

Summary

Evaluation of starting up cargo bike deliveries - a pilot project in Oslo

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DHL Express is, in an ongoing pilot, delivering express parcels and documents with electric cargo bikes in Oslo city centre. The pilot is a collaboration between DHL Express Norway, Oslo municipality the Agency for Urban Environment and the Norwegian National Road Administration. This report evaluates the start-up and planning phase of this project.

Overall, the findings indicate that it has been challenging for DHL Express during the start-up period to reach their target of an average of 90 deliveries with 2-3 cargo bikes. The reason for this is the design of the cargo bike adjusting it to the industry in which it operates and difficulties in recruiting cyclists.

With a shorter range, capacity and speed is a cargo bike used for express and parcel deliveries dependent on a location in the city centre for storage of the goods and for the cargo bike to be locked in overnight. Due to limited knowledge and experiences with these kinds of activities within the municipality identifying this location in the city centre was a key challenge in starting up the cargo bike pilot. For similar logistics activities in the future it can therefore be valuable to ease this process. Either by 1) defining space in land use plans for logistics activities, 2) setting aside existing locations for this usage or 3) by developing a centrally located multi-user terminal.

Finally, the pilot has been an important driver in focusing and spreading information on urban freight. It has also created a fruitful collaborative environment between public and private sector.

Opportunities and limitations of using cargo bikes in urban freight transport

Advantages and disadvantages of cargo bikes

Accessibility, improved opportunities for loading, unloading and parking, reduced costs and improved flexibility are often identified as important advantages of urban cargo bikes. Leonardi, Browne and Allen (2012) and cargo bike companies at The European Cycle Logistics Conference highlights the following as main assets of the cargo bike:

- It requires less space for loading compared to a van
- Easier to maneuver in situations with traffic
- Separate bike lanes in cities
- Can in some cases access areas where vans are not allowed
- Zero-emission vehicles with limited noise
- Lower investment and maintenance costs
- Require less space for storage during night
- In most cases exempt from parking fees and tickets
- Does not require a driving license
- Safer in pedestrian zones
- The conditions for biking are improving

- More flexible when it comes to loading and unloading.
- Opportunities to find routes directly through urban areas and avoid queuing.

Despite this there are also some disadvantages related to cargo bikes. Cargo bikes are not suited for all types of goods due to weight, size, value and durability (Rundberget et al., 2016). These limitations place restrictions on which segments in which cargo bikes can operate. The main challenges of using cargo bikes are therefore:

- A limitation in weight and volume which places restrictions on which type of goods that can be transported.
- Reduces speed which means that the cargo bike uses longer time and are most suitable in the city centre.
- The reduced speed limits the distance in which the cargo bike can cover.
- Existing terminals are often located outside of the urban area which makes it difficult to complete the last-mile deliveries only by bike.
- Cargo bike deliveries requires restructuring of the supply chain. This involves a centrally located terminal or micro depot which can increase the costs due to high rent in the city centre.
- Limited acceptance among those driving vans or trucks.

Public sector facilitation

Results from using cargo bikes in urban freight indicated that there is a need for public sector facilitation to secure an increased take-up of cargo bikes (Cyclelogistics, 2017). Governmental support and knowledge has been limited considering that logistical issues are often handled by the private sector themselves. However, this is about to change. Authorities see a need to intervene or regulate these activities due to increasing emissions. Facilitating for cargo bikes is one such measure. Recommendations to local authorities on how to do this are through: 1) network building and knowledge transfer, 2) facilitate cargo bike testing, 3) regulations, 4) infrastructure, 5) strategic planning and 6) use cargo bikes within the municipality (Gruber & Rudolf, 2017).

European experiences

The documented experiences similar to the DHL Express cargo bike concept included in this evaluation indicate that several European cities are now using the cargo bike in urban freight transport (CITYLAB, 2017b; Melo & Baptista, 2017; Schliwa et al., 2015). In the postal, courier/messenger, parcel, home delivery, on-site transport and service trips market segments (Gruber & Rudolf, 2017). A simulation study was performed in Porto and the main conclusion was that cargo bikes can replace up to 10% of the conventional vans in areas with maximum linear distances of about 2 km, without changing the overall network efficiency. The reason for this is that cargo bikes are more flexible in traffic and easier to park but have a lower speed compared to a van (Melo & Baptista, 2017). Leonardi, Browne and Allen (2012) assesses how cargo bikes in combination with a centrally located consolidation centre can reduce the impact of traffic on the environment in London. The results indicate that the total distance travelled between the outside depot and the customer per parcel fell by 20% and that the CO₂e emissions per parcel delivered fell by 14% and 55%. However, the evaluation also shows that the distance travelled per parcel rose

substantially in the City of London delivery area due to electrical vehicles carrying less weight and volume. The project Cyclelogistics has analysed the deliveries of Outspoken Delivery in Cambridge which has a depot in the outside of the city centre having 300 daily deliveries with cargo bikes (Cyclelogistics, 2016, 2017; Wrighton & Reiter, 2016). The European projects SMILE and Pro-E-Bike has undertaken similar evaluations and their findings support the two other studies. The cargo bike reduces the total distance if it operates in connection with a centrally located depot (Navarro et al., 2016; Nocerino et al., 2016).

The cargo bike concept and daily cargo bike operations at DHL Express

The DHL Express cargo bike concept

In business as usual the deliveries at DHL Express are performed by a van and the parcels has to be delivered within the day of arriving at Berger. DHL Express also offers deliveries before noon (approximately 5%). The deliveries arrive at DHL Express' main terminal at Berger Skedsmo as air cargo in the morning before it is sorted according to route of destination. From the Berger terminal the goods are delivered to the customers in the city centre. DHL Express also offer pick-ups. There are eight service partners at DHL Express operating different areas for the region and the routes are relatively set (Kjønnø & Pham, 2017).

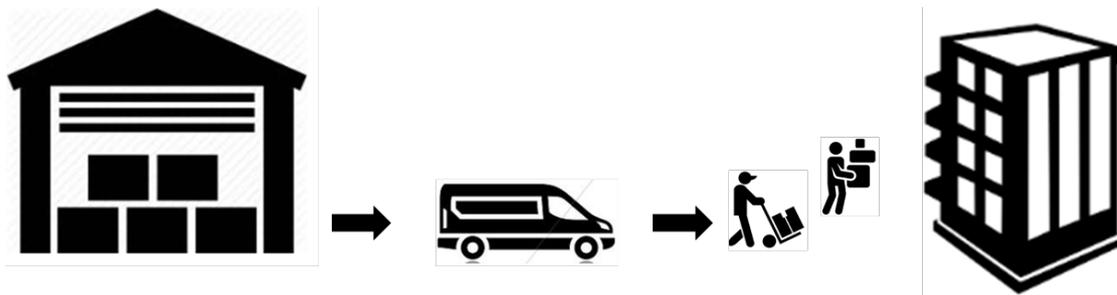


Figure S.1: The cargo bike concept.

To include cargo bikes in their daily operations DHL Express needed to make adjustments to their delivery concept. The way this is done is illustrated in Figure S.2 and the aim is to operate cargo bikes together with vans because some deliveries are too large for the bike.

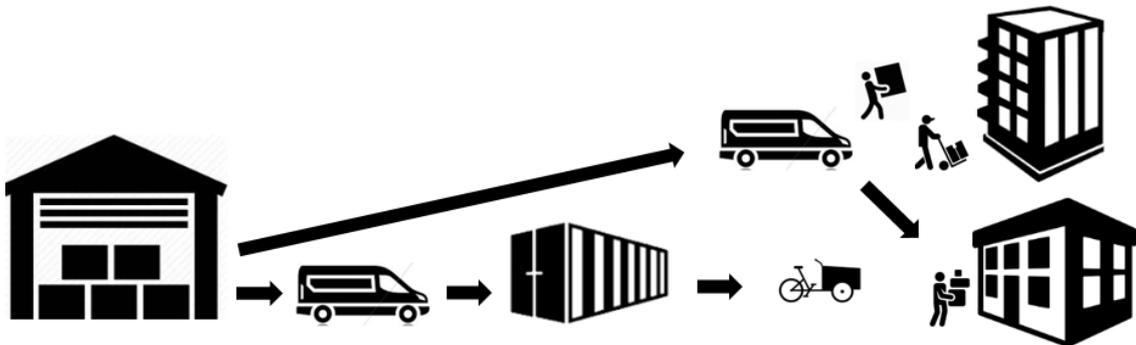


Figure S.2: The cargo bike concept.

When using cargo bikes the goods still arrive at the terminal in the morning, but in addition to sorting the goods for the vans the cargo to be delivered by bike is sorted in separate boxes. Two of these boxes constitutes half a pallet. From the main terminal the cargo bike goods is transported to the micro-depot located at Filipstad Skur 13. This location has good accessibility to the main road network in Oslo. From here the cargo bike performs its deliveries in the area of Oslo S – Vika – Aker Brygge. To compare these two methods of deliveries key characteristics of the modes of transport are included in Table S.1.

Table S.1: Key characteristics comparing vans and electric cargo bikes used in the pilot project.

	Delivery van	Cargo bike
Length	6.94 m	Cargo bike: 2.24 m Trailer: 1.26 m
Width	2.43 m	0.8m
Hight	2.56 m	1.10 m
Measurement lockers	Not applicable	H:821 mm B:608 mm L:804 mm
Volume cargo / lockers	14 m ³	Ca. 0.4 m ³
Payload	1.140 - 1.270 kg allowed total weight	270 kg incl. cyclist
Work hours	08:00-17:00	10:30-17:00

Experiences with cargo bike deliveries in Oslo

The development and start-up process (from June 2016 to November 2017) has provided valuable insights and new knowledge on how to organise cargo bike deliveries in Oslo. It has also identified some challenges related to changing an existing and functioning delivery system. The main challenges is mostly linked to the design of the cargo bike and the importance of adjusting it to the industry needs. These challenges resulted that only one out of two bikes was in operation due to maintenance, adjustments and repairs. One reason for experiencing issues with the bike is that DHL Express has installed custom made lockers at the front and the back of the bike. The idea is that three boxes which the cargo is sorted in at the main terminal can fit into one locker. However, as the deliveries progressed it became clear that the construction these lockers and the material was inadequate. Opening the locker door outwards results in the bike taking up unnecessary space. Not having a proper shelving system inside results in the deliveries taking unnecessary time. The experiences also indicate that time can be saved by installing central locking. Other adjustments on the bike is brake lights and turning signals. This is important both for the safety of the cyclist and other road and city users.

In the beginning recruitment of full-time cyclists was also an issue since the drivers of the vans had some resistance of changing to performing bike deliveries. DHL Express solved this by hiring a full-time cyclist from outside their company, but with cycling experience. In other words, someone who had bike as the preferred mode of transport.

To facilitate the working conditions the cargo bike is developed to easily disembark. On a more general level the safety relating to cycling in Oslo has been good. The cyclist has rarely felt unsafe or badly treated from other road users. The challenges relating to infrastructure has so far been the tram lines, brick roads, curb sides and cycling in areas with several other users. The security for the goods is good as the deliveries are locked at all times. There have so far been little response from the DHL Express customers about the cargo bike deliveries.

Important considerations for others who plan to engage in cargo bikes deliveries are to:

- Ensure efficient design of the cargo bike adjusted to the need of the business, the market in which it operates and safety for the cyclist in terms of brake lights and turning signal.
- Prepare to develop and change the delivery concept with cargo bikes and work out the routes to accommodate both cargo bikes and vans.
- Find ways to include the cargo bike in route planning or invest in separate systems for cargo bikes. It might be challenging to replace vans with cargo bikes thus the bike can be seen as a supplement in certain areas to reduce the use of vans in the city centre.
- Establish a positive attitude and interest among employees in the company starting with bikes.
- Recruit individuals with an interest in working as full-time cyclists rather than trying to force van drivers to use cargo bikes.
- Focus in safety for cyclist, goods, pedestrians and other road users. There might be solutions from the vans which can be transferred to the cargo bike.
- Even though cargo bikes have access to areas which vans don't, such as pedestrian zones closed for freight traffic after 11:00 am there is a lot of people in these areas slowing down the cargo bikes. It might be more efficient to find alternative routes for the bike.

Logistical, economic and environmental effects of cargo bikes

It is important to consider cargo bike deliveries from a business and logistical perspective. The main driver for private companies is profitability rather different from the public sector targets (Cyclelogistics, 2016).

Logistical effects

We have analyzed data of three different delivery vans that operate in Oslo city center, in addition to the cargo bike. The data from DHL Express is based on records of each stop performed by the delivery vans and the cargo bike.

A stop is defined as one signature to one goods recipient when one or several parcels are delivered. It can therefore be several stops within the same area. For instance, one building can have two stops to different receivers.

One delivery is defined as every time the van or cargo bike loads or unloads parcels.

The data is from the period from September 8th to October 31st 2017. In Table S.2. we present the key findings from distribution by van and cargo bike based on the analysis of these data.

Table S.2: The logistical effects on goods delivery by van compared with cargo bike. The findings concerning the van are based on an average of three vans operating in Oslo city center. Time period from September 8th to October 31st 2017.

	Goods distribution with van	Goods distribution with cargo bike
Based on data from the entire period of analysis		
Number of stops	4 671	2 127
Average number of stops per day	103	56
Maximum number of stops in one day	150	82
Minimum number of stops in one day	72	9
Average weight of deliveries per stop (kg)	6,9	1,1
Average time between each stop (minutes)	4	5
Average distance between each stop (minutes)	643	290
Kilometers driven in total during the period (average of three vans)	2 826	572
Kilometers driven on average per day	75	15
Based on data from an average day of work		
Time spent from first to last stop on the delivery route this day (hh:mm)	07:32	03:51
Average number of stops per hour this day	13	13
Total weight of deliveries this day	650	41
Number of units delivered this day	214	61

From the table we can see that the number of stops is more than the double for vans than cargo bikes during the period of analysis. There are several possible reasons why the cargo bike does not achieve as many stops and delivered units as a van:

- The loading capacity of the cargo bike is less than for the van.
- Size and weight of the packages can make them less suitable for cargo bike delivery.
- The distance between stops cannot be too long in case of cargo bike delivery.
- The driving speed is lower for the cargo bike than for the van.
- The working day of the cyclist has been shorter than for the drivers of the vans.

According to DHL Express's operations manager, several of the above mentioned factors are challenges associated with testing a new type of operation. Continuous changes to the delivery system are made to find the most optimal solution. Average time between stops, however, is only one minute more per stop for a cargo bike than for a van. This shows that the cargo bike has potential if the conditions are right.

Economic effects

Figure S.3 shows estimated cost per working day for a van and a cargo bike. A distinction is made between wage and administration, fixed vehicle costs (leasing, insurance, maintenance), fuel, road charging and parking fines for vans, as well as costs associated with the micro depot (area cost and depreciation cost for the container).

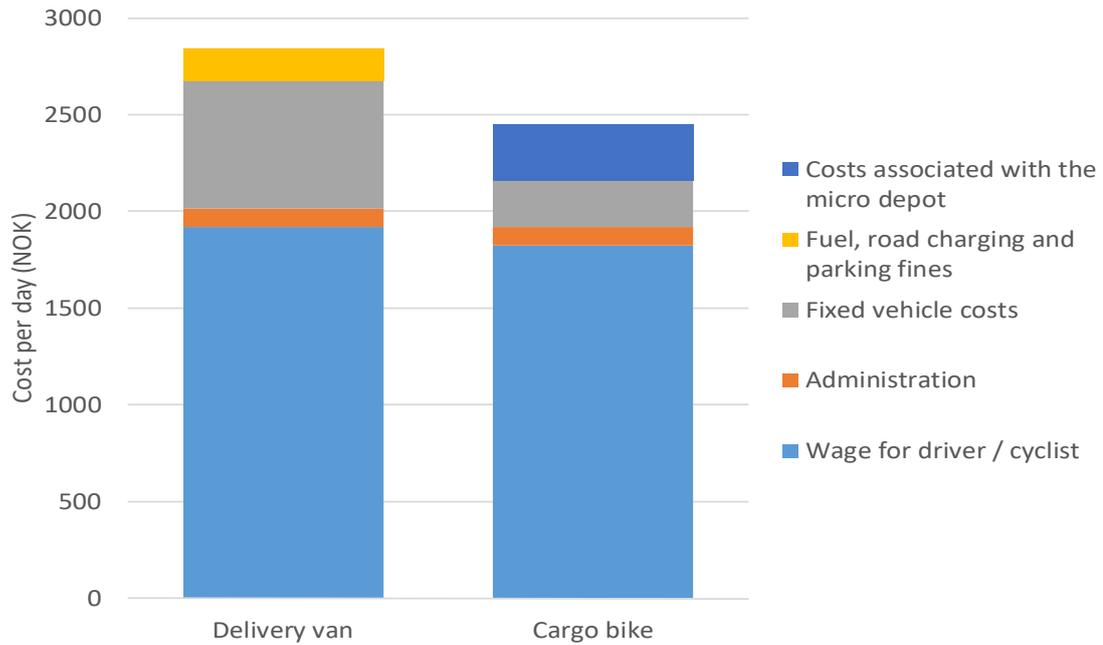


Figure S.3: Comparison of the cost of a van and a bicycle. Cost per day (NOK).

The figure shows that wages and administration is by far the largest cost component for both van and cargo bike. The cost is somewhat lower for the cargo bike because of the assumption of a shorter working day. We also see that the vehicle cost is much higher for the vans than for the cargo bike. It is relevant to relate the daily cost to the number of stops. Figure S.4 shows cost per stop for the number of daily stops per vehicle in the range 30 to 150.

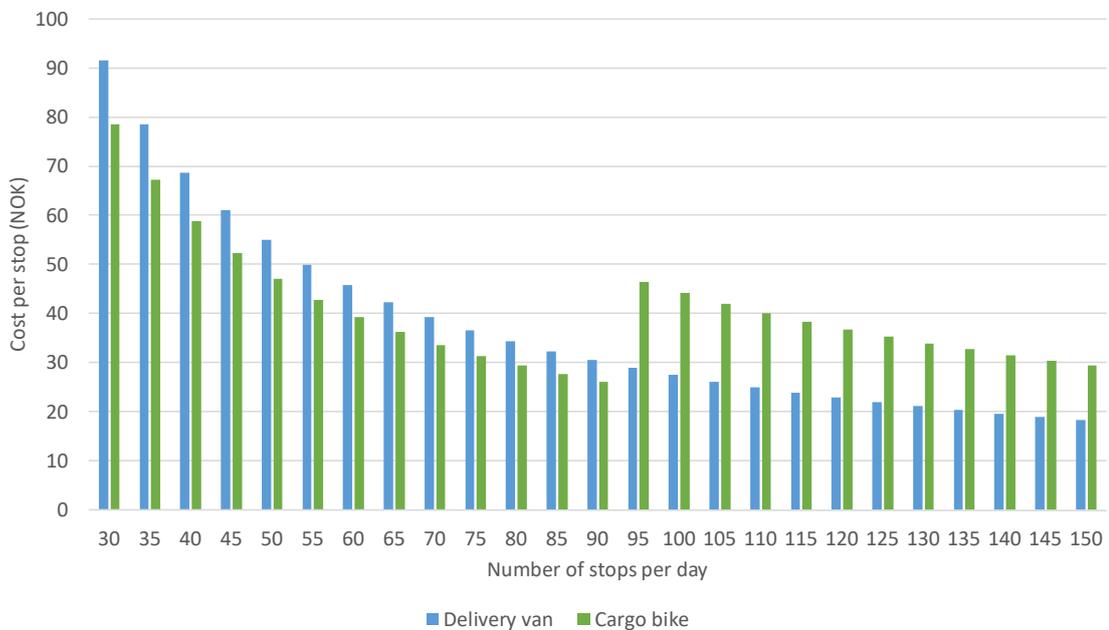


Figure S.4: Comparison of the cost of a van and a cargo bike. Cost per stop (NOK).

Figure S.4. shows that for up to 90 stops per day (bicycle capacity), the cargo bike will have a lower cost per stop than the van. When passing 90, two cargo bikes must be introduced, which makes it more expensive to use a cargo bike than a van.

Environmental effects

One possible effect of using cargo bike in goods delivery is a reduction in emissions (CO₂, NO_x, PM₁₀). This is calculated based on the information about changes in the transportation, i.e. kilometres driven. Table S.3. shows fuel consumption and emissions for a van per year and thus also the potential for environmental impact by replacing a van with cargo bike(s). When calculating environmental effects, we distinguish between kilometres driven outside Oslo city centre and within Oslo city centre. Kilometre driven outside Oslo city centre includes kilometres travelled between the main terminal at Berger and Oslo city centre. This distance is estimated to be 22.5 km one way (45 km round trip). The kilometres driven as part of the distribution inside the Oslo city centre is defined as kilometres driven within Oslo city centre.

Table S.3: Fuel consumption and emissions for vans per year outside Oslo city centre and within Oslo city centre. Data of kilometres driven used in the analysis are from DHL Express in 2016. Emission factors collected from Thune-Larsen et al. (2016).

	Diesel consumption (l)	CO ₂ (kg)	NO _x (g)	Thereof NO ₂ (g)	PM ₁₀ (g)	PM _{2,5} (g)
Outside Oslo city centre	1 480	3 256	12 432	3 996	1 480	1 036
Within Oslo city centre	1 214	3 238	9 108	2 935	1 316	1 012
Total per year	2 694	6 495	21 540	6 931	2 796	2 048

Table S.3 shows that for each van replaced by cargo bikes, CO₂ emissions drop by almost 6,5 tonnes and the emission of NO_x decreases by approximately 22 kg per year.

Collaboration and public sector facilitation

Collaboration and a function network between the participating stakeholders are key in planning and executing this pilot project. Also public sector facilitation has been important in terms of identifying a proper location for the micro-hub. The stakeholders involved in this project came together as a result of a cargo bike workshop organised by the Oslo municipality and the Norwegian Public Road Administration. It was after this event that DHL Express contacted these two stakeholders for stating up a pilot. In addition, cooperation, communication and information internally has been crucial for DHL Express internally and with the bike manufacturer.

Space for cargo bike activities

Cargo bikes with shorter distance and less capacity require space in the city centre for loading/unloading of goods and storage (Leonardi et al., 2012). When talking about cargo bikes this location is often referred to as a micro depo. In this project the space used is close to the main road network at Skur 13 Filipstad/Aker brygge. The micro depot is a 20 feet container, however, empty buildings, parking facilities or locations for storage is also an alternative.



Figure S.5: Micro-depot used for storage of goods delivered by the cargo bikes located at Skur 13 Aker Brygge in Oslo.

The process of identifying a suitable location for the micro-depot was very time and resource consuming. Oslo municipality and DHL Express investigated over 20 different locations before they found a place which could satisfy all the requirements. The choice of using a container limited the number of alternatives due to:

- Placing a container at a parking space would be a problem for other users of the neighbouring buildings. Additionally, it was a requirement from the Agency for Urban Environment in Oslo that installations on their ground must be temporary moved four times a year.
- It was also a requirement to apply for such permanent large container installations which would take time and might be costly.
- The requirement of having electricity at the micro-depot was particularly challenging and limited the number of alternatives.

The solution was to install a container at a location owned by the Port of Oslo and that the Oslo municipality, in the pilot period, pays rent for this space. What happens after the set test period is unknown, but the municipality cannot subsidise only one private operator since it reduces the competition. All the effort place into finding a suitable location indicate that there is a need for setting aside space for urban logistics activities in local plans. Especially if local authorities aim to facilitate for future urban logistics solutions.

Another challenge relating to this space is that in October 2017 the area around the terminal was reduced. This has created difficulties for the concept DHL Express defined of having a van driving the goods all the way to the terminal.

In the future other solutions for micro hubs might be available. The goods can be sorted and placed on the bike directly or mobile depots/drop-off points can be used. This can reduce some of the barriers identified in this project such as electricity, however the need for centrally located space for logistics activities is still present.

Main considerations for public sector aiming to increase professional use of cargo bike deliveries is to:

- Secure good communication and collaboration with private sector stakeholders especially logistics service providers to capture their needs and ideas.
- Ensure that rules and public contracts capture logistics activities such as permanent micro-depots, the design of such and collaboration between private and public sector.
- Aim for continuity, defined timeframe and clear work plan from public sector is necessary for private actors when investing in new technology and changing internal systems.
- Simplify and make the process of identifying a location for logistics activities (micro-depot) in close proximity to the recipients more efficient:
 - define which locations that are suitable to such activities in their plans;
 - set aside space/locations in local plans for future urban logistics activities;
 - organise and develop a centrally located terminal to be used by all transport companies. If necessary further develop in line with a consolidation centre.
- Include all municipal agencies, especially those in charge of local planning in the development of cargo bike initiatives.

Regulations

Since this is a mid-term evaluation the stakeholders in this pilot are rather careful of listing potential measures which they identify as important for increased cargo bike usage in urban freight. However, two types regulations were mentioned. Either regulations which improve the accessibility for cargo bikes or regulations that increases the costs or reduces the accessibility of traditional vans or trucks. It is the former which is highlighted by the stakeholders in this pilot project. The cargo bike infrastructure could be improved. Tram lines, curb sides and biking in pedestrian zones was more challenging than anticipated. The public sector emphasis that predictable maintenance of bike lanes, especially during winter, and adjust these for cargo bikes are valuable. In addition cargo bike parking are from a public sector perspective important.

The opportunities of biking towards a one-way street, parking on the sidewalk and the use of dedicated bike lanes are important from a private perspective. Public sector mentions the opportunities of regulation which increases costs and reduces accessibility for vans and trucks. However, this is not mentioned by the private sector stakeholder.

- regulations such as providing opportunities for cycling both ways in on-way lanes.
- Predictable road maintenance during winter and facilitate future bike policies and measures to accommodate cargo bikes.