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Measure No.3: Urban Freight

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Policy interventions with the aim of reducing the adverse effects of freight vehicle movements in urban areas

Cities can reduce the negative impacts of urban freight distribution through a range of policies: administrative / regulatory (including road pricing), urban planning and governance, infrastructure and modal shift, awareness / information, changing driving behaviour, technology and ITS, supply chain and fleet management[3].

3.1 Context and background

Cities depend upon the efficient and effective transport of goods. However, there are a number of negative social and environmental impacts originating from freight transport in urban environments. These negative externalities include local air pollution, in particular increasing concentrations of NO_2 and Particulate Matter (PM) that are harmful for public health, traffic congestion, accident-related fatalities and injuries due to freight vehicles, noise pollution on road and at delivery locations, and greenhouse gas emissions (in particular CO_2)[1].

Conventionally-powered freight vehicles, especially Heavy Goods Vehicles (HGVs), disproportionately contribute to urban polluting emissions considering their relatively low modal share. They also disproportionately damage roadway surfaces due to their weight as compared to cars and other light duty vehicles. Moreover, start-stop operation in urban environments can increase freight vehicles' fuel consumption by 140%[2].

Key messages:

- Most evidence focuses on Urban Freight Consolidation Centres (UFCCs), showing positive impacts, in terms of cost savings and better service to logistics operators and final customers.
- Where cost-benefit analysis (CBA) was conducted, positive values for net present value (NPV) were found, with a range of socio-economic and environmental impacts identified.
- UFCCs can be particularly effective if there are congestion and/or pollution problems within the area to be served, or where they are targeted to compact geographical locations, or areas with delivery-related problems
- UFCC Interventions are often small-scale with few impacts at city scale.
- Better economic assessment of schemes will require greater understanding of supply chain costs and benefits associated with urban freight measures. Commercial sensitivities, the lack of standardized evaluation and the experimental nature of some freight initiatives can make assessment more difficult.

Potential interventions

- Urban freight consolidation centres (UFCC);
- Implementation of environmentally-friendly distribution by low or zero emission freight vehicles, such as bicycles, cargo cycles and electric vehicles; water and tube logistics (i.e. using underground pipelines, see http://www.civitas.eu/content/pipenet-system-city-logistics);
- Route/weight restrictions for HGVs, loading and delivery restrictions (spatial and temporal
- Freight operator recognition schemes and quality partnership schemes (which can include driver training and best practice sharing) and local delivery plans for buildings, businesses and construction sites[1].

One of the most studied interventions is the UFCC, which can be defined as a logistics facility that is situated in relatively close proximity to the geographic area that it serves, be that a city centre, an entire town or a specific site"[4], such as a shopping centre, an airport or a construction site, from which consolidated deliveries are carried out within that area. Logistics companies/hauliers with deliveries scheduled for the urban area or site transfer their loads at the UFCC thus avoiding congested urban environments or busy sites. The UFCC operator has the task of sorting and consolidating the loads received from logistics companies and then delivering them to their end-customers, often on environmentally-friendly vehicles, operating on an agreed delivery pattern. A range of other value-added logistics and retail services can also be provided at the UFCC, for example inventory monitoring, product quality checking, consignment unpacking, preparation of products for display and price labelling, management of returns and recycling of packaging.

In addition to the social and environmental benefits in the urban areas where they operate, UFCCs are also expected to provide benefits for the logistics suppliers (hauliers) and end-receivers. The former can typically make deliveries to the UFCC on a wide time window (often 24/7), avoid entering congested urban areas where there might be delivery restrictions and few off-road loading areas, hence saving time and fuel. The latter can benefit through better stock management, faster deliveries, convenient delivery times and added services, such as recycling[4].

Micro-consolidation is a recently introduced concept to reduce delivery vehicles in urban areas that would only make small deliveries5. A more accessible local delivery centre is used instead and the final leg of the journey is completed by electric vehicle, scooter, bicycle or foot.

Examples of organisational type interventions are Delivery and Servicing Plans (DSPs) and Construction Logistics Plans (CLPs)[5].

DSPs are specifically designed for a single or small number of buildings to reduce the number of overall deliveries (through better co-ordination of deliveries and sharing of resources), improve reliability and minimise impact on the surrounding environment. DSPs typically benefit companies through cost savings from reduced delivery charges and reduced disruption. DSPs are relevant because businesses without their own integrated supply chain can often have little knowledge about where the goods come from or how they get to them. Even when such a supply chain does exist it is often managed in isolation, without considering the wider opportunities of sharing other resources.

CLPs are effectively DSPs for the duration of a construction project and are typically developed a part of a transport assessment. The benefits are similar though added savings through reduced risk of theft and improved security are also important.

3.2 Extent and Sources of Evidence

Although interventions that could be grouped under the 'urban freight' measure have been implemented since the 1990s, evaluations of schemes are scarce and very variable in terms of the breadth, depth, validity, reliability and significance of the evidence presented. This is due to various reasons, including the experimental nature of many of these interventions, the lack of consistent monitoring over the duration of the projects, and commercial sensitivity issues that might preclude collection and/or publication of performance data.

The report from the SUGAR project[3] (Sustainable Urban Goods Logistics Achieved by Regional and Local Policies) is useful to understand the range of projects and measures implemented in the European context. The project was funded by the European Regional Development fund in the period 2008-11.

Over 20 items of evidence have been identified for this review through an extensive literature search, however not all can be considered robust. This review presents evidence from a sub-section

of these studies, including one review of evidence on urban freight consolidation centres looking at several case studies, 4 peer-reviewed journal papers focused on different measures, and 4 reports from EU-funded projects focusing on 4 different freight demonstration projects. Other relevant sources of background information on urban freight measures have also been considered. The published evaluations are typically carried out during or soon after project implementation and some include Cost Benefit Analysis.

Of all the interventions covered by 'urban freight', UFCCs have received the greatest attention in terms of monitoring and evaluation, because of the number of operations existing worldwide which are often supported through public funding, for example through the CIVITAS programme of the European Commission. However, most of this evidence has been collected/produced by the same entity delivering the schemes.

The most comprehensive study of UFCCs, carried out by a team of the University of Westminster4 for the UK Department of Transport, reviewed 67 schemes across Europe (mostly in Germany, UK, Netherlands and France), US, Canada and Japan, but found some published evidence only on 17 (25%) among them. However, even in these cases the evaluation was found to be relatively limited and with little explanation of the methodology used. This review indicates that: many UFCC trials and schemes that have been terminated do not appear to have been subject to published evaluation that quantifies scheme results; of those UFCC schemes for which quantified evaluation has been identified, only a few provide a single quantified result, usually in terms of changes in vehicle trips, vehicle kilometres, parking time and frequency, total fuel consumed, and vehicle emissions. The review study also stated that it was often unclear whether evaluation results were based on measurement of actual vehicle operations or modelling work (predicted impacts).

3.3 What the Evidence Claims

3.3.1 Freight consolidation and micro-consolidation centres

This review of evidence largely confirms the findings of the most comprehensive review[4] concerning urban consolidation: the existing published results suggest that UFCCs can lead to significant reductions in freight transport activity and associated environmental impacts between the UFCC and the final point of delivery for those goods flows that pass through the UFCC. However, given the often limited scale of such schemes and modest goods throughput at UFCCs, any reduction in transport activity and associated environmental impacts due to the UFCC are, unsurprisingly, marginal in terms of total freight traffic and total motorised traffic in the urban area concerned.

Overall, the 17 UFCC evaluation studies (containing evidence) reviewed by Browne et al. (2005)4 report: 30-80% reduction in vehicle trips, 30-45% reduction in vehicle kilometres, 15-100% improvement in vehicle load factors, and 25-60% reduction in vehicle emissions. All of these results refer only to the change in transport activity associated with goods handled by the UFCC (i.e. a comparison of the transport activity from the UFCC to the receivers when the UFCC is used and when it is not for those goods flowing through it) rather than the changes in total freight transport operations and impacts in the area covered by the UFCC or the entire town/city.
Several case studies of UFCCs evaluation results are presented as follows.

1. Freight Construction Consolidation Centre, London (UK)[4, 5, 6]
The London Construction Consolidation Centre (LCCC), a two-year trial project operating from 2005 to 2007 with a cost of GBP 3.2 million (EUR 4.7 million), occupied a 5.000 m^2 facility located in South Bermondsey, approximately five kilometres south of the City of London. Its objective was to serve four major construction sites in the City of London. The partnership comprised Stanhope PLC, Bovis Lend Lease, Wilson James and Transport for London.

Allowing for a rapid flow, on a just-in-time basis, of material from suppliers to site with storage time limited to ten days, the LCCC's objective was to reduce the number of deliveries going directly to the construction sites, reducing traffic congestion and vehicle emissions. The evaluation results largely indicate that these aims were achieved.

Compared to the trips that would have previously been made, the LCCC resulted in a 15% reduction of materials waste, leading to recovery of re-usable materials on one partner project of approximate value £200.000; increased productivity of the site labour force of up to 30 minutes per day; 68% reduction of the number of construction vehicles delivering to the sites being served by the LCCC and 75% reduction of CO2 emissions. On average, supplier journey times were reduced by two hours (including loading and unloading at the LCCC). Other environmental benefits were identified, including a reduction in packaging; reduced landfill waste; and better fuel efficiency.

The evaluation reported no incidents of accident. Impacts on safety are not known but the reduction in traffic is thought to have had a positive impact. In terms of financial aspects, the evidence is limited because not enough specific details or comparative data were available on the economic efficiency of the measure.

Strong stakeholder involvement throughout the setting up of the pilot measures has been cited as key in the success of the LCCC. The private sector, Transport for London and construction centres have worked together to design and implement the scheme to ensure maximum efficiency and the highest levels of environmental benefits. The location of the LCCC in relation to the strategic road network and target businesses has contributed to its success, ensuring that users achieve logistics efficiencies when compared to traditional freight delivery methods.

In London, freight consolidation centres are part of the wider London Freight Plan, which was drawn up to support the sustainable development of the region. This plan provides guidance and support for the Mayor of London's Transport Strategy and will help combine increased economic performance with the environmental and social impacts of freight transport for London.

2. Bristol/Bath Urban Freight Consolidation Centre (UFCC)[7, 8]

The Bristol/Bath UFCC was set up thanks to three projects funded by the European Commission: CIVITAS VIVALDI (2002-2006); START (2007-2008), funded within the Intelligent Energy Europe programme; and CIVITAS RENAISSANCE (2008-2012). The scheme is currently partially supported through the Local Sustainable Transport Fund (LSTF) by the UK Department for Transport.

Under the RENAISSANCE project in 2010, the services of the Bristol UFCC were extended as an initially free trial to participating retailers in the neighbouring city of Bath, making the Bristol/Bath UFCC the first consolidation operation serving more than one centre.

The centre, managed by the logistics operator DHL, comprises an area of 1.220m2 within DHL's depot in Avonmouth, close to Junction 18 of the M5 motorway 11km northwest of central Bristol. Deliveries from the UFCC into central Bristol and Bath are made using two 'Smith Newton' 9 tonne electric delivery vehicles. The scheme includes additional services to retailers, such as pre-retailing, stock management and recycling of cardboard and plastic.

The VIVALDI project recruited 53 retailers in Bristol over its duration, while RENAISSANCE recruited 19 retailers in Bath. At the time of writing, the scheme serves 109 retailers in Bristol and 39 in Bath.

Compared to an equivalent diesel lorry, the electric vehicles used by the UFCC consume 55.7 percent less energy and have no air polluting emissions at the point of use. Vehicle utilisation averaged 65 percent under the VIVALDI project and over 1.000 vehicle km were saved per month, achieving over 70% reduction on delivery journeys. The RENAISSANCE project recorded a 76 percent average reduction in delivery journeys into Bath city centre for

the participating retailers, equivalent to 64 delivery journeys avoided per month. However, the impacts on the wider transport system and air quality are likely to be minimal given the small scale of the consolidation operation.

Surveys with users and non-users of the UFCC revealed other positive impacts. According to the VIVALDI project evaluation, deliveries were made on time with no discrepancies or damages. All surveyed retailers said the delivery team had left the delivery area clean and tidy, and retailers who had items collected by the centre said they had been taken at the correct time. Delivery times were generally shorter for users compared to those of non-users. Users stated that participation in the UFCC scheme saved staff time and improved reliability and punctuality of deliveries, whilst creating fewer access problems in the delivery areas.

Bath retailers participating in the RENAISSANCE-funded project, which was offered as a free trial until the end of March 2012, said they were pleased with the service, including recycling of packaging, and that they were satisfied with the contractor DHL and its staff. Although environmental reasons did not appear to be strong motivators for joining, retailers supported the use of the electric lorry. Attitudes towards the fee structure were also positive, as most retailers claimed to have reduced their costs, and gained benefits, by joining the scheme. Those who didn't take part in the scheme cited several reasons, including perceived costs, satisfaction with current delivery operators and issues with handling the delivered goods.

Users of the scheme were very satisfied with the service and were positive about the demonstration. Eighty-one percent of participating retailers surveyed were very likely to recommend the scheme to other businesses; the other 19 percent were quite likely to recommend the scheme. DHL reported that deliveries were made on time with no damages. Almost all interviewed businesses confirmed that deliveries were made on time and they experienced no damages to their deliveries, confirming the operator's reports.

The evaluation of RENAISSANCE reported that the cost of subsidising the scheme reduced from €221.910 in year 1 to €141.083 in year 2 as a charge of £9 per cage and £12 per pallet was made to participating businesses from 1st April 2012 (15 months into implementation).

Cost-benefit analysis was conducted by UWE to assess the social net present value (NPV) brought by the UFCC in Bath over a period of 10 years. The analysis compared two scenarios, one without the UFCC or business as usual -- and one with the UFCC. The business as usual scenario considered what would have happened if all the deliveries made with the electric vehicle had instead been made with conventional diesel-powered lorries. Based on the analysis, the measure produces a positive NPV, in other words a net benefit, of £19.251 over 10 years. Sensitivity analysis found that this figure is not significantly affected by small changes in the social discount rate and emissions costs, and remains always positive. Emission reductions contributed the most to achieving the overall positive NPV.

3. Binnenstadservice.nl (BSS), Nijmegen (Netherlands)[9]

The evaluation document reports that BSS started its services as an urban consolidation centre in April 2008 in the Dutch medium-sized city of Nijmegen, one of the oldest cities in the Netherlands with a medieval city centre situated on a hill. The city centre historical structure is characterised by narrow streets where many small, independent retailers are located. The consolidation centre is located about 1.5 km away where goods can be received and picked up 18 hours a day. BSS uses environmentally-friendly delivery vehicles: an electric bicycle and a natural gas lorry. The mission of Binnenstadservice.nl is to provide logistical services to local inner city stores, regional consumers, carriers and local government. Users were not charged for this service. The objective was to reduce freight vehicle movements in the city centre. BSS users increased from 20 to 98 after one year.

BSS received a government subsidy for one year to start business, but since April 2009 it had to operate without any public

financial support and seek revenue from additional services to users. According to the evaluation report9, the scheme did not become self-financing. The evaluation used real data on freight vehicle movements and BSS users deliveries and modelled the impacts on air quality, noise and inconvenience for residents in city centre. The evaluation did not find any significant improvement in air quality (measured as concentration of NO2 and PM10) and reduction in noise, due to the overall passenger and bus traffic and the high natural background concentration of PM10 and NO2. However it found a reduction in freight vehicle kilometres, stops and routes in the city centre, as well a reduction in large freight vehicle movements and total loading and unloading activities. If more retailers were participating, BSS would produce more detectable improvements to the shopping environment, traffic safety and residents' quality of life.

These positive results of BSS in Nijmegen gave rise to BSS franchise initiatives in other Dutch cities.

4. Cityporto Urban Distribution Centre, Padova (Italy)[10]

The city logistics service "Cityporto-consegne in città" is a 1.000 m^2 urban distribution centre (UDC) operating in the urban area of Padua, focusing on the local 830,000 m^2 Limited Traffic Zone (LTZ). The operator is a municipality-owned company called Interporto di Padova S.p.A., which also manages the local 'freight village'. The deliveries are performed by 8 vans running on Liquefied Petroleum Fuel (LPF) and one electric van, two of which equipped for the delivery of temperature-controlled goods. The service has operated since 2004 and is considered one of the most successful city logistics systems in Italy, replicated in other Italian cities and recognised as European best practice. CERTeT-Bocconi conducted an ex-post Cost-Benefit Analysis to evaluate Cityporto in 2006. At the time of the evaluation, Cityporto performed about 60,000 deliveries per year for 45 customers, which in this case are not individual retailers but third-party couriers and hauliers, and also manufacturers and companies operating on own account.

CBA used data collected in the period September 2004 – December 2005. The results show a positive Benefit to Cost ratio (1.66), NPV of 728.500 Euro and beneficial impacts on the environment. As a result of Cityporto operations, reductions were observed in the number of freight vehicle journeys into the city centre (12 saved trips/day) and total km travelled (11.000 km/month saved, 127.000 km in total over the whole monitoring period). Average trip length decreased by 37%, from 34 to 25 km. Reductions in pollutant emissions were also calculated, with the biggest contribution to external benefits provided by reductions in PM10 emissions. The study however pointed out that the overall impact on congestion was negligible due to the limited number of operating vehicles.

Success factors include the location of Cityporto in the freight village, an established logistics platform which was well-known by freight operators; a thorough engagement process with all stakeholders involved to develop an effective framework agreement; and a favourable regulatory context, with access restrictions to goods vehicles in the LTZ of Padua with exemption for Cityporto vans.

5. City of London micro-consolidation centre (UK)[11, 12]

The evidence is provided by two papers[11, 12] summarising the before and after evaluation of a trial led by a major stationery and office supplies company in which urban freight deliveries in central London made from a depot in the suburbs using diesel vehicles were replaced in 2009 with the use of an urban micro-consolidation centre located in the delivery area, together with the use of electrically-assisted cargo tricycles and electric vans. This decision was taken as part of the company's corporate social responsibility in order to reduce the environmental impacts of their delivery operation. The customers receiving the deliveries were all located in the City of London, the historic core of London with an area of 2.9 km^2, home of London's business and financial centre.

The micro-consolidation centre benefitted from the local regulatory and policy context around freight transport. The

City of London lies within the Clear Zone Partnership which was used as a testing ground to research, trial, monitor and set best practice for new transport technologies, innovations and physical measures, to be implemented on a local or regional scale. Since 1999 the London Borough of Camden, the City of London and the City of Westminster worked jointly to achieve this. This resulted in the London Borough of Camden making a small financial contribution towards the trial. All the other costs were met by the office supplies company.
The results show that the total distance travelled and the CO_2eq emissions per parcel delivered fell by 20% and 54% respectively as a result of this delivery system. However, the evaluation also indicated that the distance travelled per parcel increased substantially in the City of London delivery area as a result of the electric vehicles having far smaller load limits in both weight and volume compared with diesel vans. But, at the same time, the trial system was able to virtually eliminate CO_2eq emissions per parcel delivered in the City of London. The trial proved successful from the company's perspective in transport, environmental and financial terms. The company therefore decided to continue the operation beyond the end of the trial with it being officially launched during 2010.

The trial demonstrated that even in a supply chain in which goods are already highly consolidated there is still the potential to achieve further benefits in terms of reductions in total distance travelled and greenhouse gas emissions through additional consolidation efforts and the use of electric vehicles. This is especially true in logistics systems that involve substantial distances between depots and delivery areas. The office supplies company reported that the distribution system used in the trial with its tricycles, electric vans and micro-consolidation centre had the same operating costs as the previous system using diesel vans dispatched from the suburban London depot.

3.3.2 Environmentally-friendly urban freight distribution: water and cycle logistics

1. Beer boat, Utrecht (Netherlands)[13]

This intervention, supported by the European Commission through the CIVITAS MIMOSA 2008-12 project, consisted of the implementation of a new a zero-emission electrical vessel to transport goods to businesses, bars and restaurants in the historic centre of Utrecht, and the recruitment of new customers and suppliers to increase the potential for water freight distribution. The concept is known as the Beer Boat since the vessel initially transported mainly beer and beverages to catering businesses along the canals.

Accompanying measures included vehicle restrictions in the inner city including time windows for freight traffic to deliver goods and a low emission zone.

The Beer Boat started operations in 2010 and at the end of the project was operating 4 days a week, 6 times a day, supplying more than 60 catering businesses. As a result of the MIMOSA electric Beer Boat, in the summer of 2011 the City of Utrecht signed a contract for another electric 'Multi-Purpose Vessel', which replaced the existing boat used for rubbish collection from businesses on the wharves. One of the main drivers for the implementation of the Beer Boat was the shape of the city centre (many canals, dense city centre, most shops, bars and restaurants located along the canals and close to each other) which provided ideal conditions for the services offered by the Beer Boat.

Additionally to the impact and process evaluations, a cost-benefit analysis (CBA) was conducted. The impact evaluation reported emission reductions of the main pollutants and CO_2, compared to using a diesel boat for the same deliveries. CBA concerned the entire Beer Boat lifespan of 30 years and mainly focused on implementation and operating costs, revenues and emission effects. A positive net present value (NPV) of over €420.000 at a 3.5% discount rate was reported. It was assumed that impacts that were not part of the CBA could have additional positive

effects and could further increase the calculated NPV.

Some lessons to be learnt from the implementation of the Beer Boat which are relevant for implementing or further expanding waterborne transport in Utrecht or in other cities include: optimising water delivery schemes and thereby reducing delivery times, adapting renting prices to increase acceptance during start up phases; raising awareness among logistics companies about the potential financial gains and the ease of using water distribution; enforcing further restrictions and/or costs associated with entering the city centre by conventional motorised modes. However, not all freight transport can be shifted to water therefore cities need to consider waterborne freight an element of a more comprehensive and multi-modal urban freight strategy.

2. Cycle logistics (Europe)[14]

Evidence on the use of other cycles for freight distribution in urban areas is very limited despite the growing interest in cycle logistics especially in Western Europe. A recent investigation into cycle logistics, which also provided the results of a survey of cycle logistic operators in Europe, indicated that the main areas of application are courier, express and parcel (CEP) services and the delivery of basic products in catering. The available evidence, primarily gathered from tests carried out by companies in the CEP sector, show a significant potential for cycle freight to carry out deliveries with small volumes and comparably low weights. The provision of space for depots on the edge of city centres is an essential precondition to improve the potential for cargo bike delivery. Another important factor that considerably increases the motivation for cargo bike use in companies in the CEP sector is the considerable cost and inconvenience associated with driving and parking motorised freight vehicles in city centres, often characterised by physical and/or time access restrictions. The survey found that the largest current barrier to a broader implementation is the lack of perception of cargo cycles as a suitable mode of transport and the consequent lack of acceptance by potential customers. In sum, the study estimates that in the medium term cycle freight can form around a quarter of all freight traffic in city centres. In addition, a much greater consideration of the specific demands of cycle freight delivery is required on the part of urban planners.

3.3.3 Evidence on other types of urban freight interventions

Evidence from other types of 'urban freight' interventions is very limited.

A study[15] into the role and design of urban delivery services used a simulated North American data sample served with three transportation structures: last-mile personal vehicles, local-depot-based truck delivery, and regional-warehouse-based truck delivery. CO_2, NOx, and PM10 emissions were modelled using values from the US EPA's MOVES model and are added to an ArcGIS optimization scheme. Although not a real case study, the findings are relevant to understand how different urban delivery scenarios contribute to emission reduction and motorised vehicle movements, and whether there might be a clash between reducing emissions and easing congestion.

Local-depot-based truck delivery was found to require the lowest amount of vehicle miles travelled (VMT), whilst last-mile passenger travel generated the lowest levels of CO_2, NOx, and PM10. While last-mile passenger travel requires the highest amount of VMT, the efficiency gains of the delivery services are not large enough to offset the higher pollution rate of the delivery vehicle as compared to personal vehicles. The practical implications of this research concern the role delivery structure and logistics have in impacting the CO_2, NOx, and PM10 emissions of freight transport. Additionally, this research highlights the tension between goals to reduce congestion (via VMT reduction) and CO_2, NOx, and PM10 emissions when conventionally-powered freight vehicles are used.

The FREILOT project[16], funded as a pilot by the European Commission in the period 2009-2013, implemented a series of freight interventions with the aim to increase energy efficiency in road goods transport in urban areas through four dif-

ferent mechanisms: Traffic management (Energy efficiency optimised intersection control); in-vehicle technologies (Adaptive acceleration and speed limiters); driver behaviour (Enhanced "green driving" support); and fleet management (Real-time loading/delivery space booking). The participating cities implemented priority for freight vehicles at certain intersections (on certain roads and/or certain times of day) and provided this priority as incentive to the freight fleets which were implementing acceleration, speed limiters and provided eco-driving support to their drivers. In addition, participating cities also provided possibilities to dynamically book and re-schedule delivery spaces. The services were piloted in four European implementations: Lyon-France, Helmond-Netherlands, Krakow-Poland and Bilbao-Spain.

The evaluation report indicates that results in terms of fuel consumption and energy efficiency were positive but of modest magnitude, while the fleet management measures led to an increase in the number of deliveries and reduction of illegal parking. Because of the experimental nature of these interventions and the limitations in data collection and presentation, the evidence base is not yet sufficiently robust.

3.3.4 General considerations about the evidence

Overall, urban consolidation is the area that has received the most attention in terms of monitoring and evaluation, whilst other types of urban freight interventions have received much less scrutiny from practitioners and academics. Therefore significant gaps exist in the knowledge base around urban freight measures that do not involve consolidation centres.

The published evaluations identified typically concern the localised impacts of the interventions, in isolation from total transport activity and its social, economic and environmental impacts in the urban area concerned.

The narrow evaluation scope is likely to be the consequence of several factors, including the challenge of collecting consistent ex-ante and ex-post data especially when commercial sensitivities exist, the lack of standardised evaluation frameworks that are suitable for assessing these types of interventions[A], and the experimental nature of most urban freight interventions.

These factors impact both on the resources that might be made available for independent and robust monitoring and evaluation, and the scale of the project, which may be limited and unable to produce significant effects.

There is also a need for further investigation into the total supply chain costs and benefits associated with urban freight measures, so that better economic assessments can be performed and more adequate pricing mechanisms identified.

3.4 Lessons for Successful Deployment of this measure

Several considerations can be made in relation to the successful deployment of urban freight interventions. As a consequence of the limited range of findings these are primarily focused on UFCCs.

3.4.1 Geographic scale and location

Concerning urban freight consolidation, the area served by a consolidation centre should not be too large to avoid losing efficiencies associated with centralised distribution. The location of consolidation and micro-consolidation centres in relation to the end-receivers and the strategic road network is very important in determining the effectiveness of the centre. Environmentally-friendly distribution, for example by cycle and water or by electric vehicles with limited range, also requires a target area that is easily served by these means. The Beer Boat, for instance, performed best in a compact infrastructure, with a dense distribution of clients along the canals.

From the reviewed evidence, UFCCs are most likely to be successful in the following locations: specific and clearly defined geographical areas such as historic town centres, especially those undergoing a 'retailing renaissance' and characterised by a

[A] Browne et al. (2007)[17] provide a detailed description of a proposed evaluation framework for consolidation centres.

transport infrastructure that would be unable to cope with the resultant increase in freight; historic town centres and districts that are suffering from delivery traffic congestion where there is a common interest in improving the street environment, rather than large town-wide schemes.

3.4.2 Users and beneficiaries

In contrast with access restrictions or other types of regulatory measures of a mandatory nature, voluntary schemes such as consolidation or environmentally-friendly distribution need to secure a substantial user base, such as organisations, logistics companies, retailers and construction companies, to be effective. Market research is useful to identify potentially interested users and to estimate the potential costs and benefits achievable before implementing the measure.

The evidence on consolidation centres, for example, suggests that the major potential beneficiaries from the establishment of UFCCs would be: transport operators making small, multi-drop deliveries; shared-user distribution operations; businesses located in an environment where there are particular constraints on delivery operations; and small independent retailers/organisations, which are not part of a regional/national business with a dedicated and sophisticated supply chain, involving their own distribution centres, and which may be looking for a competitive edge.

To attract users, schemes need to be cost and time efficient and must provide an equal or better service than traditional freight delivery methods. Some of the barriers encountered during the implementation of the reviewed schemes (e.g. the Beer Boat and Bristol/Bath UFCC) were logistical challenges and perception of inconvenience which made recruiting customers difficult. The evaluation of the Beer Boat reported significant difficulties in finding interested transport companies and suppliers, as hauliers were resistant to change their current schemes and delivery patterns. A further barrier was that logistics decisions for chain stores were often made at their headquarters and implemented nationwide. Furthermore, a few logistics companies had already adapted to delivery restrictions or had made investments involving lorry-based delivery. Many clients could only accept/dispatch deliveries at certain times making the Beer Boat delivery route and schedule inefficient with significant waiting time during trips or trips had to be made twice to accommodate businesses different opening hours and staff availability.

Other barriers identified in the available literature include: lack of enforcement of regulations for delivery vehicles not included in the urban freight scheme; organisational and contractual problems that might limit effectiveness; potential to create monopolistic situations, thus eliminating competition and perhaps leading to legal issues and loss of the direct interface between suppliers and customers. Cityporto, for instance, was successful in being regarded 'impartial' from the perspective of hauliers. Nevertheless, securing their trust in the ability of Cityporto to successfully complete the delivery to the end customer was found to be a key challenge.

3.4.3 Financial resources

Cost (actual and perceived) is a crucial factor affecting the willingness to join voluntary schemes and to consider implementing a more sustainable form of urban distribution. Whilst the available evidence on urban consolidation suggests that self-financing schemes are not the norm, available CBAs report a positive NPV, or beneficial impact, which might offer a rationale for financial support. The positive financial and environmental experience of the London micro-consolidation scheme might encourage other businesses to explore similar innovative interventions.

3.4.4 Complementary supporting measures

Importantly, urban freight interventions rely on other complementary supporting measures, chiefly in the form of a favourable regulatory environment. Most of the reviewed schemes benefitted from the existence of spatial and/or temporal restrictions, for example a LTZ or LEZ in which loading/unloading operations, or even the access, is allowed only to specific vehicle categories or transport modes.

Other drivers and supporting measures include the identification and development of partnerships early on with key logistics sectors, clients, industries and suppliers; raising awareness about the available urban freight measures and their potential benefits to users, which can increase the number of businesses involved, which in turn makes operations more cost effective and increases environmental benefits.

3.5 Additional benefits

As well as the evidence of economic and financial benefits of interventions discussed above, there are a number of additional benefits that are claimed for policies promoting urban freight interventions:

- *Environmental improvements:* There is the potential achieve local environmental benefits (air quality and noise) in the areas where goods are being delivered, as a result of fewer vehicles passing through. The improvements in respect of noise can be particularly significant when electric vehicles (or bike-freight) are deployed as last-mile services.
- *Facilitating economic activity:* Provision of UFCC and last-mile delivery services such as bike-freight, can mean that economic activities can now be considered in areas of a city that through poor access, or restrictions on conventional freight vehicles might have not been feasible before. This might have benefits in respect of access to services and goods for the citizens living there, as well as creating employment opportunities.

3.6 Summary

The available evidence on urban freight interventions is growing, especially around consolidation centres, but is considerably limited in breadth and depth, especially in other areas of urban freight policy. Further research needs to address these gaps.

Positive socio-economic and environmental impacts have been identified. In the cases where CBA was conducted, positive values for NPV were found: €19.251 for the UFCC in Bath, €728.500 for Cityporto, Padua and over €420.000 for the Beer Boat in Utrecht. In particular, urban consolidation and environmentally-friendly distribution can reduce harmful emissions and freight vehicle movements in the local areas where they operate. They can also bring considerable benefits to the users of these schemes, such as reduced delivery times and better delivery services. However, these interventions need to be sufficiently scaled up, in terms of user participation, for any tangible effect on air quality and congestion to be measurable at a city level.

According to the evidence, urban freight interventions have the greatest prospect for success if they meet one or more of the following criteria: availability of funding and resources for those schemes requiring initial capital and operational costs not met by operating revenues; strong public sector involvement in encouraging their use through the regulatory framework; partnership working between public and private sectors; significant existing congestion and/or pollution problems within the area to be served; bottom-up pressure from local interests; targeted to compact geographical locations areas where there are delivery-related problems.

Increasing awareness among public and private sector actors of the range of different interventions that could be implemented and their associated costs and benefits (for each stakeholder) is necessary to overcome negative perceptions of sustainable urban freight schemes.

3.7 References for this Review

1. Browne, M., Allen, J., Nemoto, T., Patier, D. & Visser, J. (2012). Reducing social and environmental impacts of urban freight transport: A review of some major cities. Procedia – Social and Behavioural Sciences, 39, 19-33.

2. Filippi, F., Nuzzolo, A., Comi, A. & Delle Site, P. (2010). Ex-ante assessment of urban freight transport policies. Procedia – Social and Behavioural Sciences, 2, 6332-6342.

3. SUGAR (2011) City Logistics Best Practices: a Handbook for Authorities. [Online] www.sugarlogistics.eu [Accessed 15/01/2015].

4. Browne, M., Woodburn, A., Sweet, M. & Allen, J. (2005). Urban freight consolidation centres. Report for Department for Transport. [Online] http://www.freight-bestpractice.org.uk/imagebank/Consolidation%20centres%20Finalreport%20Nov2005.pdf [Accessed 14/01/2015].

5. Transport & Travel Research (2010) Freight Consolidation Centre Study. Report for Department for Transport. [Online] http://www.ttr-ltd.com/downloads/pdf/DfTFreightConsolidationCentreStudy-04112010.pdf [Accessed 14/01/2015].

6. Transport Research Laboratory & Transport Studies Unit Oxford University (2008). Success stories within the road transport sector on reducing greenhouse gas emission and producing ancillary benefits. European Environmental Agency. [Online] http://reports.eea.europa.eu/technical_report_2008_2/ [Accessed 14/01/2015]

7. Bristol City Council et al. (2006) VIVALDI Evaluation Results Report. European Commission.

8. Bath & North East Somerset Council & UWE (2012) RENAISSANCE Final Deliverable Report 56. European Commission.

9. van Rooijena, T. & Quak, H. (2010) Local impacts of a new urban consolidation centre – the case of Binnenstadservice.nl. Procedia Social and Behavioral Sciences, 2, 5967–5979.

10. Vaghi, C. (2010). City logistics in Italy: success factors and environmental performance. Paper presented at the European Transport Conference 2010. [Online] www.aisre.it/images/old_papers/Paper_Vaghi_AISRE.pdf [Accessed 20/2/2015]

11. Browne, M., Allen, J. & Leonardi, J. (2011) Evaluating the use of an urban consolidation centre and electric vehicles in central London. IATSS Research, 35, 1–6

12. Leonardi, J., Browne, M., Allen, J. (2012) Before-after assessment of a logistics trial with clean urban freight vehicles: A case study in London. Procedia - Social and Behavioral Sciences, 39, 146 – 157

13. Hoetjes, G., Degenkamp, M., de Jong, J. & Hogenberg, J. (2012) MIMOSA Measure Evaluation Results: Distribution by Boat. European Commission

14. Lenz, B. & Riehle, E. (2013) Bikes for Urban Freight? Experience in Europe. Transportation Research Record: Journal of the Transportation Research Board, 2379, Transportation Research Board of the National Academies, Washington, D.C., 39–45

15. Wygonik, E. & Goodchild, A. (2014). Comparison of Vehicle Miles Traveled and Pollution from Three Goods Movement Strategies. In Sustainable Logistics, 63-82

16. Volvo et al. (2012) FREILOT Urban Freight Energy Efficiency Pilot D.FL.4.2 Final Evaluation Report. European Commission

17. Browne, M., Woodburn, A. & Allen, J. (2007). Evaluating the potential for urban consolidation centres. European Transport/Transporti Europei, 35, 46-63