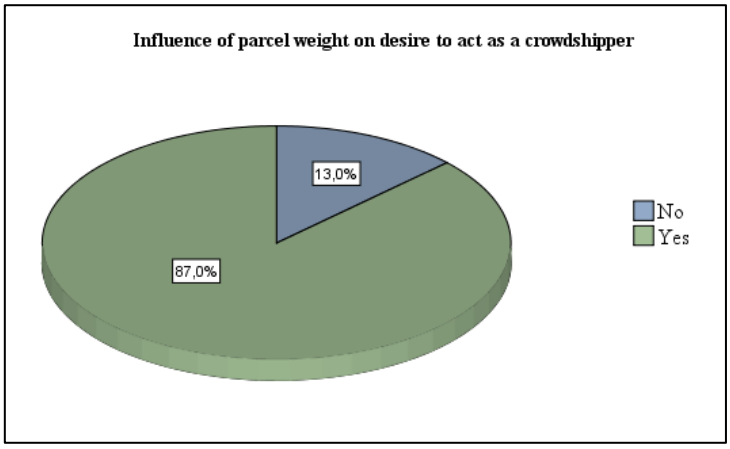

Figure 24: Influence of parcel weight on desire to act as a crowdshipper

Those 87% of respondents that said “Yes” we asked to specify which weight a parcel may have for them to still perform the delivery. As can be observed in figure 25, 42.6%, and thereby most people, choose to only deliver parcels with a weight up to 5 kg. Still, there are 25.3% of people who would consider the transport of parcels with a weight of 5.1 to 15 kg. When a parcel weighs between 15.1 and 30 kg, there are about 18% who are ready to deliver it. The category “more than 30 kg” was selected by only 1.2%.

We perceive a clear downward trend in willingness to deliver parcels when the weight increases. This is most likely due to the respondents’ vehicle of choice. If, for example, a crowdshipper were to deliver parcels with a bicycle, the weight of the parcel would have to be as light as possible since more weight aggravates the delivery exponentially.

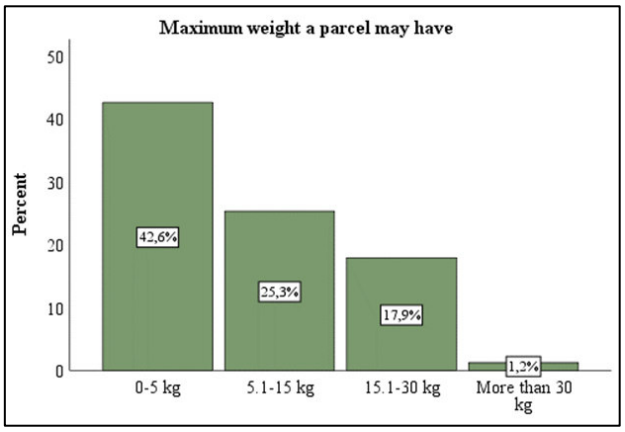

Figure 25: Maximum weight a parcel may have

5.1.12 Workdays as a crowdshipper

To determine whether a crowdshipping service in Oslo would have bottlenecks on the weekends or during the week, the next question is directed toward the respondents’ preferences regarding the days they would wish to work. Figure 26 illustrates the answers to this question, which are relatively balanced. The number that stands out to a small degree is the number of people that choose “Weekend only”. Only 24.1% would exclusively work on the weekend. However, an unexpectedly high number of respondents are eager to act as a crowdshipper on seven days of the week.

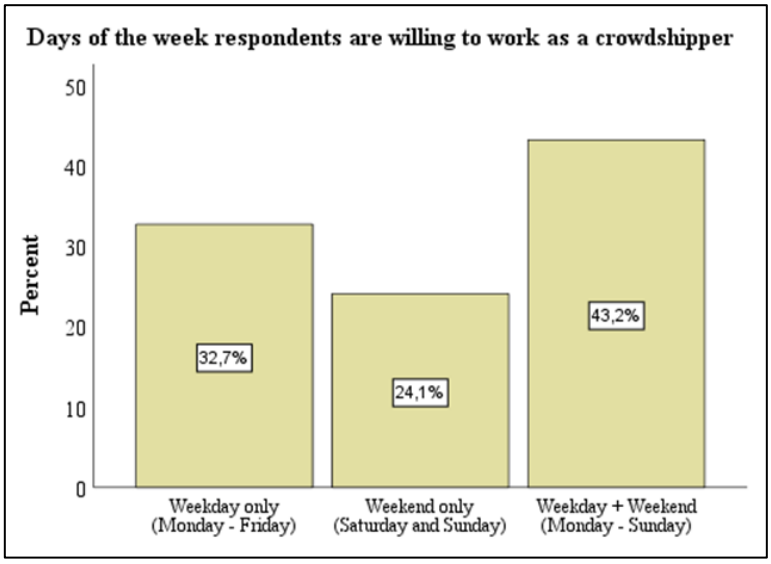

Figure 26: Days of the week respondents are willing to work as a crowdshipper

5.1.13 Environmental consciousness

The following figures 27 to 30 display the respondents' attitudes towards environmental issues. Participants in the survey were requested to, on a scale from 1 to 6, give their approval or disapproval to four statements: 1) I sign petitions for environmental protection, 2) I prefer to use less polluting means of transport than cars, 3) I purchase sustainable eco-friendly products and cars, and 4) I think it is a good idea to use sharing services (car sharing, Airbnb, …).

Respondents are presented with these statements through ordinal Likert scales. As suggested by Nemoto and Beglar (2014) we use 6-point scales, which allow increased measurement precision. Moreover, a 6-point scale does not have a neutral or middle category. According to Nemoto and Beglar (2014), this is beneficial because neutral categories do not match the continuum of a scale. They not only cause statistical problems, but they also tend to confuse the respondent. The scale points in our questionnaire are labelled from 1: Incorrect to 6: Correct.

Analysing the answers to our Likert scale, we quickly see a pattern emerge. The mean for all four statements ranges between 4.15 and 4.65, indicating that respondents are overall endorsing behaviour that is oriented towards environmental friendliness.

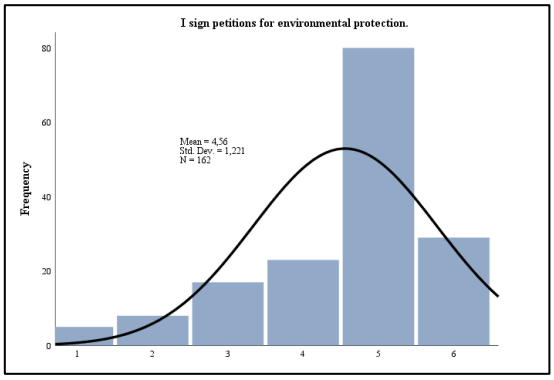

Figure 27: Willingness to sign petitions for environmental protection

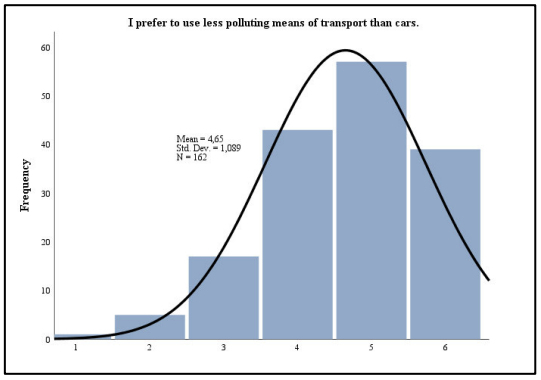

Figure 28: Preferences concerning polluting means of transport

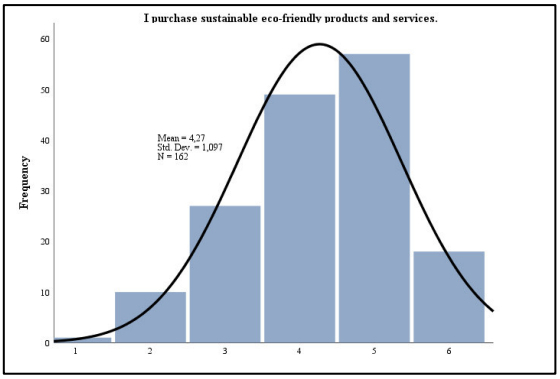

Figure 29: Purchasing behaviour regarding eco-friendly products

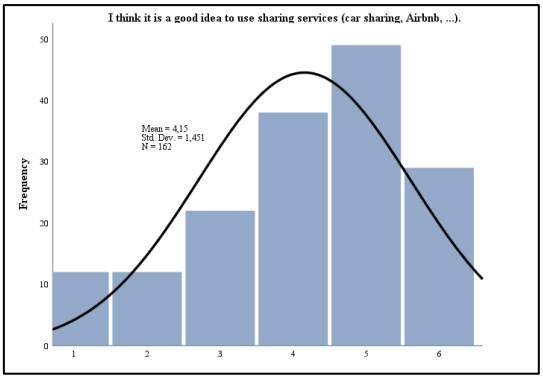

Figure 30: Attitude towards sharing services

5.1.14 Sociodemographic data

The sample consists of 97 men, representing 59.9%, and 65 women, representing 40.1%, as illustrated in figure 31. In figure 32, we show that 92% are between the ages of 18 to 45, which is vastly youth. Six and two-tenths percent (6.2%) are within the age of 46 to 55, the remaining 1.8% are above 55 years.

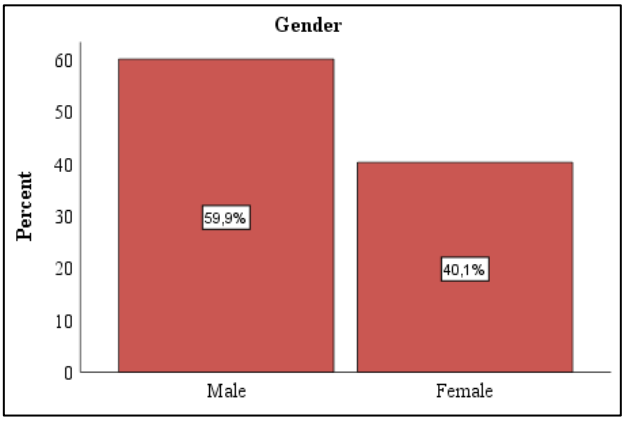

Figure 31: Gender

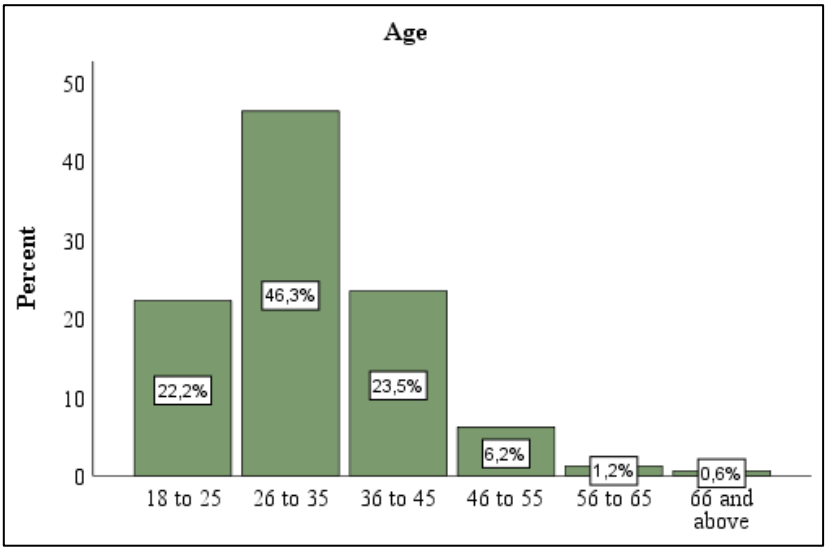

Figure 32: Age

5.1.15 Educational level

The respondents' educational level is depicted in figure 33. Sixty-nine (69) out of 163 respondents are undergraduate's degree holders, representing 42.6%. Postgraduate degree holders follow closely with 56, representing 34.6%. High school students represent 19.1% of the total respondents. Five (5) are Ph.D. holders and 1 as other, both representing 3.7%.

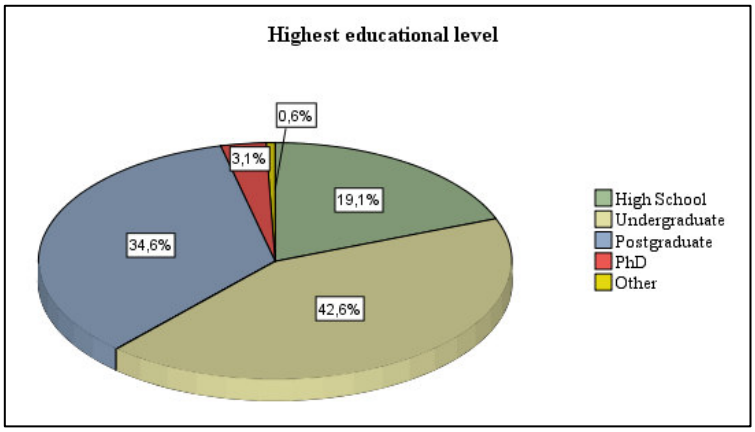

Figure 33: Highest educational level

5.1.16 Occupational status

Sixty and one-tenth percent (61%) of the respondents are either employed full-time (55.6%) or employed part-time (10.5%). Twenty-three of the respondents are students and 31 are students with part-time employment, representing 14.2 % and 19.1% respectively. One of

the respondents is a retiree. None of the respondents is unemployed, that is why it is not recorded in the occupational status number. This is displayed in figure 34.

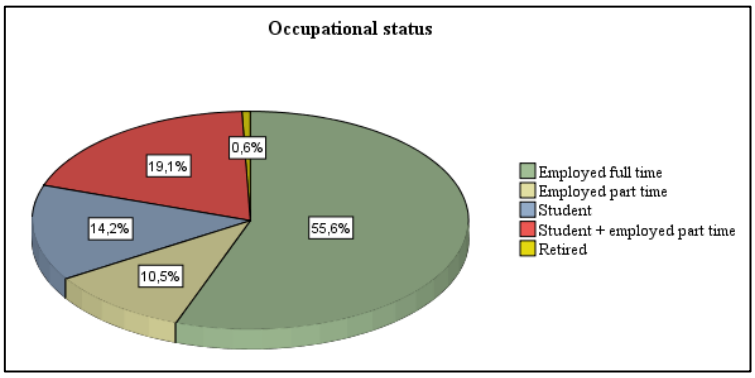

Figure 34: Occupational status

5.1.17 Annual income

Eventually, we want to portray people's income in figure 35. Seventy-six and five-tenths percent (76.5%) of correspondents earn between 60,000 NOK and 600, 000. Approximately 5% earn less than 60,000 NOK. Eight percent (8%) earn between 600,001 NOK and 800,000 NOK. Three of the respondents, representing 1.9% of the respondents earn more than 800,000 NOK. Fourteen (14) of the respondents did not disclose the income level. Disclosure of the income level is a sensitive question, for this reason, we did not make it a compulsory question for respondents.

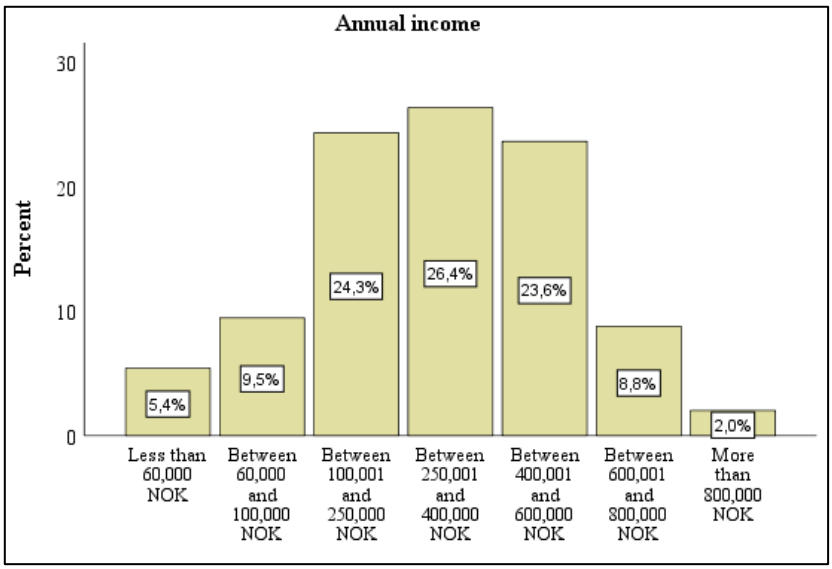

Figure 35: Annual income

The income level of respondents correlates with the age of respondents. The value of 0.345 represents a moderate positive correlation, meaning older respondents earn more, but this effect is moderate. With a standard alpha of 0.01, table 14 shows a 2-tailed significance value of 0.000, meaning that the correlation is highly significant.

Table 14: Age and annual income correlation

		Age	Annual income
Age	Pearson correlation	1	0.395**
	Significance (2-tailed)		0.000
	N	162	162
Annual income	Pearson correlation	0.395**	1
	Significance (2-tailed)	0.000	
	N	162	162
**. Correlation is significant at the 0.01 level (2-tailed).			

5.2 Results from choice experiments

This section presents and explains the results and the models for the estimates. The results were obtained by considering all attributes and levels. The estimation also considered the socio-demographic/economic and aptitude variables as this could influence a respondent in their choices. Considering these other variables in the estimation enhanced the results.

Nlogit software package was used in the estimation process, based on the maximum likelihood function.

The first estimation considered only the attributes and levels in the scenarios To have a balanced result, the estimate was done with the same number of responses for each of the 6 blocks. Twenty- seven (27) responses for each block, giving a total of 162 responses.

The second estimation introduced the sociodemographic and aptitude variables (desire to work as a crowdshipper in the future, gender, occupation, annual income, and interest in environmental issues) since these variables were not present in the experimental design.

Presentation of results

In estimating the coefficients of the model, the model structure considered three alternatives: “option A”, “Option B” and “NO Choice”. Options A and B serve as the unlabelled alternatives and NO choice as the third option represents individuals who do not prefer either option. The utility functions used in estimating the model are displayed in equation (12):

$$
\begin{aligned}
Utility_{Option\ A} &= \beta_0 + \beta_1 \times remuneration_A + \beta_2 \times delivery\ time_A \\
&\quad + \beta_3 \times payment\ frequency_A + \beta_4 \times delivery\ assignment_A \\
&\quad + \beta_5 \times delivery\ distance_A \\
\\
Utility_{Option\ B} &= \beta_0 + \beta_1 \times remuneration_B + \beta_2 \times delivery\ time_B \\
&\quad + \beta_3 \times payment\ frequency_B + \beta_4 \times delivery\ assignment_B \\
&\quad + \beta_5 \times delivery\ distance_B \\
\\
&Where\ \beta_0\ is\ crowd = alternative\ specific\ constant
\end{aligned}
\tag{12}
$$

5.2.1 Presentation of overall results

In table 15 we display the results of the estimated models with the complete sample. The attributes Remuneration, Time Level 1 (L1), Frequency, Delivery assignment, Distance Level 1 (L1), and Alternative specific constant (ASC) are significant either at the 1%, 5%, or 10% level. Looking at the value of the coefficients, we observe to which extent a respondent's utility is influenced by a specific attribute.

Table 15: Choice model results

Choice	Coefficient	Standard Error	Z value	Probability |z|>Z*
Remuneration	0.00817***	0.00088	9.32	0.0000
Time L1	-0.20895**	0.09348	-2.24	0.0254
Time L2	-0.00756	0.10566	-0.07	0.9430
Frequency	0.00309*	0.00188	1.65	0.0992
Delivery assignment	-0.23229*	0.13003	-1.79	0.0740
Distance L1	0.29663***	0.10456	2.84	0.0046
Distance L2	0.00811	0.09207	0.09	0.9298
ASC	1.13471***	0.33539	3.38	0.0007
***, **, * ==> Significance at 1%, 5%, 10% level.				

Output	Value
Number of Observations	486
Skipped observations	0
Estimation observation	486
Log likelihood	-404.58867

The above table 15 shows the model for the overall sample considering all five attributes. The total number of observations for the model is 486, all 486 were in the estimation, none of them were skipped because the software considered all of them as fit for use.

Remuneration, delivery in the morning, frequency of payment, delivery assignment, short delivery distance are all significant, meaning they have an impact on the independent variable (choice).

From table 15, we can see that remuneration has a positive sign and is statistically robust at 1% significance. The expectation or assumption is that with higher pay, people are more likely to work as crowdshippers, therefore the coefficient will have a positive sign. This means an increase in payment for delivery will increase the utility of a crowdshipper by 0.00817.

When it comes to delivery time, the assumption is that people are more likely to work in the evening than in the morning and afternoon. Because of time constraints in the morning, there is a higher chance of someone not likely to work in the morning. So, the expectation is that the coefficient of morning and afternoon delivery will have a negative sign. Morning has a negative sign and is statistically robust at 5% significance. The same cannot be said of afternoon delivery. Even though afternoon delivery has a negative sign which is expected, it is not statistically robust, meaning we cannot reject the assumption that the value is zero. This means afternoon delivery is not relevant for our comparison. Therefore, we compare the morning delivery, which is statistically robust, to evening delivery and can confirm that people prefer evening delivery to morning delivery because morning delivery has a negative coefficient.

The coefficient of frequency of payment is positive and statistically robust at 10%, which means people will prefer if payment is more frequent. The assumption is that people will prefer a single delivery payment to payments for 5 and 10 deliveries.

The assumption with delivery assignment is that people will prefer selecting deliveries by themselves to the company assigning them deliveries or being told which deliveries to perform. With the negative coefficient, it proves that the assumption of people rather not wanting the company to assign them deliveries is true. If the company assigns deliveries to people, it will reduce their utility by -0.23229.

From table 15, the coefficients for distance show that short-distance delivery is the most important attribute with a positive coefficient of 0.29663 and it is statistically robust at 1% significance. Meaning a short distance increases a respondent's desire to work as a

crowdshipper and increases their utility by 0.29663. The medium distance also has a positive coefficient but has no stars, which indicates that it is not statistically robust, so we cannot reject the assumption that it is zero. Hence, medium distance delivery is not relevant for our comparison, so we compare short-distance delivery to long-distance delivery. What this means is that given respondents act rationally they are more willing to accept a short-distance delivery than long-distance delivery. With a positive alternative specific constant of 1.13471 which is statistically robust at 1%, this means, with everything else being equal, people will rather not work as crowdshippers under the conditions presented. Additional attributes are required to describe people's willingness to participate in a crowdshipping service.

To give a good explanation of how specific socio-demographics respondents are willing to act as crowdshippers, the subsample results of these socia-demographics are compared to the results of the total sample.

5.2.2 Gender – female vs. male

Respondents were asked about their gender and had three options to choose from. 1) Male 2) Female 3) Other. For the gender subsample, respondents were grouped into two. Table 16 represents male respondents' subsample results and table 17 represents female respondents' subsample.

Table 16: Results from respondents that are male

Choice	Coefficient	Standard Error	Z value	Probability |z|>Z*
Remuneration	0.00780***	0.00112	6.96	0.0000
Time L1 (Morning)	-0.10143	0.12203	-0.83	0.4059
Time L2 (Afternoon)	-0.24615*	0.13628	-1.81	0.0709
Frequency	0.00225	0.00237	0.95	0.3418
Delivery assignment	-0.18718	0.16845	-1.11	0.2665
Distance L1 (0-5 km)	0.27744**	0.13303	2.09	0.037
Distance L2 (5.1-10 km)	0.01308	0.12127	0.11	0.9141
ASC	0.74371*	0.43902	1.69	0.0903

***, **, * ==> Significance at 1%, 5%, 10% level.

Output	Value
Number of Observations	291
Skipped observations	0
Estimation observation	291
Log likelihood	-229.90204

Table 17: Results from respondents that are female

Choice	Coefficient	Standard Error	Z value	Probability |z|>Z*
Remuneration	0.00925***	0.00149	6.19	0.0000
Time L1 (Morning)	-0.33881**	0.15417	-2.2	0.028
Time L2 (Afternoon)	0.39413**	0.18025	2.19	0.0288
Frequency	0.005	0.00329	1.52	0.1287
Delivery assignment	-0.27097	0.21681	-1.25	0.2114
Distance L1 (0-5 km)	0.035714**	0.17713	2.02	0.0438
Distance L2 (5.1-10 km)	0.04718	0.15184	0.31	0.756
ASC	1.84939***	0.55612	3.33	0.0009

***, **, * ==> Significance at 1%, 5%, 10% level.

Output	Value
Number of Observations	195
Skipped observations	0
Estimation observation	195
Log likelihood	-166.71256

Comparing the results of the male subsample, short delivery distance is the most important attribute, with a positive coefficient of 0.27744. This is followed by remuneration with a positive coefficient of 0.0780. Even though both frequency of payment and medium delivery distance have a positive coefficient, both have no stars and are not statistically robust. Delivery in the afternoon is statistically robust at 5% significance but this hurts a male respondent's utility. With delivery in the morning not statistically robust and delivery in the afternoon statistically robust but with a negative impact, a male respondent is likely to make deliveries in the evening than in the morning and the afternoon.

Same cannot be said of a female respondent. The coefficient of delivery in the morning for a female respondent is statistically robust but negative, which means this reduces their utility. However, delivery in the afternoon is positive and statistically robust at 5%, so therefore, a female respondent is likely to work as a crowd shipper in the afternoon than in the morning and in the evening. Short delivery distance and remuneration are also positive and statistically robust, meaning these two attributes have a positive impact on a respondent's desire to work as a crowdshipper.

Comparing the coefficients of both male and female respondents, short delivery distance has more impact on a males' desire to work as a crowdshipper than other attributes. Whereas

delivery in the afternoon has more impact on a female respondent's desire to work as a crowd shipper than other attributes.

5.2.3 Annual income – low vs. medium vs. high

Another socio-demographic/economic subsample that was estimated is the annual income of respondents. For estimating the annual income subsample respondents were grouped into three groups: Q30<4, Q30=4, and Q30>4, where Q30<4 represents respondents whose annual income ranges from 1 NOK to 250,000 NOK, Q30=4 represents respondents whose annual income ranges from 250,001 NOK to 400,000 NOK, and Q30>4 represents respondents whose annual income is more than 400,001 NOK. Table 18 is the subsample result for Q30<4, table 19 for Q30=4, and 20 for Q30>4.

Table 18: Results from respondents with an income less than NOK 250,001

Choice	Coefficient	Standard Error	Z value	Probability |z|>Z*
Remuneration	0.00834***	0.00121	6.91	0.0000
Time L1 (Morning)	-0.38575***	0.12712	-3.03	0.0024
Time L2 (Afternoon)	0.15089	0.14636	1.03	0.3025
Frequency	0.00176	0.00251	0.7	0.482
Delivery assignment	-0.02835	0.17336	-0.16	0.8701
Distance L1 (0-5 km)	0.31937**	0.14321	2.23	0.0257
Distance L2 (5.1-10 km)	0.08308	0.12145	0.68	0.4939
ASC	1.14339**	0.46109	2.48	0.0131

***, **, * ==> Significance at 1%, 5%, 10% level.

Output	Value
Number of Observations	270
Skipped observations	0
Estimation observation	270
Log likelihood	-221.62830

For respondents who earn between NOK 1 and NOK 250,000, short delivery distance gives the highest utility which has a positive coefficient of 0.32937 and is statistically robust at 5% significance. This is followed by remuneration which has a positive coefficient of 0.00834 and statistically robust at 1% significance. Crowdshippers who earn between 1NOK and 250,000NOK will not work as crowdshippers if they are offered deliveries in the morning because this reduces their utility. This has a negative utility of -0.38575 and statistically robust at 1% significance. Even though delivery in the afternoon has a positive

coefficient, it is not statistically robust. This means respondents who earn within this range will prefer to work in the evening than in the morning and afternoon since working in the morning impacts their utility negatively and working in the afternoon has no significance.

Table 19: Results from respondents with income betw. NOK 250,001 and NOK 400,000

Choice	Coefficient	Standard Error	Z value	Probability |z|>Z*
Remuneration	0.00763***	0.00099	7.68	0.0000
Time L1 (Morning)	-0.17121	0.10595	-1.62	0.1061
Time L2 (Afternoon)	-0.06279	0.12056	-0.52	0.6025
Frequency	0.00314	0.00215	1.46	0.1443
Delivery assignment	-0.35541**	0.14865	-2.39	0.0168
Distance L1 (0-5 km)	0.27318**	0.11826	2.31	0.0209
Distance L2 (5.1-10 km)	0.00795	0.10474	0.08	0.9395
ASC	0.93240**	0.37971	2.46	0.0141

***, **, * ==> Significance at 1%, 5%, 10% level.

Output	Value
Number of Observations	369
Skipped observations	0
Estimation observation	369
Log likelihood	-310.1324

For respondents who earn between NOK 250,001 and NOK 400,000, short delivery distance gives them the highest utility which has a positive coefficient of 0.32937 and is statistically robust at 5% significance. This is followed by remuneration with a positive utility of 0.00763 and it is statistically robust at 1%. Even though the delivery assignment is statistically robust at 5% significance, it hurts the utility of respondents. This means respondents within this income bracket will prefer to select delivery assignments rather than the company assigning them deliveries.

Table 20: Results from respondents with an income more than NOK 400,000

Choice	Coefficient	Standard Error	Z value	Probability |z|>Z*
Remuneration	0.00923***	0.00113	8.2	0.0000
Time L1 (Morning)	-0.10944	0.11744	-0.93	0.3514
Time L2 (Afternoon)	-0.07509	0.13166	-0.57	0.5685
Frequency	0.00435*	0.00232	1.87	0.0612
Delivery assignment	-0.26610*	0.16177	-1.64	0.1
Distance L1 (0-5 km)	0.30899**	0.12918	2.39	0.0168
Distance L2 (5.1-10 km)	-0.0383	0.11641	-0.33	0.7422

ASC	1.52883***	0.4215	3.63	0.0003

***, **, * ==> Significance at 1%, 5%, 10% level.

Output	Value
Number of Observations	333
Skipped observations	0
Estimation observation	333
Log likelihood	-273.2188

The table above which is the result for respondents who earn more than NOK 400,000 has a short-delivery distance with the highest utility. This is followed by remuneration with a positive coefficient of 0.00923 and statistically robust at 1% significance. Again, the respondents who earn above NOK 400,000 do not want the company to assign them deliveries because this hurts their utility. Meaning they would prefer to select deliveries themselves.

5.2.4 Occupational status – employees vs. students/retirees/unemployed

Also, it is worthwhile exploring the results based on the occupation of respondents. For this, we grouped people who are employed full time with people who are employed part-time (results in table 21), and people who are students with part-time employed students, retirees, and unemployed persons (results in table 22). The coefficients that were significant in both cases are Remuneration and Distance L1. Because of their tight schedule, it appears as if full-time and part-time employees value their time more than students, retirees, and unemployed persons. With a coefficient value of 0.01099, an increase in remuneration has a higher effect on employees than on students, retirees, and unemployed persons, whose remuneration coefficient is only at 0.00748.

Table 21: Results from people who are employed full time or part time

Choice	Coefficient	Standard Error	Z value	Probability |z|>Z*
Remuneration	0.01099***	0.00188	5.86	0
Time L1	0.0898	0.17594	0.51	0.6098
Time L2	-0.13539	0.20566	-0.66	0.5103
Frequency	0.00492	0.00349	1.41	0.159
Delivery assignment	-0.49733**	0.24118	-2.06	0.0392
Distance L1	0.48240**	0.2009	2.4	0.0163
Distance L2	-0.12208	0.17279	-0.71	0.4799
ASC	1.79469***	0.65723	2.73	0.0063

***, **, * ==> Significance at 1%, 5%, 10% level.

Output	Value
Number of Observations	165
Skipped observations	0
Estimation observation	165
Log likelihood	-125,28162

Distance affects utility in a similar ratio. Employees are more likely to set great value on the distance they cover being as little as possible. Students, retirees, and unemployed persons still associate positive utility with travelling short distances, however, with a value of only 0.22393 it is distinctly lower than 0.48240 – the value associated with employees.

Table 22: Results from people who are studying (empl. part time), retired, or unempl.

Choice	Coefficient	Standard Error	Z value	Probability |z|>Z*
Remuneration	0.00748***	0.00105	7.14	0.0000
Time L1	-0.33173***	0.11446	-2.9	0.0038
Time L2	0.02981	0.12692	0.23	0.8143
Frequency	0.00232	0.00226	1.03	0.3049
Delivery assignment	-0.13186	0.15746	-0.84	0.4024
Distance L1	0.22393*	0.12619	1.77	0.076
Distance L2	0.06616	0.11046	0.6	0.5492
ASC	0.99562**	0.40439	2.46	0.0138
***, **, * ==> Significance at 1%, 5%, 10% level.				

Output	Value
Number of Observations	321
Skipped observations	0
Estimation observation	321
Log likelihood	-274,40824

When looking at the alternative specific constant (ASC) that displays the part of the model that is not covered by the rest of the attributes, in both cases we see a positive utility. This is caused by the fact that unless being paid high compensation people would not go out of their way to perform crowdshipping delivery, which especially applies to people who are employed. This is confirmed by a relatively high value of 1.79469 for the ASC, compared to 0.99562 for the group that is not or only part-time employed.

5.2.5 Signing environmental petitions – rather vs. rather not

In addition, we want to find out whether respondents that are likely to sign environmental petitions also have different preferences regarding crowdshipping attributes. In table 23 we display the results for respondents with Likert-scale-values of either 4, 5, or 6 – indicating an exceptionally high level of environmental consciousness. Table 24, on the other hand, depicts results for respondents with values 1, 2, or 3, showing lower interest in environmental issues.

Table 23: Results for respondents that rather sign environmental petitions

Choice	Coefficient	Standard Error	Z value	Probability |z|>Z*
Remuneration	0.00340*	0.00180	1.89	0.0585
Time L1	-0.26655	0.22517	-1.18	0.2365
Time L2	0.14476	0.22053	0.66	0.5116
Frequency	0.00207	0.00412	0.50	0.6162
Delivery assignment	-0.12891	0.29523	-0.44	0.6624
Distance L1	0.12074	0.21453	0.56	0.5736
Distance L2	0.44486**	0.21297	2.09	0.0367
ASC	-0.28609	0.68390	-0.42	0.6757
***, **, * ==> Significance at 1%, 5%, 10% level.				

Output	Value
Number of Observations	90
Skipped observations	0
Estimation observation	90
Log likelihood	-77,77282

A precondition for comparing the subsamples' coefficients is that their values are significant. The coefficient that is significant for both subsamples is for the attribute Remuneration. When comparing the value, it becomes evident that an increase in remuneration affects the utility of respondents that rather not sign environmental petitions *more* than those who sign environmental petitions. This makes sense insofar as people that are interested in environmental issues are likely to not see income as their priority, and are not influenced as much by an increase in remuneration.

Table 24: Results for Respondents that rather not sign environmental petitions

Choice	Coefficient	Standard Error	Z value	Probability |z|>Z*
Remuneration	0.00930***	0.00104	8.95	0.0000
Time L1	-0.18633*	0.10630	-1.75	0.0796

Time L2	-0.00190	0.12460	-0.02	0.9879
Frequency	0.00381*	0.00216	1.77	0.0771
Delivery assignment	-0.21164	0.14789	-1.43	0.1524
Distance L1	0.37038***	0.12199	3.04	0.0024
Distance L2	-0.08679	0.10560	-0.82	0.4111
ASC	1.52572***	0.39129	3.90	0.0001

***, **, * ==> Significance at 1%, 5%, 10% level.

Output	Value
Number of Observations	396
Skipped observations	0
Estimation observation	396
Log likelihood	-320,53624

5.2.6 Awareness of crowdshipping – yes vs. no

Another interesting observation to make is whether respondents that were not aware of crowdshipping before they answered the questionnaire (Table 25) selected different choices than people who already knew of crowdshipping (Table 26). Again, we consider only significant coefficients. In this case, coefficients for attributes Remuneration and Distance L1 have significant values in both tables.

Table 25: Results from respondents that were not aware of crowdshipping

Choice	Coefficient	Standard Error	Z value	Probability |z|>Z*
Remuneration	0.00602***	0.00156	3.86	0.0001
Time L1	0.04455	0.17787	0.25	0.8022
Time L2	-0.43101**	0.2019	-2.13	0.0328
Frequency	-0.00058	0.00337	-0.17	0.8631
Delivery assignment	-0.22313	0.24278	-0.92	0.3581
Distance L1	0.33076*	0.19294	1.71	0.0865
Distance L2	-0.12867	0.1775	-0.72	0.4685
ASC	0.13425	0.60721	0.22	0.825

***, **, * ==> Significance at 1%, 5%, 10% level.

Output	Value
Number of Observations	138
Skipped observations	0
Estimation observation	138
Log likelihood	-112,38875

If we inspect the coefficients for Remuneration, it becomes apparent that people who knew of crowdshipping beforehand have higher standards in terms of payment. A value of 0.00911 implies a larger impact on utility than a value of 0.00602. Furthermore, we take a look at the distance attribute, particularly at level 1 (0-5 km). Here, the results depict a higher coefficient value for people who were not aware of crowdshipping, signifying shorter distance being of higher importance to them. People who are aware of crowdshipping and have perhaps already worked as crowdshippers are not as concerned about taking longer detours from their original route.

Output	Value
Number of Observations	348
Skipped observations	0
Estimation observation	348
Log likelihood	-286,15188

Table 26: Results from respondents that were aware of crowdshipping

Choice	Coefficient	Standard Error	Z value	Probability |z|>Z*
Remuneration	0.00911***	0.0011	8.3	0.0000
Time L1	-0.31015***	0.114	-2.72	0.0065
Time L2	0.15798	0.12868	1.23	0.2196
Frequency	0.00480**	0.00233	2.06	0.0393
Delivery assignment	-0.27659*	0.1575	-1.76	0.0791
Distance L1	0.27893**	0.12768	2.18	0.0289
Distance L2	0.02403	0.11187	0.21	0.8299
ASC	1.54979***	0.41441	3.74	0.0002
***, **, * ==> Significance at 1%, 5%, 10% level.				

Chapter 6

6. Discussions

This chapter discusses the implications of the results for crowd shipping companies and how they can exploit this service going forward. It also discusses the limitations of the research and finally recommendations for further research.

6.1 Managerial implications

The primary objective of any business is to maximize profit. How crowdshipping is designed and offered to potential crowdshippers will play an important role in how successful the business will be. The findings and results give insight into whether people are willing to act as crowdshippers and what companies should consider when making business decisions about crowdshipping as a product.

The data shows that a crowdshipper's utility is dependent on remuneration, delivery time window, frequency of payment, delivery assignment, and distance. All these attributes at specific levels affect the utility of crowdshippers with short-distance delivery having a huge impact or significance. With crowdshippers being rational, giving whatever payment, they will prefer to make short deliveries than medium and long-distance deliveries. What this means is that crowdshipping companies will have to provide structures and systems that make deliveries less than 5km. More consolidation centers/hubs in public stations and parcel lockers closer to densely populated residential areas will help reduce the distance between final origin and destination. Remuneration is the next attribute that has a positive impact on the utility of crowdshippers. The higher the earning, the higher the utility and chance of a person acting as a crowdshipper.

The delivery time window is also essential and has an impact on the utility of crowdshippers. Delivery in the morning is significant but this has a negative impact on the utility of consumers. Crowdshippers will rather not work in the morning as it reduces the utility derived from working as a crowdshipper. Crowdshipping companies must be aware that parcels are likely not to be delivered in the morning and afternoon. Crowdshipping companies need to have dedicated delivery drivers as an option, who should be ready to make deliveries in the morning and afternoon if a parcel needs to be delivered in the morning or the option of delivering parcels in the morning should not be made available to consumers

or it should be more expensive than in the evening so it can compensate for the cost of doing a dedicated delivery.

Company assigning deliveries to crowdshippers also has a negative impact on the utility of crowdshippers. Companies should allow crowdshippers to select deliveries themselves.
The data shows that crowdshippers prefer receiving payments after every delivery than after 5 and 10 deliveries. The best policy is to pay after every delivery since as it will increase a crowdshippers desire to work as a crowdshipper.

In a nutshell, the best policy to implement that will increase the chance of a person acting as a crowdshipper is to make final deliveries shorter, increase payment for deliveries, allow crowdshippers to voluntarily select deliveries they want to do, and make more deliveries available in the evening than in the morning and afternoon.

6.2 Conclusions

The significance of this thesis was to ascertain whether crowdshipping is technically feasible and economically and financially viable.

Crowdshipping is an innovative service that provides a sustainable way for goods to be delivered by commuters who already intend to take a trip from one place to another. Irrespective of delivering goods, these commuters take their trip anyway. This helps to reduce the cost of last-mile delivery as compared to traditional dedicated logistics delivery, reduce emission, and also reduce traffic congestions in cities.

The thesis considered Oslo, the most crowded city in Norway with a huge volume of daily e-commerce activities and a robust public transport system. Considering its population and traffic activities, it was suitable to consider Oslo, as it is the perfect location for a public-based crowdshipping thesis.

The research questions served as the foundation for the research. We sought to find out the factors that influence people's willingness to participate as crowdshippers in last-mile delivery in the city of Oslo, and how these factors can be measured appropriately to see if it is technically feasible. Only 64 out of the 162 respondents in our survey confirmed that they are willing to work as crowdshippers in the future, 74 are undecided as to whether they will work as crowdshippers in the future and 14 said they are not willing to work as

crowdshippers in the future. We realised that short distance delivery is the most influential factor, should someone decide to work as a crowdshipper. Morning deliveries have a similar effect in that they reduce participants‘ desire to work as crowdshippers.

The results show that with all things being equal people are likely not to act as crowdshippers, but the positive alternative specific constant of 1.13471 which is statistically robust at 1% significance tells us that there are unobserved factors (other attributes) in the design that could have influenced a respondent’s desire to work more as a crowdshipper.

6.3 Limitations and recommendations for further research

Although we are confident of the results from the survey, some limitations were noted. The thesis considered only a limited number of attributes and levels that were inadequate for a crowdshipper in making choice decisions. Secondly, the results are limited by the case study sample size. Additionally, the sample size skewed towards a useful population.

For futures studies, researchers should consider using other attributes apart from the ones mentioned in this work. A larger sample size that is normally distributed should be used for a more statistically robust result.

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Appendix A – Choice situations

Choice situation 1	Option 1	Option 2
Remuneration (kr)	150	350
Time (hrs)	Morning (07:00-12:00)	Afternoon (12:01-17:00)
Frequency (number)	Per 10 deliveries	Single delivery
Delivery assignment	Company	Self-select
Distance (km)	5.1-10	10.1-20

Choice situation 2	Option 1	Option 2
Remuneration (kr)	150	350
Time (hrs)	Afternoon (12:01-17:00)	Morning (07:00-12:00)
Frequency (number)	Per 5 deliveries	Per 5 deliveries
Delivery assignment	Company	Self-select
Distance (km)	5.1-10	0-5

Choice situation 3	Option 1	Option 2
Remuneration (kr)	350	150
Time (hrs)	Morning (07:00-12:00)	Afternoon (12:01-17:00)
Frequency (number)	Per 10 deliveries	Single delivery
Delivery assignment	Self-select	Company
Distance (km)	0-5	5.1-10

Choice situation 4	Option 1	Option 2
Remuneration (kr)	250	250
Time (hrs)	Evening (17:01-22:00)	Afternoon (12:01-17:00)
Frequency (number)	Single delivery	Per 10 deliveries
Delivery assignment	Company	Self-select
Distance (km)	0-5	5.1-10

Choice situation 5	Option 1	Option 2
Remuneration (kr)	350	150
Time (hrs)	Morning (07:00-12:00)	Evening (17:01-22:00)
Frequency (number)	Per 10 deliveries	Single delivery
Delivery assignment	Company	Self-select
Distance (km)	10.1-20	0-5

Choice situation 6	Option 1	Option 2

Remuneration (kr)	250	250
Time (hrs)	Afternoon (12:01-17:00)	Morning (07:00-12:00)
Frequency (number)	Per 5 deliveries	Per 5 deliveries
Delivery assignment	Self-select	Company
Distance (km)	10.1-20	5.1-10

Choice situation 7	Option 1	Option 2
Remuneration (kr)	350	150
Time (hrs)	Evening (17:01-22:00)	Afternoon (12:01-17:00)
Frequency (number)	Per 10 deliveries	Single delivery
Delivery assignment	Company	Self-select
Distance (km)	0-5	10.1-20

Choice situation 8	Option 1	Option 2
Remuneration (kr)	250	250
Time (hrs)	Evening (17:01-22:00)	Morning (07:00-12:00)
Frequency (number)	Single delivery	Per 10 deliveries
Delivery assignment	Self-select	Company
Distance (km)	5.1-10	10.1-20

Choice situation 9	Option 1	Option 2
Remuneration (kr)	150	350
Time (hrs)	Afternoon (12:01-17:00)	Evening (17:01-22:00)
Frequency (number)	Per 5 deliveries	Per 5 deliveries
Delivery assignment	Self-select	Company
Distance (km)	0-5	5.1-10

Choice situation 10	Option 1	Option 2
Remuneration (kr)	350	150
Time (hrs)	Evening (17:01-22:00)	Morning (07:00-12:00)
Frequency (number)	Single delivery	Per 10 deliveries
Delivery assignment	Self-select	Company
Distance (km)	10.1-20	0-5

Choice situation 11	Option 1	Option 2
Remuneration (kr)	250	250

Time (hrs)	Evening (17:01-22:00)	Afternoon (12:01-17:00)
Frequency (number)	Per 5 deliveries	Per 5 deliveries
Delivery assignment	Self-select	Company
Distance (km)	5.1-10	10.1-20

Choice situation 12	Option 1	Option 2
Remuneration (kr)	150	350
Time (hrs)	Afternoon (12:01-17:00)	Morning (07:00-12:00)
Frequency (number)	Per 10 deliveries	Single delivery
Delivery assignment	Company	Self-select
Distance (km)	0-5	5.1-10

Choice situation 13	Option 1	Option 2
Remuneration (kr)	350	150
Time (hrs)	Afternoon (12:01-17:00)	Evening (17:01-22:00)
Frequency (number)	Per 5 deliveries	Per 5 deliveries
Delivery assignment	Self-select	Company
Distance (km)	0-5	10.1-20

Choice situation 14	Option 1	Option 2
Remuneration (kr)	150	350
Time (hrs)	Evening (17:01-22:00)	Afternoon (12:01-17:00)
Frequency (number)	Single delivery	Per 10 deliveries
Delivery assignment	Company	Self-select
Distance (km)	10.1-20	5.1-10

Choice situation 15	Option 1	Option 2
Remuneration (kr)	250	250
Time (hrs)	Morning (07:00-12:00)	Evening (17:01-22:00)
Frequency (number)	Per 5 deliveries	Per 5 deliveries
Delivery assignment	Self-select	Company
Distance (km)	10.1-20	0-5

Choice situation 16	Option 1	Option 2
Remuneration (kr)	250	250
Time (hrs)	Morning (07:00-12:00)	Evening (17:01-22:00)

Frequency (number)	Single delivery	Per 10 deliveries
Delivery assignment	Company	Self-select
Distance (km)	10.1-20	0-5

Choice situation 17	Option 1	Option 2
Remuneration (kr)	350	150
Time (hrs)	Afternoon (12:01-17:00)	Morning (07:00-12:00)
Frequency (number)	Per 10 deliveries	Single delivery
Delivery assignment	Company	Self-select
Distance (km)	5.1-10	0-5

Choice situation 18	Option 1	Option 2
Remuneration (kr)	150	350
Time (hrs)	Morning (07:00-12:00)	Evening (17:01-22:00)
Frequency (number)	Single delivery	Per 10 deliveries
Delivery assignment	Self-select	Company
Distance (km)	5.1-10	10.1-20

Appendix B – Descriptive statistics tables

Most frequent trip occurence

Statistics

Think of the trip that you take most frequently to/within/from Oslo. When does this trip usually occur?

N	Valid	162
	Missing	0

Think of the trip that you take most frequently to/within/from Oslo. When does this trip usually occur?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Weekdays	141	87,0	87,0	87,0
	Weekend/Holidays	21	13,0	13,0	100,0
	Total	162	100,0	100,0	

Main motivation for taking this trip

Statistics

What is your main motivation for taking this trip?

N	Valid	162
	Missing	0

What is your main motivation for taking this trip?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Study	43	26,5	26,5	26,5
	Work	103	63,6	63,6	90,1
	Shopping	5	3,1	3,1	93,2
	Other leisure activities	11	6,8	6,8	100,0
	Total	162	100,0	100,0	

Usual time for outbound trip

Statistics

What is your usual time for this outbound trip?

N	Valid	162
	Missing	0

What is your usual time for this outbound trip?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Morning (07:01-12:00)	128	79,0	79,0	79,0
	Afternoon (12:01-17:00)	27	16,7	16,7	95,7
	Evening (17:01-22:00)	7	4,3	4,3	100,0
	Total	162	100,0	100,0	

Outbound trip duration

Statistics

What is the outbound trip duration?

N	Valid	162
	Missing	0
Mean		34,14
Minimum		1
Maximum		145

What is the outbound trip duration?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	,6	,6	,6
	2	1	,6	,6	1,2
	8	1	,6	,6	1,9
	10	6	3,7	3,7	5,6
	12	3	1,9	1,9	7,4
	13	2	1,2	1,2	8,6
	14	1	,6	,6	9,3
	15	8	4,9	4,9	14,2
	17	2	1,2	1,2	15,4
	18	3	1,9	1,9	17,3
	19	3	1,9	1,9	19,1
	20	11	6,8	6,8	25,9

	22	3	1,9	1,9	27,8
	23	4	2,5	2,5	30,2
	24	1	,6	,6	30,9
	25	10	6,2	6,2	37,0
	26	1	,6	,6	37,7
	29	1	,6	,6	38,3
	30	14	8,6	8,6	46,9
	32	9	5,6	5,6	52,5
	34	3	1,9	1,9	54,3
	35	13	8,0	8,0	62,3
	36	1	,6	,6	63,0
	38	1	,6	,6	63,6
	39	2	1,2	1,2	64,8
	40	9	5,6	5,6	70,4
	42	2	1,2	1,2	71,6
	43	3	1,9	1,9	73,5
	45	11	6,8	6,8	80,2
	46	1	,6	,6	80,9
	47	1	,6	,6	81,5
	48	1	,6	,6	82,1
	50	7	4,3	4,3	86,4
	51	1	,6	,6	87,0
	52	1	,6	,6	87,7
	54	1	,6	,6	88,3
	55	4	2,5	2,5	90,7
	56	2	1,2	1,2	92,0
	60	7	4,3	4,3	96,3
	67	1	,6	,6	96,9
	70	1	,6	,6	97,5
	76	1	,6	,6	98,1
	78	1	,6	,6	98,8
	90	1	,6	,6	99,4
	145	1	,6	,6	100,0
	Total	162	100,0	100,0	

Usual time for return trip

Statistics

What is your usual time for this return trip?

N	Valid	162
	Missing	0
Mean		2,54
Minimum		1
Maximum		4

What is your usual time for this return trip?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Morning (07:01-12:00)	6	3,7	3,7	3,7
	Afternoon (12:01-17:00)	86	53,1	53,1	56,8
	Evening (17:01-22:00)	47	29,0	29,0	85,8
	Night (22:01-07:00)	23	14,2	14,2	100,0
	Total	162	100,0	100,0	

Usual time for return trip

Statistics

What is the return trip duration?

N	Valid	162
	Missing	0
Mean		35,39
Minimum		1
Maximum		145

What is the return trip duration?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	,6	,6	,6
	8	1	,6	,6	1,2
	10	5	3,1	3,1	4,3
	12	4	2,5	2,5	6,8
	13	1	,6	,6	7,4
	14	1	,6	,6	8,0
	15	9	5,6	5,6	13,6
	17	1	,6	,6	14,2
	19	3	1,9	1,9	16,0

	20	12	7,4	7,4	23,5
	22	3	1,9	1,9	25,3
	23	5	3,1	3,1	28,4
	24	1	,6	,6	29,0
	25	9	5,6	5,6	34,6
	29	1	,6	,6	35,2
	30	12	7,4	7,4	42,6
	32	9	5,6	5,6	48,1
	34	3	1,9	1,9	50,0
	35	15	9,3	9,3	59,3
	36	1	,6	,6	59,9
	38	1	,6	,6	60,5
	39	2	1,2	1,2	61,7
	40	10	6,2	6,2	67,9
	42	3	1,9	1,9	69,8
	43	2	1,2	1,2	71,0
	45	12	7,4	7,4	78,4
	46	1	,6	,6	79,0
	47	1	,6	,6	79,6
	48	1	,6	,6	80,2
	50	6	3,7	3,7	84,0
	52	2	1,2	1,2	85,2
	54	1	,6	,6	85,8
	55	5	3,1	3,1	88,9
	56	2	1,2	1,2	90,1
	60	10	6,2	6,2	96,3
	67	1	,6	,6	96,9
	70	1	,6	,6	97,5
	76	1	,6	,6	98,1
	78	1	,6	,6	98,8
	90	1	,6	,6	99,4
	145	1	,6	,6	100,0
	Total	162	100,0	100,0	

Crowdshipping awareness

Statistics

Have you heard of Crowdshipping?

N	Valid	162
	Missing	0
Mean		,28
Minimum		0
Maximum		1

Have you heard of Crowdshipping?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	116	71,6	71,6	71,6
	Yes	46	28,4	28,4	100,0
	Total	162	100,0	100,0	

Worked as a crowdshipper in the past

Statistics

Have you ever worked as a crowdshipper?

N	Valid	162
	Missing	0
Mean		,15
Minimum		0
Maximum		2

Have you ever worked as a crowdshipper?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	143	88,3	88,3	88,3
	Yes	14	8,6	8,6	96,9
	I don't know	5	3,1	3,1	100,0
	Total	162	100,0	100,0	

Work as a crowdshipper in the future

Statistics

Would you consider working as a crowdshipper in the future?

N	Valid	162
	Missing	0
Mean		1,31
Minimum		0
Maximum		2

Would you consider working as a crowdshipper in the future?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	24	14,8	14,8	14,8
	Yes	64	39,5	39,5	54,3
	I don't know	74	45,7	45,7	100,0
	Total	162	100,0	100,0	

Maximum length of detour

Statistics

Suppose you are delivering a parcel on the trip you take most frequently. What is the maximum length of detour you would take?

N	Valid	162
	Missing	0

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-5 km	70	43,2	43,2	43,2
	5.1-10 km	78	48,1	48,1	91,4
	10.1-15 km	12	7,4	7,4	98,8
	More than 15 km	2	1,2	1,2	100,0
	Total	162	100,0	100,0	

Case experiment: Delivery options

Statistics

Which of these services would you be willing to offer as a crowdshipper?

N	Valid	162
	Missing	0

Which of these services would you be willing to offer as a crowdshipper?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Delivery from hub (Lysaker) with Ikea items	46	28,4	28,4	28,4
	Delivery from hub (Lysaker) with Ikea items + other boxed items	42	25,9	25,9	54,3
	Delivery from hub (Lysaker) with Ikea items + food	62	38,3	38,3	92,6
	Delivery from hub (Lysaker) with Ikea items + other boxed items + food	12	7,4	7,4	100,0
	Total	162	100,0	100,0	

Influence of parcel size

Statistics

Will the size of the parcel influence your willigness to act as a crowdshipper?

N	Valid	162
	Missing	0

Will the size of the parcel influence your willigness to act as a crowdshipper?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	19	11,7	11,7	11,7
	Yes	143	88,3	88,3	100,0
	Total	162	100,0	100,0	

Maximum parcel size

Statistics

State the maximum size a parcel may have.

N	Valid	162
	Missing	0

State the maximum size a parcel may have.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	20	12,3	12,3	12,3
	Small (e.g. Laptop computer)	79	48,8	48,8	61,1
	Medium (e.g. coffee table, microwave)	57	35,2	35,2	96,3
	Large	6	3,7	3,7	100,0
	Total	162	100,0	100,0	

Influence of parcel weight

Statistics

Will the weight of the parcel influence your willigness to act as a crowdshipper?

N	Valid	162
	Missing	0

Will the weight of the parcel influence your willigness to act as a crowdshipper?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	21	13,0	13,0	13,0
	Yes	141	87,0	87,0	100,0
	Total	162	100,0	100,0	

Maximum parcel weight

Statistics

State the maximum weight a parcel may have.

N	Valid	162
	Missing	0

State the maximum weight a parcel may have.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	21	13,0	13,0	13,0
	0-5 kg	69	42,6	42,6	55,6
	5.1-15 kg	41	25,3	25,3	80,9
	15.1-30 kg	29	17,9	17,9	98,8
	More than 30 kg	2	1,2	1,2	100,0
	Total	162	100,0	100,0	

Workdays as a crowdshipper

Statistics

Which days of the week are you willing to act as a crowdshipper?

N	Valid	162
	Missing	0

Which days of the week are you willing to act as a crowdshipper?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Weekday only (Monday - Friday)	53	32,7	32,7	32,7
	Weekend only (Saturday and Sunday)	39	24,1	24,1	56,8
	Weekday + Weekend (Monday - Sunday)	70	43,2	43,2	100,0
	Total	162	100,0	100,0	

Petitions for environmental protection

Statistics

I sign petitions for environmental protection.

N	Valid	162
	Missing	0

I sign petitions for environmental protection.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	5	3,1	3,1	3,1
	2	8	4,9	4,9	8,0
	3	17	10,5	10,5	18,5
	4	23	14,2	14,2	32,7
	5	80	49,4	49,4	82,1
	6	29	17,9	17,9	100,0
	Total	162	100,0	100,0	

Less polluting means of transportation

Statistics

I prefer to use less polluting means of transport than cars.

N	Valid	162
	Missing	0

I prefer to use less polluting means of transport than cars.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	,6	,6	,6
	2	5	3,1	3,1	3,7
	3	17	10,5	10,5	14,2
	4	43	26,5	26,5	40,7
	5	57	35,2	35,2	75,9
	6	39	24,1	24,1	100,0
	Total	162	100,0	100,0	

Purchase eco-friendly products

Statistics

I purchase sustainable eco-friendly products and services.

N	Valid	162
	Missing	0

I purchase sustainable eco-friendly products and services.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	,6	,6	,6
	2	10	6,2	6,2	6,8
	3	27	16,7	16,7	23,5
	4	49	30,2	30,2	53,7
	5	57	35,2	35,2	88,9
	6	18	11,1	11,1	100,0
	Total	162	100,0	100,0	

Sharing services

Statistics

I think it is a good idea to use sharing services (car sharing, Airbnb, ...).

N	Valid	162
	Missing	0

I think it is a good idea to use sharing services (car sharing, Airbnb, ...).

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	12	7,4	7,4	7,4
	2	12	7,4	7,4	14,8
	3	22	13,6	13,6	28,4
	4	38	23,5	23,5	51,9
	5	49	30,2	30,2	82,1
	6	29	17,9	17,9	100,0
	Total	162	100,0	100,0	

Gender

Statistics

What is your gender?

N	Valid	162
	Missing	0

What is your gender?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	97	59,9	59,9	59,9
	Female	65	40,1	40,1	100,0
	Total	162	100,0	100,0	

Age

Statistics

What is your age?

N	Valid	162
	Missing	0

What is your age?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18 to 25	36	22,2	22,2	22,2
	26 to 35	75	46,3	46,3	68,5
	36 to 45	38	23,5	23,5	92,0
	46 to 55	10	6,2	6,2	98,1
	56 to 65	2	1,2	1,2	99,4
	66 and above	1	,6	,6	100,0
	Total	162	100,0	100,0	

Educational level

Statistics

What is your highest educational level?

N	Valid	162
	Missing	0

What is your highest educational level?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High School	31	19,1	19,1	19,1
	Undergraduate	69	42,6	42,6	61,7
	Postgraduate	56	34,6	34,6	96,3
	PhD	5	3,1	3,1	99,4
	Other	1	,6	,6	100,0
	Total	162	100,0	100,0	

Occupational status

Statistics

What is your occupational status?

N	Valid	162
	Missing	0

What is your occupational status?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Employed full time	90	55,6	55,6	55,6
	Employed part time	17	10,5	10,5	66,0
	Student	23	14,2	14,2	80,2
	Student + employed part time	31	19,1	19,1	99,4
	Retired	1	,6	,6	100,0
	Total	162	100,0	100,0	

Annual income

Statistics

Which category best represents your annual income?

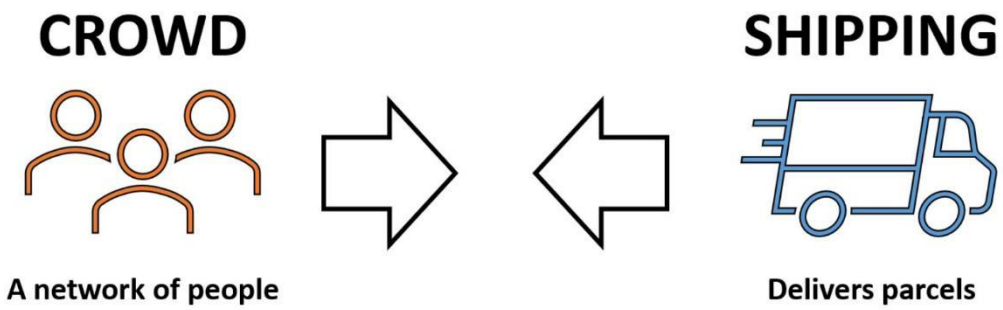
N	Valid	148
	Missing	14

Which category best represents your annual income?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 60,000 NOK	8	4,9	5,4	5,4
	Between 60,000 and 100,000 NOK	14	8,6	9,5	14,9
	Between 100,001 and 250,000 NOK	36	22,2	24,3	39,2
	Between 250,001 and 400,000 NOK	39	24,1	26,4	65,5
	Between 400,001 and 600,000 NOK	35	21,6	23,6	89,2
	Between 600,001 and 800,000 NOK	13	8,0	8,8	98,0
	More than 800,000 NOK	3	1,9	2,0	100,0
	Total	148	91,4	100,0	
Missing	System	14	8,6		
Total		162	100,0		

Appendix C – Questionnaire

To answer the questionnaire in Norwegian, click here.



To reduce congestion and externalities in cities

Every day society is taking steps to protect the environment. Crowdshipping is an emerging concept to improve sustainability. The crowd is used to deliver parcels on trips that they would take anyway. Thereby, traffic congestion and externalities are reduced.

*Our research project aims to improve crowdshipping delivery in the city of Oslo. This **specific survey** is linked to **transporting items** from a **hub in Lysaker** to consumers within Oslo. We want to know what it will take for you to be willing to work as a crowdshipper (courier).*

The survey should take **5 minutes** and your responses are **completely anonymous**. This survey has a **500 kr gift card** for one lucky winner.

If you have questions or comments on the survey, please direct them to:

nikolas.kolb@stud.himolde.no

Page break

The following questionnaire is only for those who reside in – or com-mute to Oslo.

Please confirm that you belong to this category. *

Yes

No

Page break

Think of the trip that you take most frequently to/within/from Oslo. When does this trip usually occur? *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

- Weekdays
- Weekend/Holidays

What is your main motivation for taking this trip? *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

- Study
- Work
- Shopping
- Other leisure activities

What is your usual time for this outbound trip? *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

- Morning (07:01-12:00)
- Afternoon (12:01-17:00)
- Evening (17:01-22:00)
- Night (22:01-07:00)

What is the outbound trip duration? *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

*Indicate the average time it takes to get to destination **in minutes**.*

What is your usual time for this return trip? *

This element is only shown when the option "Yes" is selected in the question

"Please confirm that you belong to this category."

- ◯ Morning (07:01-12:00)
- ◯ Afternoon (12:01-17:00)
- ◯ Evening (17:01-22:00)
- ◯ Night (22:01-07:00)

What is the return trip duration? *

ℹ This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

*Indicate the average time it takes back from destination **in minutes**.*

ℹ This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

Which of the following zip code ranges represents your place of origin/destination?

Place of origin

ℹ This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

Select ...

Place of destination

ℹ This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

Select ...

ℹ This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

What mode/s of transport do you use?

You can select multiple options in both rows.

	Public transport (Bus, Tram, Train, ...)	Own vehicle (mostly combustion-powered)	Own vehicle (mostly electric-powered)	Bicycle (regular, electric, cargo, ...)	Walk (more than 5 minutes)

Outbound trip *	☐	☐	☐	☐	☐
Return trip *	☐	☐	☐	☐	☐

Page break

Have you heard of Crowdshipping? *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

- ○ Yes
- ○ No

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This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

As a reference for the next questions, here is the definition of Crowdshipping:

Crowdshipping is an alternative way of delivering goods. Commuters are used to deliver parcels on trips that they would take anyway.

Have you ever worked as a crowdshipper? *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

- ○ Yes
- ○ No
- ○ I don't know

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Indicate the crowdshipping service(s) you have worked for. *

This element is only shown when the option "Yes" is selected in the question "Have you ever worked as a crowdshipper?"

- [ ] Nimber (Easybring)
- [ ] PiggyBee
- [ ] MyBoxMan
- [ ] TravelPost
- [ ] Other

Please specify.

This element is only shown when the option "Other" is selected in the question "Indicate the crowdshipping service(s) you have worked for."

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Would you consider working as a crowdshipper in the future? *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

- ( ) Yes
- ( ) No
- ( ) I don't know

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This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

*After defining crowdshipping we provide you with some **crowdshipping delivery alternatives**. Under which conditions are you willing to work as a crowdshipper? In what follows, we present two hypothetical options and ask you to **choose the one you prefer**.*

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

Scenario 1	Option A	Option B
Remuneration (kr) - Payment per delivery	250	250
Time (hrs) - Delivery time window	Evening (17:01-22:00)	Afternoon (12:01-17:00)
Frequency (number) - Payment interval	Single delivery	Per 10 deliveries
Delivery assignment - Self-Select/Company*	Company	Self-Select
Distance (km) - Delivery distance interval	0-5	5.1-10

* Self select: Do you want to select the deliveries you want to perform yourself?
Company: Do you want the company to assign deliveries to you?

Which option would you choose? *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

- ○ Option A
- ○ Option B
- ○ None of the above

If A and B are the only options available, indicate which option you prefer. *

This element is only shown when the option "None of the above" is selected in the question "Which option would you choose?"

- ○ Option A
- ○ Option B

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This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

Scenario 2	Option A	Option B
Remuneration (kr) - Payment per delivery	350	150
Time (hrs) - Delivery time window	Morning (07:00-12:00)	Evening (17:01-22:00)
Frequency (number) - Payment interval	Per 10 deliveries	Single delivery
Delivery assignment - Self-Select/Company	Company	Self-Select
Distance (km) - Delivery distance interval	10.1-20	0-5

Which option would you choose? *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

- ○ Option A
- ○ Option B
- ○ None of the above

If A and B are the only options available, indicate which option you prefer. *

This element is only shown when the option "None of the above" is selected in the question "Which option would you choose?"

- ○ Option A
- ○ Option B

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This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

Scenario 3	Option A	Option B
Remuneration (kr) - Payment per delivery	250	250
Time (hrs) - Delivery time window	Evening (17:01-22:00)	Afternoon (12:01-17:00)
Frequency (number) - Payment interval	Per 5 deliveries	Per 5 deliveries
Delivery assignment - Self-Select/Company	Self-select	Company
Distance (km) - Delivery distance interval	5.1-10	10.1-20

Which option would you choose? *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

- ○ Option A
- ○ Option B
- ○ None of the above

If A and B are the only options available, indicate which option you prefer. *

This element is only shown when the option "None of the above" is selected in the question "Which option would you choose?"

- ○ Option A
- ○ Option B

Page break

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

We want to know your views on other environmental issues. How do youevaluate the following statements?

I sign petitions for environmental protection. *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

Not correct					Correct
1	2	3	4	5	6
[	[	[	[	[	[

Value

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

I prefer to use less polluting means of transport than cars. *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

Not correct					Correct
1	2	3	4	5	6
[	[	[	[	[	[

Value

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

I purchase sustainable eco-friendly products and services. *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

Not correct					Correct
1	2	3	4	5	6
[	[	[	[	[	[

Value

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

I think it is a good idea to use sharing services (car sharing, Airbnb, ...). *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

Not correct					Correct
1	2	3	4	5	6
[	[	[	[	[	[

Value

Page break

Suppose you are delivering a parcel on the trip you take most frequently. What is the maximum length of detour you would take? *

This element is only shown when the option "Yes" is selected in the question

"Please confirm that you belong to this category."

- ○ 0-5 km
- ○ 5.1-10 km
- ○ 10.1-15 km
- ○ More than 15 km

Which of these services would you be willing to offer as a crowdshipper? *

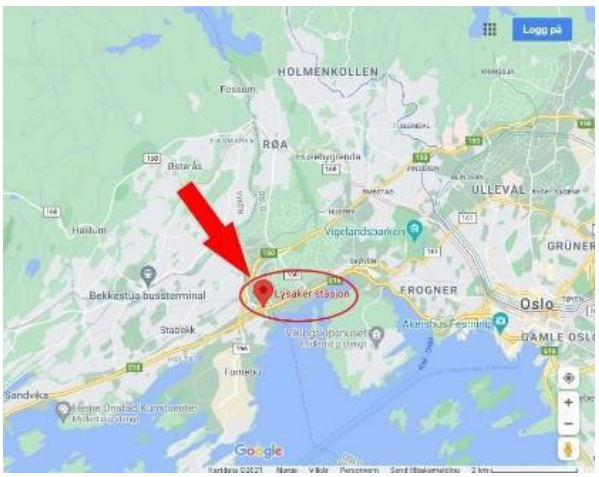
ⓘ This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

This question refers to a particular experiment. Select the option that appeals to you **the most.**

"Hub" *definition in this case*: shipments from Ikea are stored and combined here for onward transfer to customers

- ○ Delivery from hub (Lysaker) with Ikea items
- ○ Delivery from hub (Lysaker) with Ikea items + other boxed items
- ○ Delivery from hub (Lysaker) with Ikea items + food
- ○ Delivery from hub (Lysaker) with Ikea items + other boxed items + food

ⓘ This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."



Will the size of the parcel influence your willigness to act as a crowdshipper? *

ⓘ This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

- ○ Yes
- ○ No

State the maximum size a parcel may have.

This element is only shown when the option "Yes" is selected in the question "Will the size of the parcel influence your willigness to act as a crowdshipper?"

- ○ Small (e.g. Laptop computer)
- ○ Medium (e.g. coffee table, microwave)

- ○ Large

Will the weight of the parcel influence your willigness to act as a crowdshipper? *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

- ○ Yes
- ○ No

State the maximum weight a parcel may have.

This element is only shown when the option "Yes" is selected in the question "Will the weight of the parcel influence your willigness to act as a crowdshipper?"

- ○ 0-5 kg
- ○ 5.1-15 kg
- ○ 15.1-30 kg
- ○ More than 30 kg

Which days of the week are you willing to act as a crowdshipper? *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

- ○ Weekday only (Monday - Friday)
- ○ Weekend only (Saturday and Sunday)
- ○ Weekday + Weekend (Monday - Sunday)

Page break

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

Conclusively, we would like to gain information on your socio-demographic characteristics.

What is your gender? *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

Select ...

What is your age? *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

Select ...

What is your highest educational level? *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

Select ...

What is your occupational status? *

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

Select ...

Which category best represents your annual income?

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

Select ...

Page break

This element is only shown when the option "No" is selected in the question "Please confirm that you belong to this category."

Please exit the questionnaire now. Do not press "Send"

Page break

This element is only shown when the option "Yes" is selected in the question "Please confirm that you belong to this category."

Thank you for answering the questionnaire, submit your answers now!