GREEN URBAN DISTRIBUTION: EVALUATION OF ADAPTED MEASURES FOR THE CITY OF OSLO

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1. INTRODUCTION

The city of Oslo, like many other cities, is in rapid growth, with a population expected to increase by over 30 % by the year 2030 (Oslo kommune 2011). As a consequence, the demand for transport services will rise rapidly and markedly over the next years, and freight distribution will also increase by 50 % by 2030.

Freight deliveries are vital to an attractive and living city centre with shops, restaurants and other businesses. Nevertheless, freight distribution causes hazardous gas emissions, congestion, noise and other disturbances. Furthermore, freight vehicles are often in conflict with other road user groups such as pedestrians, cyclists and public transport.

As a consequence of urbanisation and requirements to reduce pollution, the Municipality of Oslo is considering how transportation of both goods and passengers can be effectively optimised. Even though some improvements for greener freight transport have already been achieved, the Municipality of Oslo is seeking new innovative measures that may improve the situation for stakeholders and for the environment even further. Hence, the project Green Urban Distribution (GUD) aims at identifying and demonstrating environmentally friendly and efficient solutions for urban goods distribution in the city centre of Oslo.

This is sought accomplished by a methodological process consisting of four steps; from identifying measures that may lead to more efficient and environmentally friendly goods distribution, to selecting, adapting and evaluating measures found to be the most feasible and efficient in the context of Oslo. This process is illustrated in Figure 1.

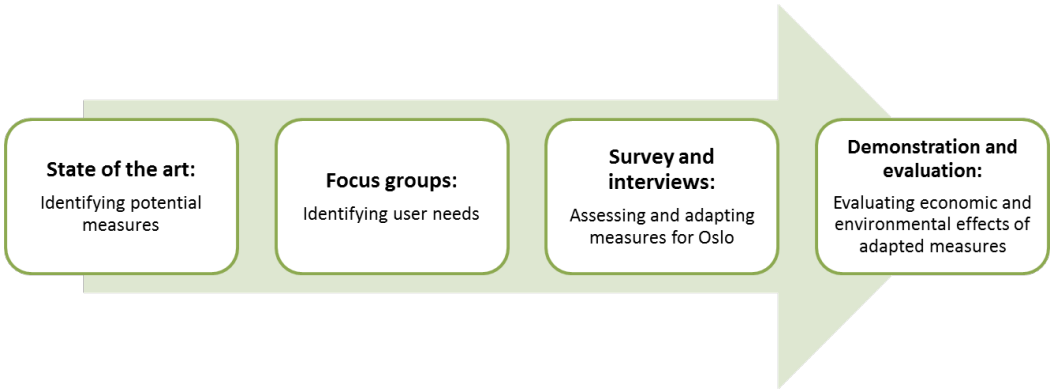

Figure 1: The process in the GUD project from identifying potential measures to evaluating effects of selected and adapted measures

In this paper, focus will be placed on the two steps furthest to the right in the Figure 1; assessing and evaluating measures.

Policy design must always be based on knowledge of the particular context to which the policy will apply. Even though reports from initiatives taken in other cities may show positive results, a thorough analysis of the implications of transferring these measures to the context of another city is required (Macário and Marques 2008). Thus, in order to implement successful urban freight measures, it is of vital importance that potential measures are properly assessed in a local context beforehand.

Some of the measures tested in other European cities have seemingly showed good results, while others have caused unwanted consequences. A general observation is that the evaluation results in many cases are absent or not published. The evaluations already realised are often adapted to the measure at-hand. Better evaluation frameworks could lay the ground for more transferable experiences and learning between countries and cities. One of the main objectives of the GUD project is therefore to yield impact assessments based on a framework of indicators tested by collected data from two demonstrations.

On this basis, the objective of the paper is twofold. Firstly, the paper presents methods and results from an *ex-ante* study of measures. The study is based on a survey among the stakeholders that would be the most affected by an implementation of the measures in question. Secondly, the evaluation framework used in an *ex-post* study of demonstrated measures is presented, as well as how the framework has been applied to evaluate a demonstration of electric distribution vehicles.

2. ASSESSING FEASIBILITY OF NEW CITY LOGISTICS PRACTICES

The successful introduction of new measures depends on the acceptability and receptivity of involved stakeholders. In order to successfully implement city logistics policies, it is of vital importance to recognize and adequately understand the concerns of different stakeholders (Stathopoulos et al. 2011).

One of the most important predictors of a measure's feasibility is therefore its consequences to involved stakeholders. Stakeholders will adhere to a measure only if it will not inflict any negative consequences upon them (Rogers 1983), or if positive consequences outweigh negative ones. Further, negative consequences are typically more important to stakeholder evaluations than the measure's effectiveness (Schuitema and Steg 2005). Consequently, stakeholders should play an important role in revealing potentially negative and positive outcomes of a measure before it is implemented.

A stakeholder can be defined as an actor or group of actors which affects or are affected by the phenomenon under study (see also Freeman 1984). Recent research has identified carriers, end-receivers and local authorities as the most relevant stakeholders in the urban distribution chain (Lindholm 2012, Russo and Comi 2010, Stathopoulos et al. 2012). These are also considered vital for the introduction of measures in the city of Oslo, and are the main focus in the GUD project. An increased international focus on reducing emissions from urban freight has resulted in a significant number of city initiatives and new practices in this domain, as well as studies of these practices. In a state of the art report, Roche-Cerasi (2012) identified and documented European city logistics practices. Based on stakeholder interviews undertaken in the GUD project (documented in Bjerkan et al. 2013) and an initial assessment of the suitability of the identified logistics practices for the local context of Oslo, the following measures were found to be of relevance:

- Off-hour deliveries
- Booking of loading bays
- Multiple use lanes
- Urban consolidation centre
- Access restrictions
- Environmentally friendly vehicles
- Unmanned freight receipt

In order to assess the feasibility of each of these measures, a survey was carried out among 67 stakeholder representatives. The survey was carried out online, and the link to the web survey was distributed to partners in the GUD project and other persons named by the partners on the basis of their competence areas.

The survey is not representative for the stakeholders in the city centre of Oslo as a whole, but it does give valuable input from a relatively large and varied selection of actors in the local setting. The end-receivers were the largest group

of respondents with 42 % of the sample, representing shops, restaurants and coffee places, hotels and canteens. Representatives from local and central authorities amounted to 36 % of the sample, with competence areas like city and road planning, parking regulations, environmental issues, urban freight and public transport. Carriers constitute only 13 % of the sample, but these respondents represent companies that handle the majority of deliveries to receivers in the city centre of Oslo. The last 9 % of the sample are representatives from interest groups for carriers and end-receivers and consultants.

The main part of the survey was concentrated around assessing consequences of the measures. More precisely, the carriers and end-receivers were asked to consider the consequences for *freight distribution* in the city centre of Oslo, whereas representatives from the authorities were asked to assess the consequences for *society*. The measurement scale went from 1=very positive consequences to 5=very negative consequences, which is recoded into the scale -2=very negative consequences to 2=very positive consequences in the analyses presented in this paper. The respondents were also free to comment every measure.

The questions were introduced by a short description of the measure in question. The completion time of the questionnaire was 10-20 minutes.

In the following section, the results from the stakeholder assessments of each measure are presented.

2.1 Results

Off-hour deliveries

Today, the majority of deliveries in the city centre of Oslo are made between 9 AM and 3 PM, when stores and office buildings are open and staff is present to receive the goods. If more deliveries are made during evenings, nights and early mornings, the time spent in traffic is likely to be significantly reduced, resulting in lower emission levels and more predictable delivery times (Holguin-Veras et al. 2012). Furthermore, the delivery stop times will be reduced, with easier and more direct access to delivery points. Focus group interviews with stakeholders in Oslo have indicated that both carriers, end-receivers and authorities recognize these gains and are positive towards off-hour deliveries (Bjerkan et al. 2013).

The survey revealed a less optimistic assessment of this measure, as limitations regarding HSE (working hours and security for drivers and receiver staff) and noise were pointed out (Figure 2 and 3). Some respondents, notably among end-receivers, were also concerned about increased wage costs. They argue that it would be too expensive to have staff in their shop or office reception solely for the purpose of receiving goods. The respondents also comment that some types

of goods are not suited for deliveries outside opening hours, such as high-value articles and drugs.

Previous research has identified the end-receivers (Holguin-Veras et al. 2012, Holguín-Veras et al. 2006) or whole-salers (Tretvik et al. 2013) as the most influential parts of the logistics chain when it comes to deciding time of delivery. Thus, policies designed to encourage off-hour deliveries should target the transport service buyers in order to be effective. In line with these findings, the carriers in the GUD survey comment that off-hour deliveries are not feasible as most customers require that the deliveries are made when the receiver is present; that is during opening hours.

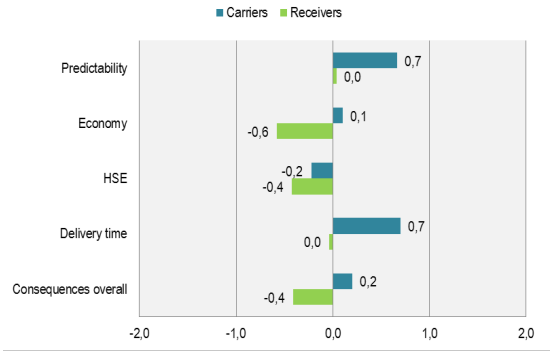

Figure 2: Assessment of off-hour deliveries. Carriers and end-receivers.

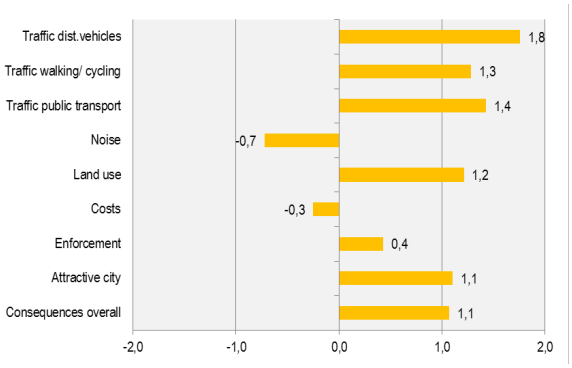

Figure 3: Assessment of off-hour deliveries. Authorities.

Booking of loading bays

One of the main problems for carriers in inner cities is to find a place to unload the vehicle near the delivery point. When no parking space is available, the carrier must drive around until he/ she finds a space, or park illegally. This has negative effects on traffic flow, environment, and safety. It also delays deliveries to the receiver and causes unpredictable delivery times for both carrier and receiver.

By using a system of booking or otherwise pre-approval of access to loading bays for certain types of vehicles, the plausibility of finding an available space increases. However, the respondents are concerned that a booking system is not feasible. If a driver has booked a parking space and for some reason (traffic and weather conditions, delays with earlier deliveries) is unable to arrive at the specified time, the space will be left unavailable to other drivers even though it is not physically occupied for that time period. Thus, such a system could lead to more inefficient use of street area, contrary to the intentions.

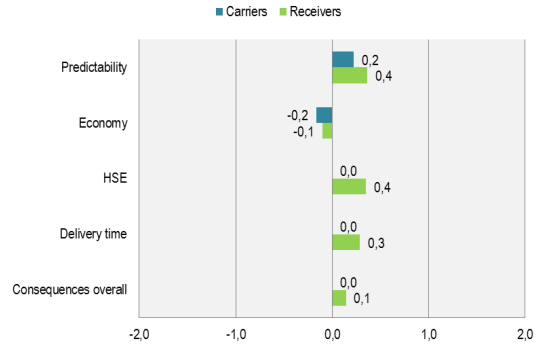

Figure 4: Assessment of booking of loading bays. Carriers and end-receivers.

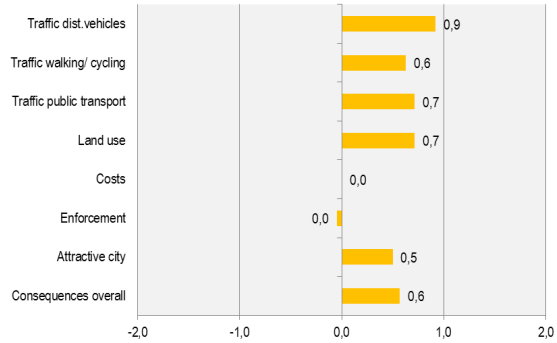

Figure 5: Assessment of booking of loading bays. Authorities.

A more feasible way to increase availability of parking space for carriers could be to restrict availability for other vehicles. In Oslo, most parking spaces are only allowed for shorter stops for loading/ unloading goods or passengers. These spaces are accessible not only for carriers but also for private drivers, light distribution vehicles with direct deliveries of for instance fruit or office supplies, taxis and workmen. Making these spaces accessible only for carriers in the time periods that most deliveries are made could therefore be a more suitable measure than advance booking for a single vehicle.

Multiple use lanes

In the city centre of Oslo, buses and trams constitute a significant portion of the traffic. Certain streets are open only to buses or trams, and the authorities plan to establish more such streets in the next years. Giving distribution vehicles access to bus streets outside peak hours may lead to a more efficient utilisation of available street areas. For the carriers this could lead to shorter delivery times and reduced emission levels, and for the receivers the delivery times can become more predictable.

The respondents are positive towards giving carriers access to bus streets outside peak hours, although carriers and receivers are more positive than authorities. However, some point out that the need to access these streets is most prominent during peak hours, and that the usefulness of such a measure would be limited in the busiest streets as there is a continuous flow of buses and trams.

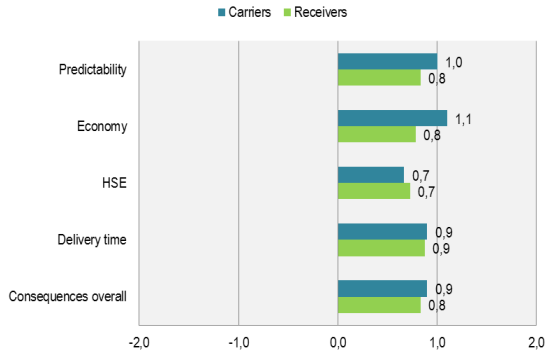

Figure 6: Assessment of multiple use lanes. Carriers and end-receivers.

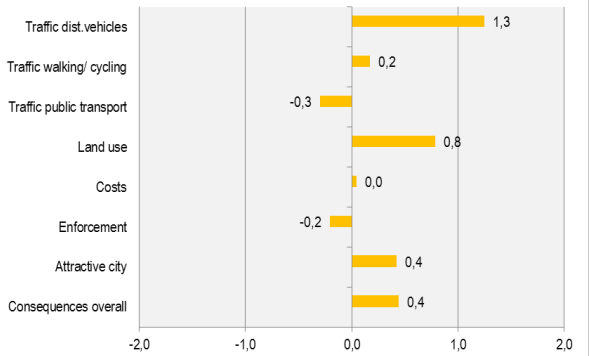

Figure 7: Assessment of multiple use lanes. Authorities.

Such a measure necessitates effective regulation and control of the number of distribution vehicles that are allowed in the bus streets simultaneously, to avoid delays for buses and trams. Restricting access only to environmentally friendly distribution vehicles would enhance the environmental benefits. It is an important aim both for local and national authorities that public transport should be an attractive alternative to driving private cars. Combined with a solid population growth, the number of buses, trams, cyclists and pedestrians in the city centre of Oslo are expected to increase markedly over the next years. Thus, before implementing such a measure a thorough study of potential and capacity is needed.

Urban consolidation centre

Consolidation of goods from different carriers in a centre in or near the outer limits of the city centre can lead to more effective goods distribution, by facilitating fewer and/ or more environmentally friendly distribution vehicles. This solution can reduce local emissions from goods distribution significantly. Several European cities have developed urban consolidation centres, through projects often financially supported by public authorities (Roche-Cerasi 2012).

In the GUD survey, respondents from the authorities are mainly positive to the idea of a consolidation centre, whereas carriers and receivers comment that this would represent an additional level of goods management and as such would be too demanding with regard to time and costs. Carriers also point out that goods are already consolidated within the company and optimised so that most vehicles are filled.

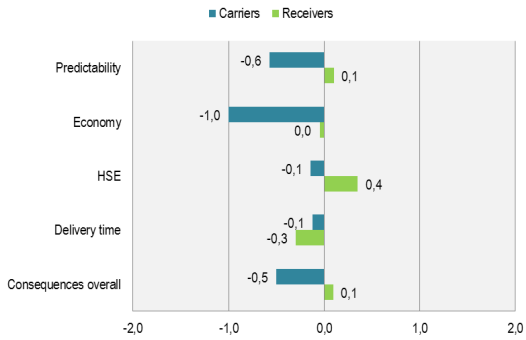

Figure 8: Assessment of urban consolidation centre. Carriers and end-receivers.

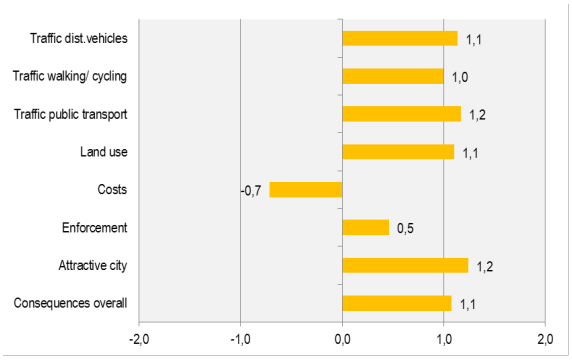

Figure 9: Assessment of urban consolidation centre. Authorities.

Although the will to use consolidation centres is limited among commercial actors, local authorities may force on the establishment of such centres by demanding that freight distribution in the city centre must be accomplished by use of environmentally friendly vehicles. Moreover, counter-terror measures can necessitate consolidation and alternative last-mile transport with approved vehicles.

Access restrictions

There are several forms of access restriction schemes that may be implemented in order to reduce traffic and thereby vehicle emissions in certain areas. Such schemes are typically based on criteria such as time windows and/ or vehicle characteristics, and may entail full denial of access or pricing schemes. In Oslo, variations of access restrictions already exist in pedestrian areas and streets reserved for buses and trams.

The stakeholder views on access restrictions depend on the actual design of a defined measure when it comes to criteria for restriction. In general, the carriers and end-receivers in the survey are very negative towards access restrictions, while the authorities are more positive. Several respondents comment that access restrictions would only work if accompanied by other types of measures, such as environmentally friendly vehicles, consolidation centre and/ or off-hour deliveries. Some are concerned that goods deliveries will be so difficult and costly that commercial actors will move out of the inner city.

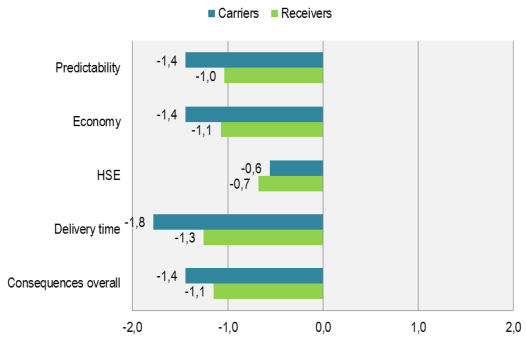

Figure 10: Assessment of access restrictions. Carriers and end-receivers.

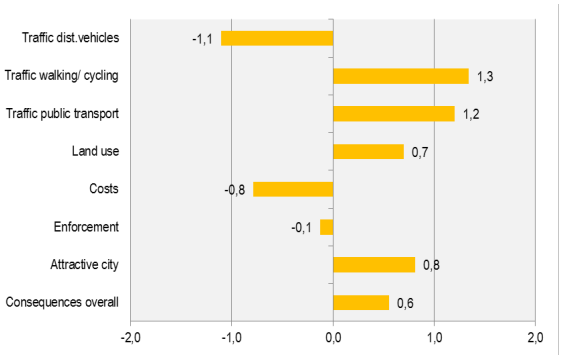

Figure 11: Assessment of access restrictions. Authorities.

Environmentally friendly vehicles

Increased use of bicycles or vehicles driven by electricity or gas may lead to a significant reduction in emissions, and thus represents a very efficient measure in order to obtain more environmentally friendly goods distribution. Smaller vehicles may also be easier to park near delivery places, and thereby lead to more efficient freight distribution.

In the survey, carriers are rather optimistic towards increased use of environmentally friendly vehicles. This is somewhat surprising, as the carriers will be carrying the economic burden of investing in new and more environmentally friendly vehicles, at least in a short-term perspective. It should be noted the carriers represented in this survey are mainly large companies already using electric and gas driven vehicles, who for various reasons would like other companies to take the same steps. The results may therefore not be representative for the whole stakeholder group.

The end-receivers in the survey are more negative to this measure, mainly because of the economic consequences.

In the GUD project, use of small electric distribution vehicles has been tested in the city centre of Oslo. The evaluation results from this demonstration are documented in Chapter 3.

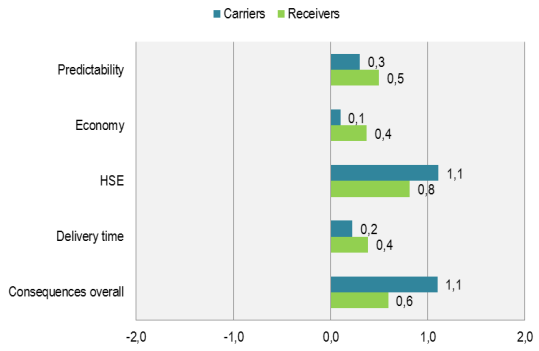

Figure 12: Assessment of environmentally friendly vehicles. Carriers and end-receivers.

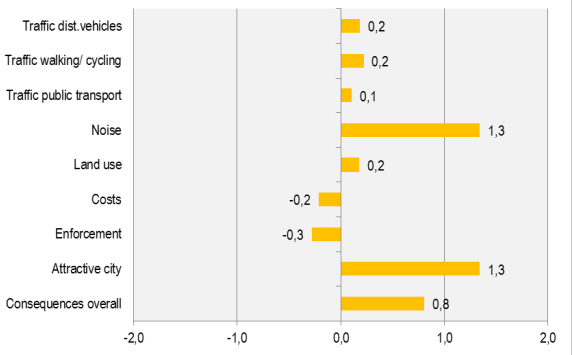

Figure 13: Assessment of environmentally friendly vehicles. Authorities.

Unassisted deliveries

Delivery solutions that do not require receiver staff to be present may contribute to a more effective and environmentally friendly distribution of goods, by facilitating deliveries outside regular office/ opening hours. For instance, placing goods in a secure container or storage room will reduce the need for a physical receiver to be present.

The response to such measures in the GUD survey is mixed. The authorities are positive; the carriers and the receivers are a little negative. The stakeholders comment that such an arrangement would not be suitable for large deliveries, neither for goods that require uninterrupted cooling or freezing, nor valuable goods, medicines and alcohol (due to security reasons). As such, the effect of such a measure is assumed to be limited. Furthermore, the staff could also be required to pick up the goods themselves, which introduces issues related to HSE (heavy lifting) and ability to leave the shop.

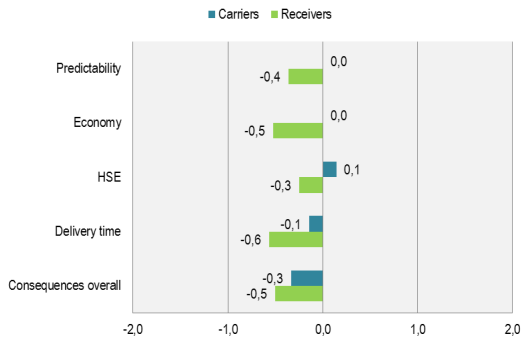

Figure 14: Assessment of unassisted deliveries. Carriers and end-receivers.

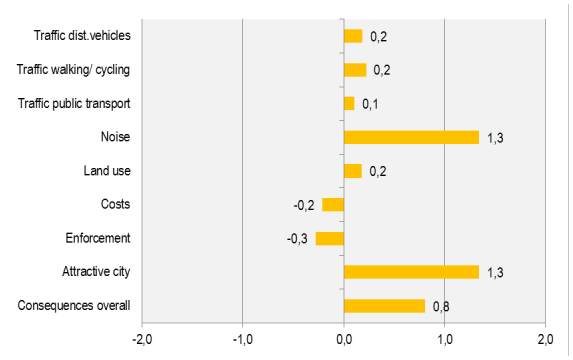

Figure 15: Assessment of unassisted deliveries. Authorities.

2.2 Overall assessments and conclusions

Figure 16 shows the mean scores for each measure from carriers (blue columns), end-receivers (green columns), authorities (yellow columns) and for all groups together (brown columns).

Figure 16: Assessments of consequences of measures for urban freight distribution by stakeholder groups and for stakeholder groups combined (total).

The figure shows that in total, the measure that the stakeholders together assess most positively is more use of environmentally friendly vehicles. The measure that is assessed most negatively is access restrictions for distribution vehicles. The figure also shows that the three stakeholder groups are not in harmony in how they assess the measures. Notably, the authorities have differing views from the two commercial stakeholder groups. For example, the authorities are much more positive towards access restrictions and urban consolidation centres than the carriers and the end-receivers, while they are more negative towards multiple use lanes. Thus, the authorities lean towards restrictive measures, while they are reluctant to prioritize freight transport over passenger transport.

However, in order to keep a positive and productive cooperation with the commercial actors, the authorities are recommended to study the possibilities of adapting the measures that are viewed as positive by carriers and end-receivers in such a way that they can be implemented without compromising other interests society might have. Multiple use lanes is a solution that is very welcomed by the carriers, but seen as conflicting with the goal of an attractive public transport system by the authorities. This measure can be modified so that only environmentally friendly distribution vehicles earn access to bus lanes, and only outside peak hours. In this way, the measure is adapted into the local context in a way that is suboptimal but acceptable for each stakeholder group,

and positive for society as a whole. With the survey results as a basis, similar adaptations can be done to other measures in order to achieve city logistics practices that are both acceptable and efficient.

3. EVALUATING MEASURES

For the purpose of evaluating a set of demonstrated measures, the GUD project has established an evaluation framework. In the following, the framework is presented, as well as an example of how the framework is applied to evaluate a demonstration of electric distribution vehicles.

3.1 Evaluation framework

In order to evaluate a set of heterogeneous measures, the evaluation framework must be designed in a general manner. The evaluation approach is therefore not targeted towards specific measures, it is rather general and intended for use of any measure aimed at improved urban distribution in Oslo.

The evaluation is based on a set of indicators for comparison of scenarios with and without a measure. Litman (2009) defines an indicator as a variable chosen and defined to measure the development towards an objective. Indicators serve two main purposes (OECD 2003):

1. They reduce the number of measurements and parameters that otherwise would be needed for an exact representation of an situation or state
2. They simplify the communication of results to users

CIVITAS POINTER (2009) and STRAIGHTSOL (2012) define four main impact areas that should be considered when measures in the transport sector are evaluated, these are Economics, Environment, Society and Transport. For the GUD project, a simplified and slightly adapted version of the STRAIGHTSOL framework (STRAIGHTSOL 2012) was used. In total 20 indicators are used to represent the four impact areas, these are shown in Figure 17. There will be interrelations between indicators, typically (but not exclusively) from left to right in Figure 17. All indicators will not be relevant for all measures, but they should together be able to capture the most important aspects of relevant measures.

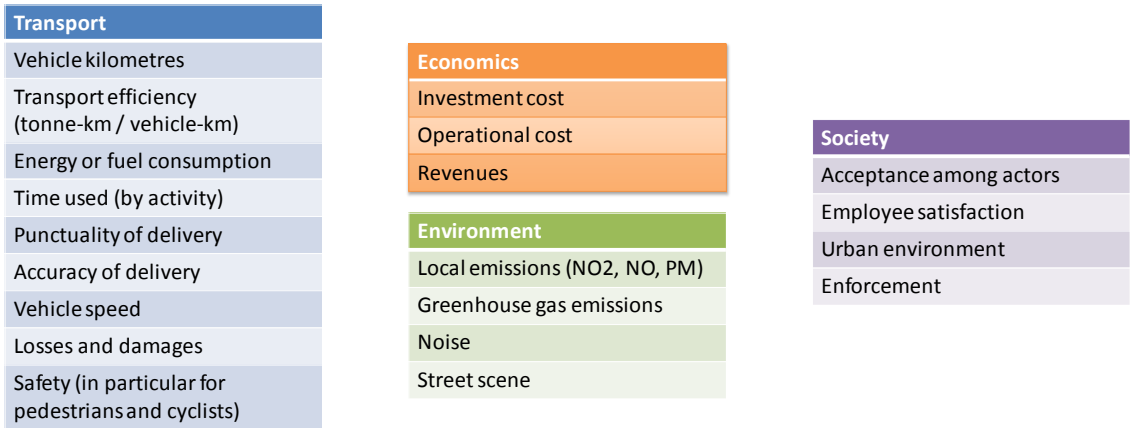

Figure 17: Indicators organised by main impact area

3.2 Ex-post evaluation of electric vehicles demonstrator

The Logistics Service Provider BRING Express (BEX) is one of the largest courier and express shipment provider in Norway. They have a strong environmental strategy and one of their goals is to establish a fleet of electric vans for their operations. Express shipments in cities are well suited for electric vehicles, with short distances and small volumes. In Norway electric vehicles are exempt from toll charges and parking fees on public parking areas, which we return to below. There is, on the other hand, hesitation to use electric vans due to their limited range, performance during winter, etc.

During 2012 BEX tested several electric vehicles in their operations for one or more days, ranging from simple Comarths to electric versions of Ford Connect and Renault Kangoo. After these experiences, they decided to test the Renault Kangoos more extensively. BEX does not own the vehicles they use, they rather engage transporters as subcontractors, who often act as drivers as well. The testing was therefore performed by transporters who volunteered.

Two Renault Kangoos were tested in real operations during two weeks in the inner parts of Oslo, one operating fixed routes, while the other one was used in ad-hoc operations. Significant effort was placed on actual measurement of the operations that took place, and the vehicles were equipped with GPS devices that monitor their movements. In addition, the drivers were equipped with cameras enabling them to take photos of their delivery conditions ant the actual parking of the vans. Below we summarise the main experiences within the four impact categories transport, economics, environment and society.

Transport

The logistics operations were conducted in a similar way with electric vehicles as if the same operations were conducted with traditional diesel vehicles. Thus, the majority of the transport-related indicators were not affected by the measure. The testing of the electric vehicles suggested that on most days the battery capacity was sufficient for shorter delivery routes within the inner parts of Oslo. On a few days it was necessary to charge the car during lunchtime to have enough capacity for the remaining day.

The most prominent effect was obtained for the indicator related to energy use and fuel consumption. Sund et al. (2013) have calculated the litres of diesel saved by use of electric vehicles to be roughly 4.8 litres per day. Given 220 days in operation per year, this gives an annual saving of 1,056 litres of diesel per vehicle. Sund et al. (2013) maintains that this estimate probably is conservative.

Economics

Norway has the world's highest uptake of electric passenger cars, this is caused by fiscal measures as lower taxes on new cars and additional benefits like access to public transport lanes and exception from toll charges and parking fees on public parking places. The latter benefits also apply for electric vans, while the tax benefit on new vans is much smaller. Based on a calculator tool that has been developed by the organisation *Grønn Bil* ("Green car"), comparisons were made between electric vans and conventional diesel vans. Assuming that cars were leased, electric vans were estimated to be around 500 Euros more expensive per year than diesel vans. Assuming that cars were bought, electric vans were estimated to be around 500 Euros cheaper than diesel vans. These calculations were based on a Peugeot Partner Electric van. The overall finding from these calculations is that electric and diesel vans seem to be about equal in terms of financial performance. There is however uncertainty involved, and this uncertainty is particularly high for the electric cars.

In the electric passenger car market the technological developments are moving fast and this has made investment in electric cars risky. When Nissan Leaf was introduced, the price of other electric cars was cut drastically. Analogously, the improvement of technology may lead to high depreciation costs for those who invest in electric vans today. The investment in electric vans may thus seem more risky than investment in conventional diesel-fuelled vans. It is also known that the capacities of batteries are reduced over time, and replacement batteries are expensive. The Renault Kangoos that were tested by BEX come with battery leasing based on a monthly fee, where the battery is guaranteed to have a capacity of at least 75 % of that of a new battery. This may reduce some of the uncertainty.

Environment

Evaluating emission effects in an urban setting is a complex task. However, for the indicators related to local emissions and greenhouse gas emissions it is possible to calculate savings from the saved diesel consumption due to electric powering of the vehicles.

A key finding from the Green freight transport project is that freight transport service providers have production systems that provide a digital mirror image of the freight transport activities (Levin and Norvik 2013). The GUD project draws on this and includes GPS traces to get more detailed emission estimates by calculation of average speeds between stops on the route. Thus the emission estimates are more accurate and will document effects related to change in time of day, routes and access to parking spaces for electric vehicles. From the data set collected in the demonstration of electric distribution vehicles the activities of two days were studied in detail.

In order to assess the emission effects of using electric vehicles instead of an ordinary diesel vehicle, the route driven by the demo vehicles was applied as a basis to calculate emissions from a diesel car (Euro IV). The calculations show that diesel cars would have used 0.07 litres diesel per km, producing around 0.17 kg of CO_2 per km and 0.49 g NO_x. Further details are given in table 1.

Table 1: Calculated emission savings for replacing diesel vehicles with electric vehicles in the GUD demonstrator

		Diesel (litres)	CO_2 (kg)	NO_x (g)	*sPM (g)*	HC (g)	CO (g)
Day 1	**Total**	4.77	12.68	35.82	*2.56*	1.38	4.20
	Per km	0.07	0.17	0.49	*0.04*	0.02	0.06
Day 2	**Total**	4.80	12.76	35.95	*2.55*	1.39	4.60
	Per km	0.07	0.18	0.50	*0.04*	0.02	0.06

It should be noted that the emission calculations are conservative as they assume that when the vehicle is parked for pickups and deliveries the engine is always shut down and not idling.

To study the effect of on/off-peak emissions average speeds per hour were accessed. Average speed emission functions from the ARTEMIS project (Boulter and McCrae 2007) were used to calculate the emission reductions by switching to electric vehicles. For CO_2 calculations it was assumed the direct emission from using electricity in Norway was 0 g/kWh as Norway's energy is produced from renewable resources.

Based on standard emission factors and valorisation values, the environmental savings caused by the reduced emission of one diesel car has been estimated to around 450 Euros per year. That being said, Oslo has experienced air quality problems the latest years related to NO_2, which has not been accounted for in the valorisation used. The impact of emission savings may therefore be larger than calculated.

Society

The use of electric vans is not controversial and most stakeholders have a positive attitude to it. The issue of acceptance is therefore mostly related to whether transporters are willing to test these vans. During the demonstration period BEX gave some benefits to the electric vans, they were for instance given priority during assignment of jobs, and their routes were planned with an eye on the range of these vehicles. The employee satisfaction for the drivers was good, but these were biased in the sense that they volunteered to participate in the demonstration.

Future outlook

The testing of electric delivery vehicles by Bring Express (BEX) appeared successful. The vehicles have been tested during real operations, which may remove doubts and uncertainties. Even though some charging has been required during lunchtime, the Renault Kangoos have been able to operate some of the BEX services in a similar way as with diesel-fuelled vans.

After the demonstration, one of the transporters working for BEX invested in an electric van, this was the first electric van of BEX in the Nordic countries. The further long-term experiences of this transporter will probably influence the further up-take of electric vans among the BEX transporters. A more extensive testing will be needed to convince other transporters to change.

4. CONCLUSIONS AND FURTHER WORK

This paper has documented the results from an *ex-ante* stakeholder survey on potential solutions for more environmentally friendly and efficient urban distribution in Oslo. The evaluation framework for an *ex-post* study of actual effects of selected measures is also presented, as well as the evaluation results from a demonstration of environmentally friendly vehicles.

The GUD research project has shown that there is a will and a need from all parts to improve the present freight distribution situation in Oslo. However, there are several conditions that must be in place in order to implement environmentally friendly and efficient solutions. The three stakeholder groups are marked by significant heterogeneity, both inside and between the groups, which poses an obstacle for optimal outcomes. More effective and environmentally

friendly goods distribution is thus preconditioned by the involved actors' knowledge about other actors' roles and needs. Furthermore, solutions that are optimal for one actor are likely to be suboptimal for other actors. In order to implement successful measures it is thus vital to adapt measures in such a way that they are both efficient in terms of greening urban freight and acceptable to all parties.

The survey results show that the measure that overall is considered to entail the most positive consequences for both urban freight transport and the society is environmentally friendly vehicles. The evaluation of electric vehicles tested in the GUD project suggests that electric vans can serve parts of the express shipment market very well with their existing range. Removing uncertainties related to their performance and financial viability seems to be an important task for further take-up of these vehicles.

The next step of the Green Urban Distribution project is to support one or more new demonstrations. The assessment of stakeholder opinions and the evaluation of the first demonstrator by Bring Express will feed into the design of the demonstration measure and evaluation set-up of the new demonstration(s).

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References

Bjerkan, K. Y., A. B. Sund and M. E. Nordtømme (2013): *Measures for achieving green and efficient urban freight transport*, World Conference on Transport Research 2013, Rio de Janeiro

Boulter, P. and I. McCrae (2007): *Assessment and reliability of transport emission models and inventory systems. Final report.* , ARTEMIS final report.

CIVITAS POINTER (2009): *Framework for Evaluations in POINTER. Deliverable 2.3.1.*,
Holguin-Veras, J., K. Ozbay, A. Kornhauser, S. Ukkusuri, M. A. Brom, S. Iyer, W. F. Yushimito, B. Allen and M. A. Silas (2012): *Overall impacts of off-hour delivery programs in the New York city metropolitan area: Lessons for European cities*, European Transport Conference, Glasgow, Scotland

Holguín-Veras, J., N. Pérez, B. Cruz and J. Pollimeni (2006): *On the effectiveness of financial incentives to off peak deliveries to Manhattan restaurants*, Transportations Research Record, 1966 pp. 51-59

Levin, T. and R. Norvik (2013): *Green freight - A dynamic tool to improve environmental performance in the freight transport industry*, Selected proceedings, World Conference of Transport Research, Rio de Janeiro, Brazil

Lindholm, M. (2012): *How local authority deciosion makers address freight transport in the urban area*, Procedia Social and Behavioral Sciences, 39 pp. 134-145

Litman (2009): *Well Measured: Developing Indicators for Comprehensive and Sustainable Transport Planning.* , Victoria Transport Policy Institute

OECD (2003): *OECD environmental indicators. Development, measurement and use.* , OECD Environmental Directorate

Oslo kommune (2011): *Kommuneplan 2013: Planstrategi og planprogram. Høringsutkast*, Municipality of Oslo

Roche-Cerasi, I. (2012): *L2.1: State of the art report. Urban logistics practices.*, SINTEF Teknologi og samfunn

Rogers, R. W. (1983): "Cognitive and Pshcyhological Processes in Fear Appeals and Attitude Change: A Revised Theory of Protection Motivation", in Cacioppo, J. T. and R. E. Petty (ed.): *Social Psychophysiology: A Sourcebook*, New York:Guilford Press, pp. 153-176

Russo, F. and A. Comi (2010): *A classification of city logistics measures and connected impacts*, Procedia Social and Behavioral Sciences, 2 pp. 6355-6365

Schuitema, G. and L. Steg (2005): *Effects of Revenue Use and Perceived Effectiveness on Acceptability of Transport Pricing Policies*, 45th Congress of the European Science Association, Amsterdam

Stathopoulos, A., E. Valeri and E. Marucci (2012): *Stakeholder reactions to urban freight policy innovation*, Journal of Transport Geography, 22 pp. 34-45

STRAIGHTSOL (2012): *Description of indicators, KPIs and measurement methods, Deliverable 3.3.*, STRAIGHTSOL - Strategies and measures for smarter urban freight solutions.

Sund, A. B. and T. Levin (2013): *L 7.1 Demonstrator (d1). Demonstrere bruk av miljøvennlige kjøretøy i samarbeid med Bring Express.*, SINTEF Teknologi og samfunn

Tretvik, T., M. E. Nordtømme, K. Y. Bjerkan and A.-M. Kummeneje (2013): *Environmentally sensitive charging for freight vehicles in low emission zones*, Selected Proceedings of World Conference on Transport Research 2013, Rio de Janeiro, Brazil

