Institute of Transport Economics
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Summary

Evaluation of Elskedeby and an urban consolidation centre in Oslo

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In the pilot project Elskedeby, Ragn-Sells and Posten have replaced diesel vehicles with smaller electric vehicles in city distribution in Oslo. The result is a 94 percent reduction in greenhouse gas emissions. Logistics efficiency was lower than expected, but can be improved through more shared customers, better integration of smaller vehicles in the logistics system and increased freight volume. Driving with Paxsters and Lindetrucks in pedestrian streets has resulted in many interactions, but no conflicts or accidents. This indicates that these types of vehicles are safe and interact well with vulnerable road users.

If an Urban Consolidation Centre (UCC) was established for goods deliveries to the pedestrian street in Torggata, the number of vehicles could be reduced by 80 percent and space occupied by freight vehicles by 45 percent, given certain conditions.

Results from the evaluation of both Elskedeby and an UCC indicate it will be appropriate with regulations giving UCC vehicles exclusive access to pedestrian streets part of the day, combined with stricter enforcement of access and speed restrictions. This could increase traffic safety and reduce illegal driving, the number of vehicles in pedestrian streets.

Summary

Goal

This report is based on an evaluation of the pilot project *Elskedeby (Beloved city)* in Oslo, Norway. Elskedeby is a collaboration between Posten, Ragn-Sells, and KLP Eiendom. The goal of the evaluation is to establish a knowledge base for the development of regulations related to the use of consolidation centres and light electric freight vehicles in cities.

The evaluation seeks to answer: 1) How are logistic efficiency and C02 emissions impacted by the Elskedeby project? 2) How are traffic safety, interactions between road users, and occupancy of urban space affected by the use of small electric freight vehicles (Paxsters and Linde trucks) in pedestrian streets outside of normal delivery windows? And 3) How can an urban consolidation centre for Torggata affect the number of delivery vehicles and the demands on space in this pedestrian street? In addition, the use of geofencing for enforcing speed limits in the pedestrian streets of Torggata and Smalgangen in Oslo, is documented and highlighted.

Methods

Data were obtained through interviews, observations and registrations (done manually and through video), surveys, driving data from Ragn-Sells and Posten, GPS tracking and CAN-bus (vehicles), as well as vehicle specifications.

A working group was established in which all project partners participated: The Norwegian Public Roads Administration (Statens vegvesen, SVV), Posten, Ragn-Sells, Paxster, Oslo municipality, and The Institute of Transport Economics (TØI). All partners have contributed to technical discussions, data collection, and quality assurance of the report.

Logistic efficiency

As of fall 2021, Elskedeby had not achieved the levels of logistic efficiency expected by Posten and Ragn-Sells. Waste management and package delivery have few customers in common, and developing a wider and more collaborative customer base was seen as a prerequisite for the success of Elskedeby. Additionally, the vehicles were found to have a lower efficiency when compared with Posten's other vehicles operating in the same area. There is a need to integrate the smaller vehicle types in a more goal-oriented manner in order to achieve higher levels of efficiency, such that these vehicles are used on routes that are designed in accordance with their abilities. There is a need for frequent collection of small amounts of waste from shops with little storage space of their own. The capacity of Linde trucks can function well in this context.

Covid-19 is one of the primary reasons why Elskedeby's logistic efficiency has under-performed expectations so far. In particular, Ragn-Sells experienced a significant reduction in the number of orders, at lower volumes, and occurring more sporadically.

It is easier to increase efficiency when dealing with large volumes and, over time, develop-ing more efficient methods to complete tasks. It is expected that with increased learning, increased volumes, and more shared customers, Elskedeby has higher potential to increase logistic efficiency than current analyses show.

Greenhouse Gas Emissions

Elskedeby has resulted in a dramatic reduction in direct greenhouse gas emissions, respectively 98.9 % (without biogenic emissions) and 94.6% (including biogenic emissions). Biogenic emissions are $C0_2$ emissions from the burning of biofuels and other emissions related to biomass. Elskedeby uses a bio methane truck which produces biogenic emissions. Despite the inclusion of potential methane gas emissions (from unburned methane gas) in the calculations, the change would be marginal (from 94.63 % to 94.55 %). Posten and Ragn-Sells emissions goal of a 70 % reduction by 2023 for Elskedeby has already been reached.

There is a relatively high degree of uncertainty related to the number of driven kilometres used as a basis for emission calculations, especially considering the situation before Elskedeby. Due to this uncertainty, a conservative estimate was used for driven kilometres.

Safety and interactions between road users in pedestrian streets

The risk of accidents in pedestrian streets is generally low due to limited access for motorized vehicles and a speed limit corresponding to walking speed (6 km/h). Surveys from Torggata and Smalgangen support this. No accidents were registered during the project. Seven of 583 freight vehicles (1.2 %) experienced a conflict - an interaction with an obvious and sudden evasive action – with vulnerable road users in Torggata. About half of the freight vehicles had an interaction with vulnerable road users and the vast majority of these situations were resolved without issue and involved no risk to traffic safety. No dangerous or risky situations involving the Paxsters or Linde trucks from Elskedeby were observed. All of the interactions between these vehicles and vulnerable road users were the result of normal coexistence between road users. Paxsters and Linde trucks had many interactions with road users but no conflicts, which is a strong indication that these vehicle types are safe and well suited to sharing space with vulnerable road users in pedestrian streets.

Cargo bikes were registered with an average speed between 14.2 and 19.2 km/h in the pedestrian area of Torggata. Due to the higher average speed, smaller vehicle types pose a higher accident risk in pedestrian streets. Larger vehicles, especially delivery trucks, drove slowly and defensively. Despite this, delivery trucks were often observed performing manoeuvres, especially during parking, that were seen as a risk to vulnerable users because of the driver's blind zones. Nevertheless, no direct conflicts with vulnerable road users were observed in Torggata during these manoeuvres. The two conflicts observed with larger freight vehicles were associated with simpler but less predictable manoeuvres such as overtaking or turning.

The surveys showed that there are many freight vehicles in Torggata throughout the day during times when the density of pedestrians is at its highest. There is a clear tendency for vehicles to drive more slowly the higher the number of pedestrians present. Large vehicles are especially sensitive to this and there are clear indications that drivers adopt a more defensive driving style under crowded conditions.

Delivery trucks registered an average speed of 12 km/h in Torggata and, when pedestrian densities were low, up to 15,7 km/h. Even at such low speeds, the consequences of an accident with a large vehicle can be serious for vulnerable road users due to the greater external forces. Cargo bikes, Paxsters, and other light vehicles reduce the risk of injury for vulnerable road users.

In smaller vehicles, such as cargo bikes and Paxsters, the driver's seat is lower and located in the middle of the vehicle, providing good sightlines and an overview of the surroundings on both sides. Lighter vehicles are also relatively easy to manoeuvre. All in all, smaller freight vehicles enjoy several advantages over their larger counterparts in regards to safety.

Illegal Driving in Pedestrian Streets

The use of motorized vehicles in pedestrian streets is prohibited, with the exception of freight delivery during specified time windows. The pedestrian areas of Torggata and Smalgangen in Oslo are open to freight vehicles before 11:00 during weekdays. Delivery windows are often ignored by freight vehicles in Torggata. During an observation period of 8 days in August, 2020 69 vehicles were registered in the pedestrian area of Torggata between 11-12 o'clock. The same pattern was observed in November, 2020 and August, 2021 where, respectively, 16 % and 22 % of vehicles were illegally present (between 8:00 and 15:30/16:00).

In Smalgangen, illegal driving was rarely observed. Observations suggest that there are very few vehicles delivering both before and after 11 am. The entrances at both ends of Smalgangen are restricted by bollards and a guard was observed actively enforcing the ban on driving. This is likely an important contribution to reducing illegal driving in the pedestrian area.

In Torggata (august 2020), it was primarily delivery vehicles that were registered after 11:00, though some through traffic was observed in addition to a number of vehicles belonging to tradespeople and service companies. The reasons for illegal driving in Torggata have not been researched, but is presumably related to the challenges transporters face in reaching all deliveries within a given time window. How early goods can be delivered is dependent on both where they fit within a delivery route and when those goods arrive at the freight terminal from either domestic or international origin. Goods must be sorted and loaded before they can be transported from the terminal to the recipient in the city (potentially via a hub). In addition, there is not always someone present to receive the delivery before stores/businesses open, there can be a need for express deliveries throughout the day, and

congestion and roadwork can cause delays. There are also cases where pedestrian streets are used as a shortcut outside of normal delivery windows.

Spatial Footprint in Pedestrian Streets

Elskedeby received permission to operate its Paxsters and Linde trucks in the pedestrian areas of Torggata and Smalgangen outside the normal delivery window times. Without this permission, the Elskedeby vehicles would have been required to either make their deliveries before 11:00 or park outside of the pedestrian area to make the same deliveries or pickups.

Linde trucks using a trailer attachment are substantially larger than a Paxster and require nearly 5 times as much space (including the space for loading and unloading) when operating in pedestrian streets. However, the Linde truck largely replaces the need for a waste collection truck, which have even higher spatial footprints. Similarly, a Paxster replaces a delivery van, which has a substantially larger spatial footprint when compared to a Paxster. Additionally, the Linde truck remains in Torggata substantially longer in comparison to the Paxster. On average, a Linde truck spends 47.5 minutes operating in Torggata while a Paxster spends 8 minutes. Consequently, the space occupied by the Linde truck over time is far higher than for a Paxster. The primary reasons for this difference can be traced to the larger volumes carried by the Linde truck, the fact that it serves Glasmagasinet (large number of shops and restaurants), as well as a frequent queue for using the goods elevator at Glasmagasinet.

Space occupied by vehicles over time can be measured as *area-time (m^2t)*. Area-time takes into account how long a vehicle stays within a given area, as well as the vehicle's size. This is relevant since a large vehicle that spends a short amount of time in a given area can have a lower requirement for space than a smaller vehicle that spends a longer amount of time in the same area.

After the normal delivery window closed at 11:00, the Paxsters and Linde trucks continued to operate within the pedestrian area until around 14:30. Observations show that during this time the density of pedestrians was substantially higher than it was before 11:00. Most stores in Torggata open at 10:00, so there are naturally higher numbers of pedestrians from this point and onward.

Covid-19 restrictions have reduced the level of activity in the pedestrian streets and affected the number of orders for Elskedeby, which has most likely affected the area occupied by Paxsters and Linde trucks.

The ability to operate in pedestrian streets after 11:00 can also have an effect on route planning and optimisation for Elskedeby. For example, Paxsters were registered driving through Torggata without stopping on several occasions, and we can assume that the pedestrian street was being used as a shortcut. This shows that the possibility of driving through Torggata after 11:00 provides a reduction in the number of kilometers driven for Paxsters and Linde trucks, as well as less time spent on distribution. The size of this effect and its impact on Elskedeby's efficiency is unknown, but it can be assumed that permission to drive through additional pedestrian areas outside the normal delivery window could contribute to increased demands on urban space by vehicles. Increased vehicle traffic through pedestrian areas could be seen as a disadvantage for vulnerable road users on pedestrian streets.

Urban Consolidation Centre for Torggata

An urban consolidation centre is a transhipment terminal where goods – and potentially waste – are consolidated by multiple logistic operators. Deliveries to - or pickups from - the

same place or area can be consolidated into a limited number of vehicles to increase efficiency.

Projections show that if a consolidation centre were established for the pedestrian area of Torggata it would contribute to reducing both the number of vehicles operating there as well as their demands on the street's limited space. Analysis shows that a consolidation centre has the potential to reduce the number of vehicles by nearly 80 % and reduce demands on urban space over time (area-time) by 45 % when compared with the current situation. These are significant reductions. The analyses show an example of how a consolidation centre can influence both vehicle movement and use of space, given that a number of prerequisites are met. It is assumed that the consolidation centre uses Paxsters, electric vans, and electric trucks (two axles), and that these are filled to 80 % of their capacity. Observations give a clear indication that, at the time of delivery, vehicles operating in Torggata have a lot of spare capacity: 45 % of vehicles were filled to just 1/3 or less of capacity, 35 % were more than half full, and the rest were about half full.

The high number of small and medium sized packages compared with the number of larger packages and pallets indicates that the size of deliveries to Torggata are well suited for an urban consolidation centre that tranships packages to the appropriately sized vehicle. This analysis does not take into account deliveries to grocery and department stores that receive a high number of large packages and pallets. A consolidation centre would not be appropriate for these industries due to the quantity and size of the goods in question.

The effect a consolidation centre has on the number of vehicles and their demands on space is dependent on the type of goods being consolidated. The effect will be larger if deliveries to private customers and offices above street level are included, as well as pickups and waste collection. Restaurants, bars, and cafés are included in the analysis, but it is challenging to include this market segment in a consolidation centre. Refrigerated cargo increases the complexity of logistic chains due to the increased demands on handling and storage in order to maintain cold temperatures throughout the delivery process.

The survey of goods recipients in Torggata shows that 12 of 19 business do not have a specific time window to receive deliveries and that nearly half receive deliveries every day or as often as 2-3 times per day. Frequent, small deliveries to stores, potentially because of limited storage space, is a substantial influence on the number of vehicles in Torggata. As a result, a large effect can be generated by switching to more consolidated deliveries coordinated by a consolidation centre.

Consolidation requires an additional step in order to tranship consolidated goods, increasing overall costs. It is generally a challenge to find economically sustainable business or financing models for consolidation centres. Reaching high enough freight volumes, especially during the start-up phase, is also challenging (Fossheim et al 2017; Jensen et al 2020b).

Regulations for urban consolidation centres

Current regulations prohibit motorized vehicles in pedestrian streets, excepting provisions for deliveries within a specific time window. In many pedestrian streets, deliveries are permitted before 11:00, such as in Torggata and Smalgangen in Oslo. Driving faster than walking speed (6 km/h) in pedestrian streets is prohibited. These rules contribute to a safer and more comfortable environment for pedestrians, while at the same time allowing stores and other businesses to receive deliveries and have waste collected.

Surveys in the pedestrian are of Torggata show that there is a substantial number of vehicles operating after 11:00. This is also evident in other pedestrian streets, both in Oslo

and other cities. Stricter enforcement of delivery windows could have negative consequences both for logistic operators and traffic throughout the city.

If freight vehicles are permitted in pedestrian areas after 11:00, when there are more people, they should be required to conform to certain weight and design specifications out of a consideration for traffic safety. In order to facilitate deliveries and waste collection while reducing the risk of accidents and injuries, access restrictions could be implemented that differentiate between multiple types of vehicles. Larger vehicles could be given access to pedestrian areas only during times when lower numbers of pedestrians are present. This would need to be combined with stricter enforcement of both access and speed restrictions. These measures would reduce the risks for accidents and injuries that were observed in Torggata.

Surveys indicate that delivery vehicles in Torggata generally drive much faster than walking speed (6 km/h). In November, 2020, the average speed for different vehicles was observed to range between 11.8-15.6 km/h. Tests conducted using geofencing for enforcing speed limits show that it is effective at reducing speeds to be similar to that of pedestrians. In Torggata, Paxsters were observed to have an average speed of 16.57 km/h without geofencing, which then fell to around 6 km/h after geofencing was put in place. This indicates that geofencing can be a powerful tool for enforcing speed limits in pedestrian areas, given that it applies for all types of vehicles. Geofencing could also be used to enforce access restrictions for different vehicle types in pedestrian streets.

A consolidation centre for urban areas with pedestrian streets, with permission to operate in restricted areas after 11:00, has the potential to increase traffic safety while also reducing illegal driving, the total number of vehicles, and the number of large vehicles in pedestrian streets. Consolidation centres can also contribute to increased efficiency for logistic operators that can deliver to the terminal instead of carrying goods all the way to the end customers.

Regulations can help make consolidation centres more attractive to establish and operate. If restrictions are imposed such that vehicles from a limited number of consolidation centres receive exclusive access to drive in pedestrian streets for large portions of the day, then the chances for establishing a profitable consolidation centre rise considerably. Logistic operators would have larger incentives to deliver to the consolidation centre. Such is the case with the consolidation centre Stadsleveransen in Gothenburg, Sweden, where the municipality gave the operator of the consolidation centre a dispensation from restrictions (access, delivery windows, vehicle weight) in the area served by the consoledation centre (Akgün et al 2020). Norwegian municipalities do not have the legal authority to grant this type of dispensation. When Stadsleveransen was established, the time window for deliveries was also changed from 11:00 to 10:00, meaning that all vehicles except those operated by the consolidation centre needed to leave the pedestrian street before the stores opened. This provided shops with an incentive to use Stadsleveransen.

Time windows for access to streets in Oslo can directly impact a logistic operators' ability to plan efficient routes and cause an increase in the number of drivers and vehicles needed. The primary reason for this is that reaching all deliveries within time restricted areas while also managing other deliveries and pick-ups is challenging. This means that the larger the number of streets with time restrictions, and the shorter the time window is, the greater the number of vehicles required to deliver the same number of goods. All else being equal, this will result in lower overall efficiency and increased costs for logistic operators, as well as increasing traffic and the number of kilometres driven by delivery vehicles.

Oslo has parking spots controlled by the municipality that are reserved for use by specific car sharing services, such as Bilkollektivet and Hertz Bilpool. Something similar could be

considered for delivery vehicles connected to a specific consolidation centre, providing them with better parking opportunities.