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# Comparing deliveries to on-street consignees and consignees located at shopping centers

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**Abstract**

The main contribution of this paper is three-fold. First, it maps the delivery structure for on-street consignees and consignees located at shopping centers. In general, micro-data regarding urban freight is sparse, thus this survey greatly contributes to the general knowledge about number of deliveries and number of freight vehicles in Oslo. This information is important to take into account for bottom-up calculations of traffic impacts. This includes private costs of freight, but also socio-economic external costs related to local and global emissions, noise, increased congestion and increased chances of traffic accidents.
Second, through surveys amongst employees and drivers, car counts and GPS data, we have identified and quantified an important cost difference between on-street consignees and consignees at shopping centers, namely the increased cost due to lower capacity for on-street consignees. The expected additional cost per vehicle related to low capacity is estimated to be NOK 49 (the additional cost per delivery will obviously depend on number of deliveries per vehicle). This is important information from a policy perspective, and suggests that both (1) increasing capacity for on-street deliveries in the city center and (2) facilitating for shopping centers with dedicated unloading spaces will reduce both private costs for transport operators and consignees, and external costs related to emissions and congestion.
Third, we give recommendations for mitigating the problem of space restrictions for on-street deliveries in the city center. This approach consist of two elements: (1) deliveries before or after stores' opening hours and (2) deliveries to a buffer storage location with a dedicated unloading space.

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## 1. Introduction

Urban areas represent particular challenges for freight transport, both in terms of logistical performance and environmental impacts (emissions, noise, accidents, congestion and land use). Urban freight is indispensable for the city's economy but at the same time freight deliveries significantly affect the attractiveness and quality of urban life. GRASS (GReen And Sustainable freight transport Systems in cities) is a project financed by Polish-Norwegian Research Programme that studies urban last mile distribution promoting efficiency and sustainable urban logistics in Poland and Norway. An important objective of the GRASS project is to accomplish and compare performance data for deliveries to on-street shops vs. shops located in a shopping center. When delivering to a shopping center the distributors usually have to deliver via a common facility for the center, and in many cases, the drivers have to transport the goods inside the shopping center by foot. When delivering to shops located along streets it may be easier to park close to the shop, but a challenge is to find a free loading/unloading bay close to the shop.

To support this objective a survey was conducted amongst retail shops, service businesses and hotels, restaurants and cafés (HoReCa) in Oslo. The survey is accomplished as face to face interviews among 40 consignees located on-street and 60 consignees located in a shopping center. This paper maps the result of that survey, as well as putting the result in context of previously gathered data to arrive at some conclusions regarding how the delivery structure for the center of Oslo can be improved. The purpose of this paper is three-fold:

- First, to describe the result of the aforementioned survey and to map the delivery structure in Oslo for on-street deliveries and shopping centers respectively. By doing this, we will effectively (1) identify differences in delivery patterns for the two groups of consignees, and (2) calculate summary statistics that are useful for characterizing the delivery structure in Oslo, such as deliveries per week and size of deliveries for each shop, etc.
- When comparing the delivery structure, our main hypothesis is that deliveries to on-street consignees are more costly than deliveries to shopping centers. This is due to delivery challenges that are faced by transport operators delivering on-street in the city center, such as congested traffic, inappropriate regulations, lack of parking space, and so on. Thus, the second purpose of this paper is to assess these challenges, (1) qualitatively, in terms of interviews with consignees, to identify what the most important challenges are and how they differ in gravity, and (2) quantitatively, calculating the additional costs of these challenges for on-street deliveries, using deliveries to shopping centers as a benchmark.
- The third purpose is to suggest solutions for mitigating the inefficiency related to on-street deliveries. These solutions are based on the situation in Oslo; however, we argue that they are generic in nature and have the potential to mitigate the negative impact of freight for on-street deliveries in other cities as well.

The next chapter is a short description of the data. This includes the freight delivery surveys collected in the GRASS project (section 2.1) as well as additional information, such as interviews with shop owners and drivers (section 2.2), registration of vehicles at on-street delivery spaces (section 2.3) and GPS coordinates from transport operators (section 2.4). Chapter 3 compares deliveries made to on-street consignees and consignees located at shopping centers. Section 3.1 calculates some useful statistics related to delivery size and number of deliveries. Section 3.2 compares time of day for deliveries at shopping centers and on-street consignees. In section 3.3, the additional challenges for on-street consignees are identified and described qualitatively. Finally, section 3.4 quantifies the additional cost related to delivering to an on-street consignee compared to a shopping center in Oslo due to these challenges, given that distances and routes are equal. Chapter 4 provides some suggestions for mitigating these challenges, and chapter 5 concludes.

## 2. Data

This paper will draw upon numerous different data sources, all collected within the center of Oslo. The main data source is the freight delivery survey from the GRASS project, collected amongst on-street consignees and consignees located in shopping centers. The second data source is a similar survey consisting of interviews with employers of on-street consignees in the same area. The third data source is a mapping of various vehicles utilizing (and the corresponding spare capacity at) two delivery spaces located on the same streets as the consignees. The fourth data source is GPS data from two large transport operators delivering to some of the consignees. The first data source is described in Kijewska and Johansen (2015), while the second, third and fourth data sources are described in Johansen et al. (2014b). We will briefly go through the content of each data source in the following sections.

### *2.1. Freight delivery survey (data source A)*

The first data source is the freight delivery survey, where 40 on-street consignees and 60 consignees located at a shopping center were interviewed. Of the 40 on-street consignees, 20 are in the retail sector, 9 are in the HoReCa sector and 11 are in the service sector. Of the 60 consignees located at shopping centers, 51 are in the retail sector, 6 are in the HoReCa sector and 3 are in the service sector. The consignees give information regarding number of deliveries, size of deliveries, and time for deliveries (both time of day and day of week). On-street consignees are also interviewed regarding what they believe are the main challenges for freight deliveries.

### *2.2. Complimentary freight delivery survey (data source B)*

The second data source is a similar survey collected for the GBO project (see Johansen et al., 2014b) in the same area among 30 consignees and approximately 20 drivers of freight vehicles. This data source focuses in particular on problems regarding on-street deliveries, including how often deliveries are delayed; what transport operators do when they do not find any spare space for unloading; when consignees would have preferred to receive goods; to what extent delays are problematic for the consignees; etc. The survey also gave information regarding size and number of deliveries, and particularities regarding the delivery system for each consignee.

### *2.3. Registrations of vehicles at on-street delivery spaces (data source C)*

The third data source consists of registrations of vehicles on two on-street delivery spaces in the center of Oslo, on the same streets as the consignees. The data set consists of registries of each delivery space for three whole days, regarding arrival and departure time for each vehicle, type of vehicle, name of transport operator, spare capacity at the delivery space at arrival of each new vehicle, purpose of stopping (freight deliveries, taxi, service sector or private car) and type of unloading operations. In total, 445 vehicles were registered.

### *2.4. GPS data from transport operators (data source D)*

The fourth data set are GPS coordinates from two different transport operators' computer systems. Data was collected on two different levels – delivery level and vehicle level. In total, information regarding 290,000 deliveries and 83,000 vehicles was obtained. Unfortunately, the data was too crude to be used in specific calculations. Moreover, since there is too little variation in terms of type of receiver and type of commodity, it is not possible to use the data to draw general conclusions regarding traffic of freight vehicles in the particular area. However, the data could be used for supporting and substantiating the information regarding deliveries and spare capacity of on-street parking. The data is also useful for finding examples of vehicle routes and examples of driving behaviour when searching for spare capacity to stop at an on-street delivery space.

## 3. Empirical comparison of deliveries to on-street consignees and consignees located at shopping centers

This chapter will describe the differences between on-street consignees and consignees located at shopping centers, focusing mainly on data source A from the GRASS project, i.e. interviews of shop owners. The main objective of this chapter is to (1) characterize the differences in delivery pattern, (2) to identify additional costs for on-street deliveries and (3) to quantify these additional costs.

### *3.1. Size and number of deliveries*

Looking at delivery sizes for on-street consignees, 33 of the 40 business entities interviewed had regular deliveries to their business entity. 20 of the entities had deliveries with an average size of less than 200 kg. 12 had average deliveries of 201–600 kg, 5 had deliveries between 601–1000 kg, two had average deliveries of 1001–1500 kg and one entity had average deliveries between 1501–2000 kg.

The average size of deliveries as well as the average number of shipments for each category of consignees are displayed in Table 1. Not surprisingly, retail entities seems to receive a larger share of small deliveries, while the HoReCa industry received the largest delivery.

Table 1. Average number of shipments per week and average number of shipments for on-street consignees.

| Categories | Retail | Service | HoReCa |
|---|---|---|---|
| Number of shipments per week | 4.7 shipments | 4.6 shipments | 5.3 shipments |
| Average size of shipment | 378 kg | 273 kg | 500 kg |
| Average size of shipment per week | 1777 kg | 1256 kg | 2650 kg |

When it comes to consignees located at shopping centers, 47 of the 60 business entities interviewed had regular deliveries to their business entity. 29 of the entities had deliveries with an average size of less than 200 kg. 17 had average deliveries of 201–600 kg, 9 had deliveries between 601–1000 kg, 3 had average deliveries of 1001–1500 kg and 2 entities had average deliveries of more than 2000 kg. For the rest of this section, we will focus on the retail entities. This is because the number of service entities and HoReCa entities at the shopping center is too low in order to draw significant conclusions. The retail entities located in the shopping center and on-street are compared in Table 2 below.

Table 2. Comparison of retail entities located at shopping centers and on-street.

| Categories | Shopping center | Independent shop |
|---|---|---|
| Number of shipments per week | 5.1 shipments | 4.7 shipments |
| Average size of shipment | 452 kg | 378 kg |
| Average size of shipment per week | 2688 kg | 1777 kg |

As can be seen, all these number are greater for entities at shopping centers than for independent entities. Based on this data only, it is difficult to know whether the higher number of weekly deliveries is related to lower costs for the driver or the fact that the shops at the shopping center are larger and therefore have a higher demand for freight.

### *3.2. Time of day for deliveries*

When it comes to time of day, most of the on-street business entities reported to receive freight shipments between 7:00 and 16:00 (about 55% of all shipments). The rest of the deliveries are mainly received between 10:00 and 13:00 (about 32%) and between 13:00 and 16:00 (about 23%). However, freight shipments are reported as early as 4:00–7:00 and as late as 22:00–01:00. The shops located at the shopping center on the other hand have to receive freight during the opening hours. Therefore, no shipments are received early in the morning or late in the afternoon.

Almost 70% of shops located at shopping centers receive their goods between 10:00 and 13:00. This is illustrated in Figure 1 below.


Fig. 1. The share of deliveries within various time windows for entities located at shopping centers and independent shops.

From the figure, it is possible to see that independent shops receive the majority of deliveries earlier than shops located at shopping centers. We hypothesise that this is most likely caused by two aspects: (1) Before 11:00, pedestrian areas in the center of Oslo is open for freight deliveries; and (2) partly due to the first aspect, the streets and on-street delivery spaces in the city seem to be more crowded after 11:00. To illustrate this, a figure from Johansen et al. (2014a) is included:

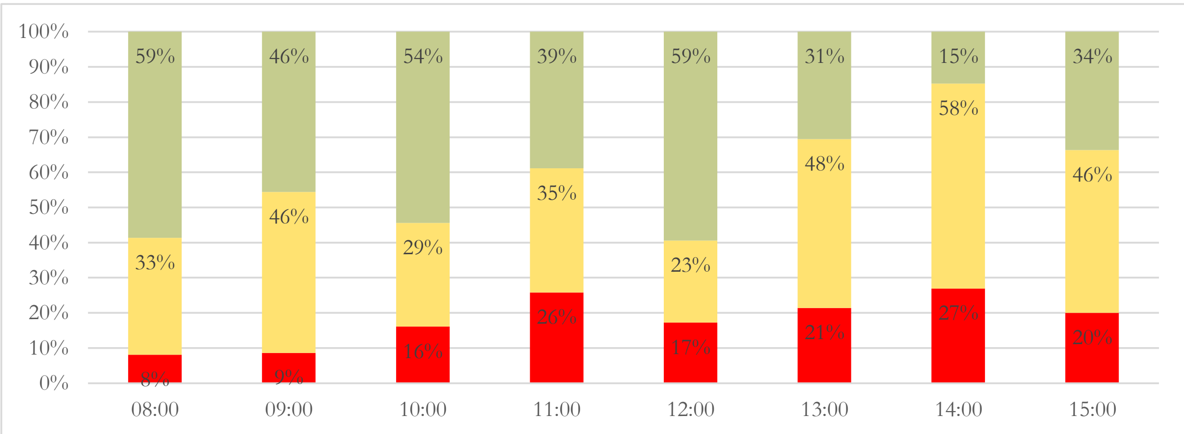


Fig. 2. Availability of on-street delivery spaces in the center of Oslo (Johansen et al., 2014).

This figure shows the availability of on-street delivery spaces for trucks throughout the day, measured in passenger car lengths. Red means “not enough space for a truck”, and is the amount of time there are zero or one passenger car lengths available. Yellow means “maybe enough space for a truck”, and is the amount of time when there are two to three passenger car lengths available. In this scenario, whether the truck will have the possibility to utilize the delivery space depends on whether the available “passenger car length” spaces are next to each other or not. Green means "enough space for a truck", and is the amount of time when four or more passenger car lengths are available. Except from the interval 12:00–13:00, which is lunch time, we can see that the availability decreases drastically from 11:00 and onwards. This reduced capacity was never a problem at the shopping center and is thus reflecting an additional challenge for on-street deliveries.

### *3.3. Additional challenges for on-street deliveries resulting from capacity restrictions*

Business owners of on-street businesses were asked about challenges when it came to on-street freight deliveries. Such challenges are not apparent for businesses in shopping centers, as they have a dedicated space for freight vehicles. Respondents were asked to give each challenge a score from 1 (not important) to 5 (very important). The challenges, as well as the average score for the whole sample and the average score for entities in three various streets are displayed in Fig. 3.

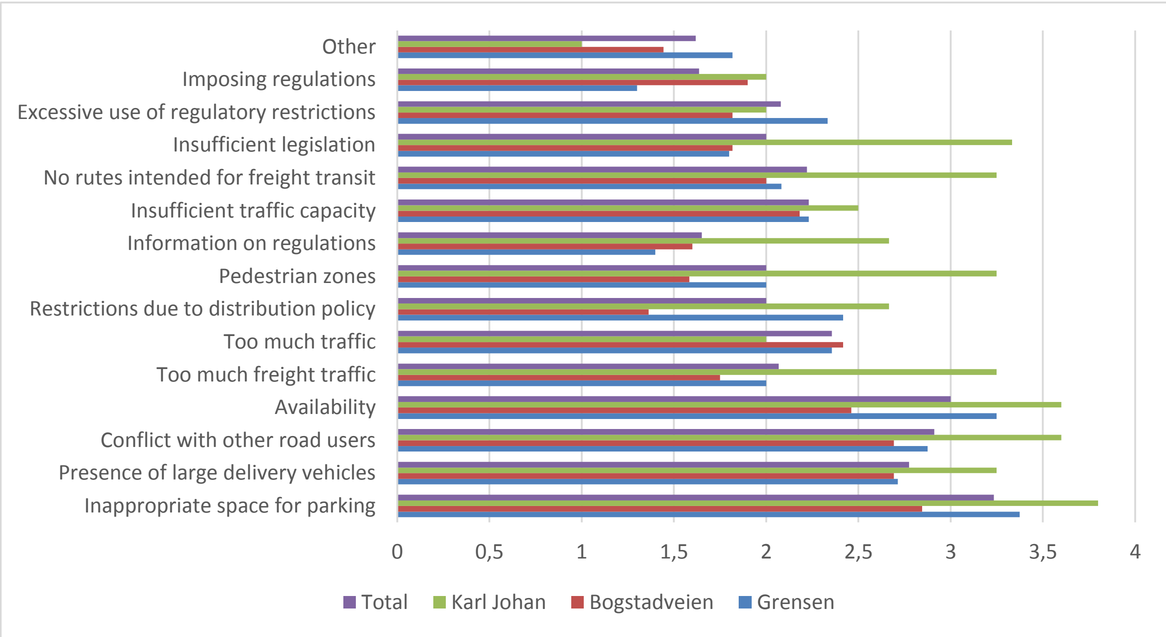


Fig. 3. Average score for each challenge faced for industries located in three different streets of Oslo.

The challenges cited by the business owners could vary quite significantly independent of location. For example, one business entity in Bogstadveien thought that lack of appropriate marking of the freight transport parking was a significant problem, while another business entity – on the same street – was unaware of any problem with parking for freight transport. Another example is from Karl Johan, where one business entity which owned its own transport found the time restricted access to pedestrian zones was problematic. Another business entity which relied on third party transport did not see it as a problem at all, as the deliveries were made before the restriction took effect.

Most issues are negligibly small for the majority of business entities. The number of businesses reporting otherwise varies from issue to issue, as does the gravity. However, the figure shows that problems are generally considered to be of more importance for entities located in Karl Johan. The reason for this is most probably that Karl Johan and connecting streets are pedestrian areas; freight deliveries are only allowed to take place between 00:00 and 11:00. This problem is partly relevant for entities located at Grensen, as the pedestrian areas connect to this area as well. This point can be highlighted by looking at the challenges "Pedestrian zones" and "Restrictions due to distribution policy". Both of these challenges apply for the situation in Karl Johan and partly for the situation at Grensen, and both of these challenges are reported to be of significantly more importance for Karl Johan and Grensen entities than for Bogstadveien entities.

The last group of issues is the category “other”. Comments made by business owners under the “other” category in the problem section of the questionnaire includes:

- “Significant problem that private cars use the freight transport parking slot. Clearer road signs are needed.”
- “We avoid the rush hour in the area to avoid parking space issues.”
- “Neighboring stores’ deliveries sometimes lead to lack of parking space.”
- “New regulations with cycling path leaves little room for parking and unloading.”
- “Snow and ice in the winter time is a problem.”
- “The main issue is conflict with the tram.”
- “We do not see any of these problems. People working with freight transport might see the problems.” (Grensen, Karl Johan and Bogstadveien)

In sum, the problems specified by the business entities were very local: few had any strong opinions on the main problems of freight transport that they couldn’t see. Some of the problems specified by the business entities were neither mentioned nor recognized by their next door store. One store might have a parking opportunity that the next door store lacks. The one store would then argue that lack of parking is a significant problem, while the next door store will claim that parking is an unimportant problem. However, the general trend is that there are visible challenges regarding freight deliveries for on-street consignees in Oslo. For the rest of the paper we will abstract from these differences by only looking at average effects. In the next paragraph, we have tried to quantify and monetize these in terms of additional costs.

### *3.4. Quantification of additional delivery costs for on-street consignees*

In the previous section, we identified additional challenges related to low capacity for deliveries to on-street consignees, when benchmarked against deliveries to shopping centers. In this section, we try to monetize these challenges in terms of additional delivery costs for transport operators delivering to on-street consignees. In a perfectly competitive market equilibrium, the additional cost for transport operators at the margin would equal the price increase for deliveries to on-street consignees

Data source C gives a detailed account of the availability of delivery spaces in the center of Oslo. In particular it shows that the probability that there is enough space for a truck is 62%, and that the probability that there is not enough space is 38%.

Interviews with drivers (data source B) indicate that not finding space for stopping for on-street delivery in the center of Oslo for a truck increases the delivery time by approximately 20 minutes. This is supported by the GPS data (data source D). Moreover, the GPS data indicates that about 10 of these minutes are used driving around looking for a place to stop, while the remaining 10 minutes are used on increased time for unloading purposes. The GPS data also show that the average speed for trucks within the center of Oslo is 12 km/h.

Based on these data, as well as distance and time specific costs for various vehicle categories for Norway (Grønland, 2011), we calculate that the additional cost for a truck that cannot find an on-street delivery space is NOK 147. Detailed calculations can be found in Johansen et al. (2014a, 2014b). Taking into account the probability of finding an available delivery space (from data source C), this corresponds to an expected increase in costs of NOK 49 for each vehicle delivering in the center of Oslo, which is a significant amount. Moreover, it increases congestion and kilometers driven, and thus imposes significant external costs on the environment. These costs are not present at all for the deliveries to shopping centers, as the shopping centers have dedicated areas for unloading where capacity restrictions are limited. The next section will contain suggestions for how to mitigate these additional costs for on-street deliveries.

## 4. Recommendations

This section contain recommendations for how to mitigate the additional costs for on-street deliveries, quantified in the previous section to amount to NOK 49 per delivery in addition to the external costs related to congestions and emissions. The first recommendation is early deliveries, and the second recommendation is city center buffer storage with dedicated unloading space.

### *4.1. Early deliveries*

Early deliveries will in this setting mean that freight deliveries take place before the shops open in the morning, effectively avoiding periods of high congestion and low capacity. The benefit from early deliveries will be largest for shops located at or in close proximity to Karl Johan or Grensen, where the interviews took place. The reason is that in those pedestrian areas, freight deliveries are currently only allowed between midnight and 11:00. Most of the shops open at 10:00, making the time windows for deliveries only one hour.

Interviews (source B) show that this solution is appropriate for some consignees. However, the consignees that stock high value goods (mainly jewelers and drug stores) deem that the risk of theft is too large. Some consignees also consider it inappropriate either because they do not have enough room for buffer storage within the shop entrance, or because of disadvantageous design of the premises in general.

The benefit of early deliveries will be avoiding the capacity constraints, effectively saving NOK 49 plus external costs per delivery vehicle. This must be weighed against the cost of early deliveries, which is either the cost of increased risk when trusting transport operators with keys to the premises, or the increased wage cost of having shop employers to show up earlier to receive the goods. Based on interviews with drivers and shop owners (data source B), we give some recommendations for how this measure can be operationalized (Johansen et al., 2014b):

- More information to freight receivers about the benefits of the measure may lead to increased acceptance;
- Price differentiation for the transport service before and after 10:00 is a possible approach, since drivers through interviews claim to have lower costs related to earlier deliveries. This would reduce private as well as external costs of transport;
- Based on interviews, high-activity shops find it more beneficial to have employers in the shop before opening time to receive goods – this will not only reduce the chance of theft, but also free up employers' capacity throughout the day, since they already have taken care of goods' deliveries;
- Early deliveries will be more beneficial and should be considered for new shops where the premises are not yet designed, so that an area can be allocated to buffer storage, and security systems suitable for the profile of the shop can be installed; and
- Since interviews revealed risk aversion for freight receivers to be a large obstacle, a demonstration project in which an external organ is responsible for the risk related to early deliveries should lead to a larger degree of acceptance in the future.

### *4.2. City center buffer storage with dedicated unloading space*

Even though early deliveries are able to mitigate additional costs for some receivers, it will not be suitable for all on-street consignees. Thus, this second recommendation is more general, but comes at a higher cost and will require more organization. This recommendation will mimic the delivery structure at shopping centers and is thus at the core of this paper.

The recommendation consists of allocating a dedicated space in the city center for buffer storage of goods with a dedicated unloading space. Since interviews showed that a lot of receivers lack buffer storage as discussed in the previous section, this approach will be a good alternative. It will also allow for deliveries throughout the day, and not only early deliveries as in section 4.1.

The benefits are, as before, reduction in additional costs for each delivery truck by NOK 49, given that there is enough capacity. Smart location of the unloading bay may also lead to increased benefits because of shorter distances driven. The costs, however, will be the socio-economic cost of allocating a large enough space in the city center for buffer storage and freight deliveries, as well as the costs related to organization and transportation from the buffer storage to the shop. To what extent the benefits are able to outweigh the costs, as well as what solution that will be most optimal, will largely depend on the number of shops that are affected.

For small parcels and light freight, employers can pick up the goods themselves for a reduced transport fee, thus reducing the negative impact of transport. For larger goods where door-to-door delivery is necessary, there are two limiting cases to consider. First, the case where the number of shops served are limited to walking distance from the buffer storage. Then, the solution could be carried out by one person and with minimal operation and organization costs, mimicking the situation at a shopping center. Second, the case where the number of consignees served is larger, covering a larger geographical area and requiring that the freight will be driven from the buffer storage to each individual shop. Then, the solution mimics an urban consolidation center. In this case the measure requires more planning and investments, but the benefits will be to serve a larger number of consignees. Using an electric vehicle to distribute the freight will minimize the negative impact of the transport. For lighter goods, using an electric bicycle will also allow deliveries to take place in pedestrian areas where other freight vehicles are not permitted.

It is clear that implementation of this measure will require a longer planning horizon, including acceptance surveys amongst freight receivers. However, it also illustrates the usefulness of the information described in sections 3.1–3.4; these are the kind of data sources needed to calculate the full potential of such a solution. Knowing the size and number of deliveries to on-street consignees in the center of Oslo will allow us to calculate the theoretical benefit from this solution bottom-up, which in turn can be used in a cost-benefit analysis to assess the efficiency of the measure.

## 5. Summary

The main contribution of this paper is three-fold. First, it maps the delivery structure for on-street consignees and consignees located at shopping centers. On average, retail consignees located in shopping centers receive 5.1 shipments per week with an average weight of 452 kg., whereas retail consignees on-street receive 4.7 shipments per week with an average weight of 378 kg. In general, micro-data regarding urban freight is sparse, thus this survey greatly contributes to the general knowledge about number of deliveries and number of freight vehicles in Oslo. This information is important to take into account for bottom-up calculations of traffic impacts. This includes private costs of freight, but also socio-economic external costs related to local and global emissions, noise, increased congestion and increased chances of traffic accidents.

Second, through surveys amongst employees and drivers, car counts and GPS data, we have identified and quantified an important cost difference between on-street consignees and consignees at shopping centers, namely the increased cost due to lower capacity for deliveries for on-street consignees. The expected additional cost per vehicle related to low capacity is estimated to be NOK 49 (thus, the additional cost per delivery will depend on number of deliveries per vehicle). This is important information from a policy perspective, and suggests that both (1) increasing capacity for on-street deliveries in the city center and (2) facilitating for shopping centers with dedicated unloading spaces will reduce both private costs for transport operators and consignees (by NOK 49 times number of trucks), and external costs related to emissions and congestion.

Third, we give recommendations for mitigating the problem of space restrictions for on-street deliveries in the city center. This approach consist of two elements: (1) deliveries before the stores open and (2) deliveries to a buffer storage location in the city center with a dedicated unloading space. Based on interviews with drivers and shop owners, we provide suggestions for how to operationalise these recommendations. Even though they are based on experiences from Oslo, we believe that they are suitable for other cities as well.

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