WHICH LINES OF ACTION FOR LOCAL AUTHORITIES TO DECREASE THE ENVIRONMENTAL IMPACT OF THE URBAN FREIGHT TRANSPORT?

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ABSTRACT

Urban freight transport is a source of numerous negative environmental impacts, such as emission of greenhouse gases, emission of local pollutant or noise pollution. Local public authorities can implement a significant number of measures in attempts to tackle these problems, but choosing the right set of instruments often remains a challenge. It is aim of this paper to investigate the panorama of possible urban freight transport measures and to provide a roadmap of measures that local public authorities can implement, according to the features of the urban freight transport that they are trying to tackle.

In order to construct this roadmap, we have used two main sources of data: on one hand, a comprehensive literature review providing typologies of the urban freight transport measures that can be implemented by the local public authorities; on the other hand, a bottom-up approach based on the analysis of more than 180 urban freight transport measures undertaken in Europe and worldwide.

This paper provides a comprehensive inventory of urban freight transport measures and a classification based on goals that they are pursuing (e.g. reducing the journeys per kg, reducing modal share of the road transport, etc.), and their nature (e.g. administrative measures, measures linked to physical infrastructure, etc.). The role of public authorities for each type of measure is discussed. Local public authorities can use directly these results in order to compare urban freight transport measures of different nature and chose the best set of measures to implement.

Keywords: urban freight transport, city logistics, local authorities

INTRODUCTION

Urban freight transport is essential for the economy and the liveability of the cities, but also a source of significant externalities. In fact, urban freight transport (including the shopping trips) represents up to 25% of transport-related externalities in urban areas (Boudouin, 2006), such as noise pollution on road and delivery locations, local air pollution, greenhouse gas emissions, traffic congestion and accident-related fatalities and injuries (Browne et al., 2011).

Local public authorities play a crucial role in developing new policies and implementing urban freight transport measures in order to tackle these problems. These measures can be very different and range from the introduction of new regulations and access restrictions, to the promotion of use of new technologies, or the introduction of collaborative and educational measures.

Many experiments have been made in the area of urban freight transport all across the globe, and an important part of them took place in Europe. Several European projects and programs (COST 321, BESTUFS, SUGAR, CIVITAS, C-LIEGE, etc.) deal with issues of urban freight transport, providing a large panel of examples and case studies of the implementations of urban freight measures.

Local public authorities have therefore a large set of examples, but the challenge remains on how to choose the right set of measures in order to tackle a specific urban freight transport problem and to replicate experiences in local conditions.

The main purpose of this paper is to identify the possible lines of action for the local public authorities to decrease the environmental impacts of the urban freight transport. In order to do this, we will construct a roadmap of possible urban freight transport measures, based on the goals that they are pursuing. For this, we will use two main sources of data: on one hand, a comprehensive literature review providing typologies of the urban freight transport measures that can be undertaken by the local public authorities; on the other hand, a bottom-up approach based on the analysis of more than 180 urban freight transport measures undertaken in Europe and worldwide.

Role of local public authorities in setting-up urban freight transport measures

Urban freight transport is the subject of local, regional and national policies in different policy fields, such as transportation planning, environmental planning and economic planning (Visser et al., 1999). A report by OECD (Organisation for Economic and Co-Operation and Development) “Delivering the Goods - 21st Century Challenges to Urban Goods Transport” analyses the urban freight policies in several countries and concludes that in most countries, problems of urban goods transport are dealt with at a local or regional level and that only a few countries have developed an explicit encompassing national policy focused on urban goods transport (OECD, 2003). As a matter of fact, out of 13 countries analysed in this report, 10 have urban freight policies at local level (OECD, 2003). (Quak, 2008) confirms this by stating that in most countries urban freight transport is considered a local issue.

Local authorities have therefore a key role to play in formulating urban freight transport policies and implementing new urban freight transport policy measures. However, in the

current situation, they are faced to obstacles, such as lack of sufficient knowledge or financial limits. (Quak, 2008) (Dablanc, 2007)

In this paper, we will provide an overview of measures that are currently implemented by the local public authorities in cities across Europe and worldwide as well as instruments that are being used for this purpose.

REVIEW OF URBAN FREIGHT TRANSPORT MEASURES APPLICABLE BY LOCAL PUBLIC AUTHORITIES

The literature on the urban freight measures is extensive - many sources describe and classify the types of measures and initiatives that can be undertaken by the local public authorities in order to reduce the negative impacts of the urban freight.

There are two main types of urban logistics measures depending on the stakeholders that are implementing them (Anderson et al., 2005): changes implemented by governing bodies and company-driven changes.

Concerning the changes implemented by governing bodies, and more particularly the public local authorities, the most common approach of classifying the urban freight transport measures in the literature is according to the field of action and the nature of the measure (technological, infrastructural, regulatory, etc.).

The COST 321 project identifies 56 theoretically feasible measures and divides them into 8 categories according to their type: (1) Logistical measures, (2) Modal choice, (3) Price of transport, (4) Infrastructure and physical planning, (5) Traffic management, (6) Technical measures concerning the vehicle, (7) Measures concerning the way of driving, (8) Other measures. (Lindkvist, 1999)

The SUGAR project (2008-2012) adopts a slightly different perspective. It analyses 44 best practice initiatives implemented by the local authorities across cities and highlights 8 different categories of measures that can be taken, according to the nature of these measures: (1) administrative measures, (2) urban planning measures, (3) governance measures, (4) awareness, (5) infrastructural measures, (6) ITS & technical measures, (7) modelling tool measures, (8) supply chain measures. In most cases, a certain best practice initiative that was undertaken in a specific city will contain several types of measures in order to reach its optimum effect. (SUGAR, 2011)

The BESTUFS I & II (2000-2008) projects differentiates six themes of action for improving freight transport in urban areas: (1) goods vehicles access and loading approaches in urban areas, (2) last mile solutions, (3) urban consolidation centres, (4) road pricing, (5) Public Private Partnerships (PPP) in urban freight transport, (6) intelligent transport systems (ITS). (Allen et. al, 2007)

CIVITAS I, II and Plus (2002-2013) initiatives adopt a similar classification to BESTUFS and differentiates eight themes for improving urban logistics: (1) Clean vehicles / clean fleet, (2) Distribution scheme, (3) Fleet management & route planning, (4) Loading and uploading, (5) Loading Zone, (6) Public private co-operation, (7) Security, (8) Urban distribution centres. (CIVITAS, 2012)

(Russo & Comi, 2009) differentiate the measures according to the feature of the transport network that they are acting on. They differentiate therefore four different types of urban freight transport measures: (1) measures related to material infrastructure (that can be linear or surface and/or nodal), (2) measures related to immaterial infrastructure, (3) measures related to equipment (that can relate to the loading or the transport units), (4) measures related to governance of the traffic network.

(Visser et al., 1999) and Ogden (1992) differentiate eleven different strategies or policy measures in urban logistics policy and planning: (1) network strategies, (2) parking or loading strategies, (3) location and zoning of land use, (4) licensing and regulation, (5) pricing strategies, (6) terminals and modal interchange facilities, (7) ITS (Intelligent Transport System), (8) Electronic Toll Collection (ETC), (9) logistics information systems, (10) vehicle technology improvement, (11) voluntary co-operation.

(Munuzur et al., 2005) classify urban freight solutions for application by the local administration according to five themes: (1) public infrastructure, (2) land use management, (3) access conditions, (4) traffic management, (5) enforcement and promotion.

(Browne et al., 2011) adopt a slightly different perspective and classify the measures not according to their nature, but according to the features of the freight transport that they are acting on: (1) Total vehicles kms / journeys by road in urban area, (2) Fossil fuel consumption per vehicle km, (3) Local pollutant emissions per vehicle km, (4) Noise level caused by each freight journey, (5) Accident risk per vehicle km;

(Ruesch et al., 2011) define roles and fields of action of administration though nine possible lines of action: (1) land use planning and town development planning, (2) construction and operating permits, (3) infrastructure measures, (4) regulations, (5) traffic management, (6) financial incentives, (7) best practice disseminations and training, (8) partnership and training, (9) environment-friendly vehicle fleet for the municipality. They also define seven roles and areas of action for industry: (1) sustainable logistics strategies, (2) location decisions, (3) products under consideration of sustainable aspect, (4) optimisation of transports, (5) efficient and sustainable infrastructure, (6) procurement and use of environment-friendly vehicles and equipment, (7) partnerships and cooperation. Same authors also provide a classification of urban freight measures according to their nature: (1) infrastructural measures, (2) operational and organizational measures, (3) economical measures, (4) land use measures, (5) technological measures, (6) legal measures, (7) co-operational , (8) educational measures.

(Verlinde et al., 2011) consider only the consolidation-oriented measures and classify them according to the following two categories: (1) physical (a. traditional UCC and b. alternative additional transhipment), (2) behavioural (a. horizontal: retailers and carriers, b. vertical: retailers + carriers).

Finally, (OECD, 2003) divides the initiatives in the following categories: (1) regulations and licensing, (2) parking and unloading, (3) economic instruments, (4) private sector initiatives, (5) information and communication technologies (ICT), (6) underground distribution centre, (7) new vehicles technologies.

A PROPOSED CLASSIFICATION OF URBAN LOGISTICS MEASURES AND THE ROLE OF LOCAL AUTHORITIES

Local authorities can implement an important number of measures to improve the freight transport in urban areas. The literature review performed in the previous section shows that these measures can differ in several ways: the type of problem that they are trying to tackle, the type of instruments that is being used, etc. Two papers adopt a specific perspective on how to classify these measures. (Browne et al., 2011) classify the measures not according to the type of instrument, but according to the feature of the freight transport that the measure is trying to tackle. (Verlinde et al., 2011) focuses on consolidation-oriented measures and adopt a similar approach, outlining that a same goal can be achieved through different instruments.

In this paper, we choose to adopt a similar perspective, i.e. to think in terms of goals rather than in terms of nature of the measures that are being used. In fact, from the perspective of the local authorities, a primary goal is to reduce the environmental impacts of freight transport while maintaining the competitiveness of the local economy. We suggest to derive this goal into several secondary goals and to classify the measures according to them.

Proposed classification of urban freight measures applicable by local authorities

In order to derive the primary goal “reducing the environmental impacts of the urban logistics”, we constructed a logical tree using mutually exclusive and collectively exhaustive secondary goals, as shown on Figure 1.

An important hypothesis that we take while constructing this tree is that the total amounts of goods being transported in and out of urban areas should remains constant.

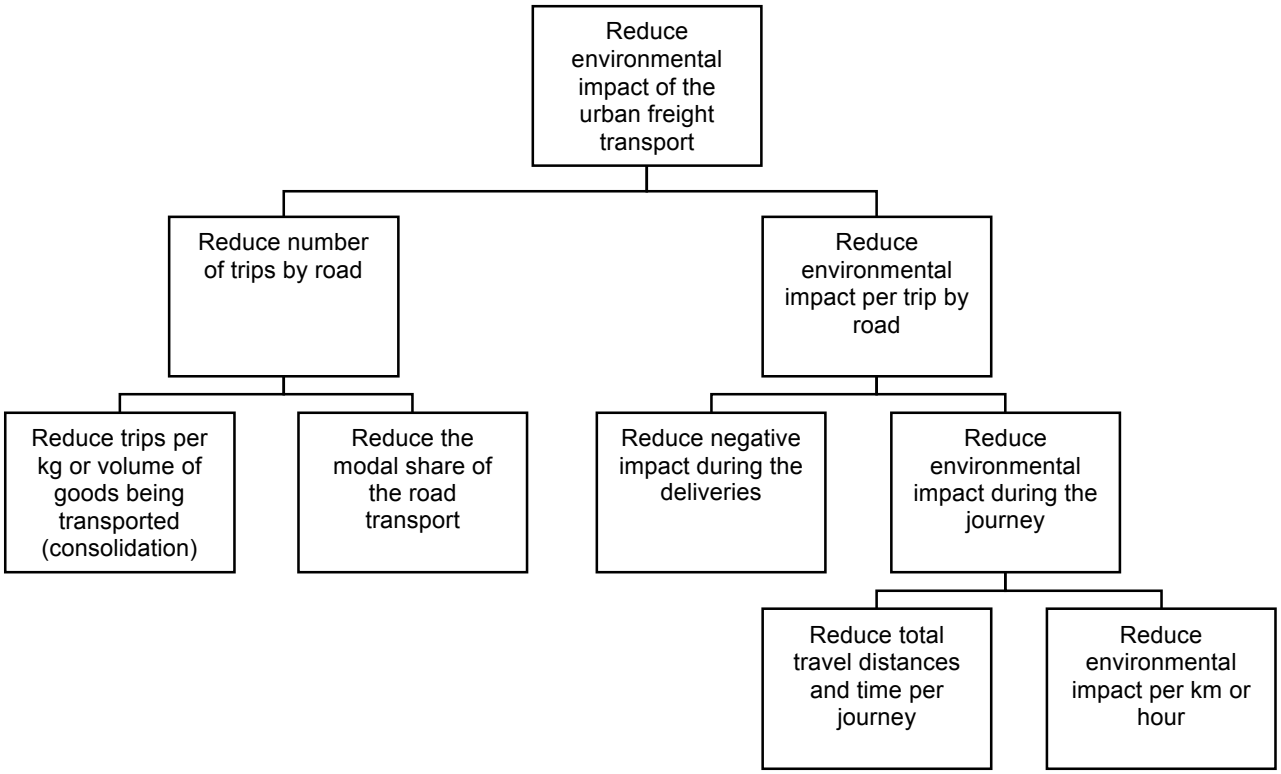

Figure 1: Reduction of the negative impacts of the urban logistics - definition of the secondary goals

Finally, we achieve a following set of secondary goals:

(1) Reduce trips per kg or volume of goods being transported (consolidation)
(2) Reduce the modal share of the road transport
(3) Reduce negative impacts during the deliveries
(4) Reduce total travel distances and time per journey
(5) Reduce environmental impact per km travelled or per hour on the road

In order to reach each one of these secondary goals and consequently to reach the general goal of improving the environmental impact of the city distribution of goods, local public authorities have the possibility of implementing measures of different nature. **Figure 2** shows the possible options that are applicable by local authorities:

(1) Measures linked to physical infrastructure
(2) Technological measures
(3) Administrative and regulatory measures
(4) Economic measures
(5) Educational measures
(6) Measures linked to urban planning

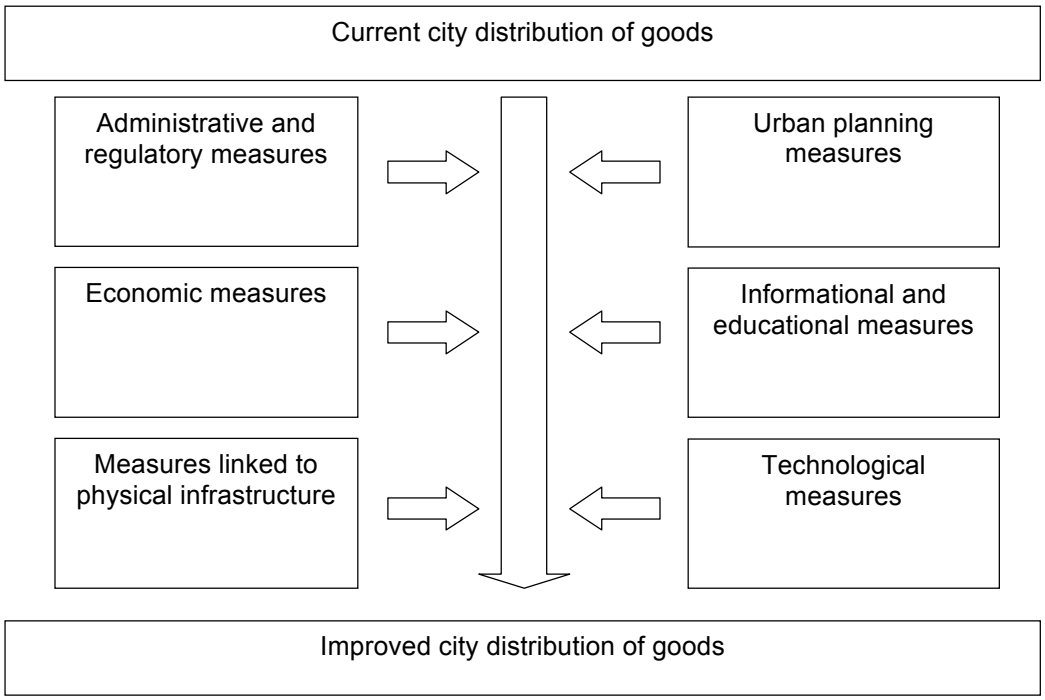

Figure 2: Possible instruments for implementation of urban freight transport measures

The shows on one hand the type of goals pursued by urban freight measures and on the other hand the nature of measures that are applicable by local public authorities in order to illustrate the panorama of the initiatives that can be implemented.

Table 1: Panorama of possible measures for urban logistics according to their nature and the pursued goal

	Reduce trips per kg or volume of goods being transported (consolidation)	**Reduce the modal share of the road transport**	**Reduce negative impact during the deliveries**	**Reduce total travel distances and time per journey**	**Reduce environmental impact per km or hour**
Administrative and regulatory measures	Access limitations based on the loading rate	Acting on the regulations governing the network access and competition in each transport mode	Establishing special time-windows for deliveries	Permission for trucks to use the bus-lanes	Access restrictions based on the emission standards
Economic measures	Toll based on the available free capacity	Fuel taxes and road tolls integrating external costs of road transportation	Parking charges	Distance-based road tolls	A congestion charge depending on the time of the day
Measures linked to physical infrastructure	Urban consolidation centre	Develop intermodal platforms	On-street and off-street loading zones	Subsurface delivery	Installing a network of charging stations for electric vans
Urban planning measures	Location of the wholesalers	Integrate inland ports in the city distribution system	Imposing off-street loading zones for new real-estate developments	Location of the retail activities in order to minimize the environmental impact	Making the preferred truck routes avoid residential areas in order to reduce effects of the noise pollution
Informational and educational measures	Awareness campaign	Awareness campaign outlining the benefits of intermodal transport	Training of drivers on appropriate behaviour during deliveries	Driver's atlas showing preferred truck-routes	Eco-driving education
Technological measures	Internet service allowing to share truck/van capacity	IT systems for seamless intermodal transport management	Internet platform for booking the delivery spaces	Advanced traffic management system	Clean vehicles

Review of urban freight transport measures applicable by local authorities

For the purpose of this paper, more than 180 urban freight measures in Europe and worldwide have been analysed, with the goal of making an inventory of possible actions and provide input for the new proposed classification. In order to compile the list of possible measures, authors have used as sources the scientific literature, as well as best practices relevant to European projects SUGAR, CIVITAS and C-LIEGE.

Table 2 provides a summary of measures that were considered for this paper. It is to be noted that some of the urban freight measures that were considered for this paper pursue more that one secondary goal (e.g. a measure that aims in setting up a urban consolidation centre in a combination with electric vehicles will aim both to reduce trips per kg or volume of goods being transported and to reduce the environmental impact per km or hour), which is why the total sum of identified measures in Table 2 is bigger than 180.

Table 2: Panorama of possible measures for urban logistics

Type of secondary goal	**Number of measures identified**
Reduce trips per kg or volume of goods being transported (consolidation)	82
Reduce the modal share of the road transport	8
Reduce negative impact during the deliveries	26
Reduce total travel distances and time per journey	35
Reduce environmental impact per km or hour	89

In the following section of the document, we will provide a review of urban freight measures according to the goal that they are trying to reach. For each of the secondary goals, the set of measures that are most frequently used by the local authorities will be detailed and examples of their implementation will be provided.

Measures that aim in reducing the journeys per kg or volume being transported (consolidation)

The first line of action consists in reducing the total number of trips by road necessary to transport the same amount of goods in terms of volume or weight. This is achieved by increasing the load factors of the vehicles, mainly through consolidation of goods.

For approaching different consolidation options, we will refer to an article by (Verlinde et al., 2011) that summarizes the possible ways of consolidating goods and puts the consolidation measures into two main categories: measures that involve a setting-up of a physical infrastructure to consolidate goods and measures that aim in changing the behaviour of the stakeholders.

Measures that involve the setting-up of a physical infrastructure consist in an introduction of an additional transhipment point where goods from several carriers are combined into a single shipment.

Among these physical measures, the most popular are the Urban Consolidation Centres (UCCs). The concept of UCCs has been tested in numerous cities across Europe and extensive literature on them exists. (Allen et al. 2012) provides a comprehensive overview 114 UCC schemes worldwide and distinguishes three main categories of UCCs. The first

category consists of UCCs serving all or part of an urban area. Existing examples of such UCCs include Elcidis UCC in La Rochelle (France), Binnenstadservice in Nijmegen (Netherlands), Bristol Consolidation Centre (UK), Cityporto in Padua (Italy), etc. Second categories are UCCs serving large sites with a single landlord, such as hospitals, shopping malls or airports. Examples include London Heathrow airport retail UCC in London (UK) and Meadowhall shopping centre UCC in Sheffield (UK) (Allen et al. 2012). Finally, Construction project UCCs are used for consolidating construction materials for major building projects. Examples include London Construction Consolidation Centre that was acting as a distribution centre and delivery service area for construction materials to four major building projects in Central London (UK) and a UCC established in Hammarby in Stockholm (Sweden) for a major housing project (Allen et al. 2012). Evidence shows that the role of local public authorities is often crucial in setting-up of the UCCs. In fact, their implementation is often initially suggested by the local authority which hopes to benefit from the traffic and environmental improvements that are typically associated with it (Allen et al. 2012). Moreover, a substantial part of UCCs require some form of financial aid from the authorities in order to be financially viable. Finally, local traffic regulations limiting access to other vehicles will generally support the business case of the UCC.

Main problem of traditional UCCs, especially those serving a city or a district (in opposition to those serving a single site or a construction project), is that the break-even volume is rarely made, making them dependent on government subsidies (Verlinde et al., 2011). A possible solution is to consider alternative transhipment points, which could be set up from an existing privately operated transhipment centrer (Verlinde et al., 2011). Examples of such UCCs can be found in several Dutch cities. For example, Utrecht (Netherlands) has several UCCs that are based on distribution centres of well-known logistics companies (Verlinde et al., 2011). Similar examples have been implemented in Maastricht and Leiden (Browne et al. 2005). In these particular cases, the local public authority does not set-up a physical UCC but encourages the consolidation by introducing a system of urban freight distribution licenses to a limited number of registered carriers who meet certain pre-defined characteristics (Browne et al. 2005).

Building on the concept of urban consolidation centres, micro-consolidation centres serve a smaller part of the city and are used as starting points for clean vehicles such as cargo bikes and electric vans. Examples of micro-consolidation centres are La Petite Reine and Chronopost in Paris (France) or the Office-Depot micro-consolidation centre in London (UK). In opposition to a classical UCC, these micro-consolidation centres are generally owned and operated by a single transportation company that specializes in the last mile deliveries. However, in many cases, the implication of local authorities is crucial for the success of these initiatives. In fact, setting-up of logistical facilities in the heart of urban areas often involves high real-estate costs and financial support from institutional actors is often needed. In case of La Petite Reine and Chronopost in Paris, local authorities provide incentives for these initiatives by renting public space at a reduced logistical cost.

Besides the introduction of physical infrastructures that aim in consolidating goods, larger load factors can be achieved by changing the behaviour of urban freight stakeholders (Verlinde et al, 2011). In this area, local authorities have two main lines of action: the fist one is to directly encourage the consolidation of deliveries by facilitating the cooperation between urban freight stakeholders; the second one is to indirectly induce consolidation and encourage individual carriers to increase the load factor of their vehicles by applying various regulations and incentives.

Regarding the cooperation between stakeholders, a first type of cooperation is the cooperation between competing carriers. An example of such co-operative freight transport system can be found in Kassel (Germany), where in a scheme supported by the Kassel City

Council, a neutral freight carrier collected goods from five freight carriers and delivered them to shops in the inner city (Thompson & Taniguchi, 2001) (Köhler & Groke 2003). Such cooperation can be enabled by the introduction of IT platforms, such as Freight Exchange platform in Tyne and Wear (UK), which is an online real time website service developed by the public authorities and allowing carriers to communicate freight traffic information to fellow operators such as transporters, forwarders and logistics companies (AECOM Transportation, 2011).

In the same perspective, it is possible to consolidate goods by making joint deliveries to shops that are using the same suppliers. An example of such co-operative deliveries can be found in Osaka (Japan) involving 11 department stores: two department stores with depots adjacent to each-other exchange their goods to be delivered in the neighbourhood of the depot. (Thompson & Taniguchi, 2001)

In the area of cooperation between carriers, local and regional public authorities play a significant role in the promotion and the coordination between actors. In fact, public promotion of this cooperation might lead to significant reduction in the number of freight vehicles (Munuzuri et al., 2005).

Finally, local authorities can modify the behaviour of stakeholders by means of actions encouraging individual stakeholders to increase their load factors by providing regulations and incentives. In Gothenburg (Sweden), in a pilot project running from 2003, freight vehicles are equipped with a GPS and a system for measuring and reporting load rates: vehicles with a load factor of minimum 65 % can benefit from special incentives, such as using of special loading and unloading zones or using public transport lanes (Konstantinopoulou, 2010). Similarly, in 2002, Copenhagen (Denmark) implemented a compulsory certification scheme allowing carriers who have a capacity utilization of at least 60% over a three month period to access the city centre use 26 special loading zones in the inner city (Kjaersgaard and Jensen 2004).

Measures that aim in reducing the modal share of the road transport

A recurring idea to help reducing the nuisances of the urban freight transport is be to lower the number of trucks accessing the city centre by shifting a transported volumes from road towards other more environmentally friendly modes. We have identified three alternative transport networks that are currently being used for urban freight transportation: urban railway network, urban tram network and a network of inland waterways and canals.

An example of urban rail logistics can be found in France in Ile de France Region: since 2007, Samada, the logistic branch of Monoprix, a major French supermarket chain, has reorganized its logistics supply chain from road to rail for the incoming products of it 90 supermarkets in Paris and its close suburbs. The new logistical concept consists in using a daily train from its distant warehouses to reach the city centre where the goods are dispatched on lighter and greener trucks (NGV) ensuring the last miles to the final destination. Results are promising both in terms of reduction of environmental impact and the logistical costs of the new system. In this experiment, Paris City Council and the Region have financed the feasibility study and the renovation of the rail terminal. (SUGAR, 2011) (Issenmann et al. 2010) (Maes & Vanelslander 2011)

Regarding the usage of the tramway network for supplying the goods in urban areas, we can mention three implementation cases: Dresden (Germany), Zürich (Switzerland) and Amsterdam (Netherlands).

In Dresden (Germany), CarGo Tram was launched in 2000 by Volkswagen (VW) in cooperation with the public transport and the government. The CarGo Tram transports spare parts and waste from the assembly part in Dresden city centre to the VW logistical platform. The system is reported to be both profitable and competitive with road. (Regue & Bristow 2012)

In Zurich (Switzerland), Cargo Tram is used since 2003 to collect bulky items, glass and metal products. In 2006, another service was launched, the E-tram, focused on the recycling of electrical and electronic equipment. The initiative was launched by the tram operator and the company in charge of recycling in the city, but the municipality had a major role in this project, in particularly in the coordination between actors and in providing necessary authorizations for transporting goods on the tram network. (Regue and Bristow 2012) (SUGAR, 2011)

In Amsterdam (Netherlands), a pilot project was launched in 2007 with aim to supply businesses and small businesses in the city centre, the final distribution being operated by small electric vehicles. However, in 2009, Citycargo applied for bankruptcy as it proved to be impossible to raise the required capital. (Augreau, 2010) (Regue and Bristow 2012)

Regarding the use of inland waterways and canals for urban freight transport, we can mention projects in Utrecht (Netherlands), Amsterdam (Netherlands) and Paris (France).

In Utrecht (Netherlands), since 1996, the city uses the Beer Boat to supply drinks and food to more than 70 catering industries located along the canals of Utrecht. The Beer Boat is owned by the municipality, which leases the boat to companies that provide the actual distribution services. In 2010 the Beer Boat that operates on diesel was replaced by an electric, zero emission Beer Boat and the extra costs for the electric propulsion and equipment of the boat were paid by the municipality. (TURBLOG, 2011)

In the city of Amsterdam (Nethelands), DHL developed a “Floating Distribution Centre” which is a specially reconstructed boat that floats through the canals of Amsterdam from where bicycle couriers perform the last leg of delivery. The boat and other facilities were financed by the DHL and the city of Amsterdam provided labour to develop the project. (ELTIS, 2012)

A similar service is in place in Paris (France), where French service provider Vert chez Vous started a multimodal delivery service consisting of a barge used as a warehouse and a fleet of electric bikes, serving entire Paris. The authorities made a financial participation for this project. (Maierbrugger, 2012) (Région Ile de France, 2012)

Another Parisian example is the French supermarket Franprix, who uses river transport to deliver food products on a daily basis to 80 of its stores in the centre of Paris. Containers are transported by truck to an inland port for transfer to a barge for the 20 km journey along the Marne and Seine rivers to the heart of the French capital – thus avoiding chronic road trafiic congestion into Paris. Authorities made a financial participation in this project. (Région Ile de France, 2012) (Todd., 2012)

Measures that aim in reducing the negative impact during the deliveries

One of the most problematic features of the urban freight transport occurs during the delivery to the final receiver. In fact, the scarcity of parking places in cities results in a large number of unauthorized behaviours during the deliveries such as double-parking during the loading and the unloading process.

Local authorities can implement two types of measures in order to reduce the impacts during the deliveries: introducing new infrastructure for the loading and unloading or regulating and exploiting the existing infrastructure.

Regarding the setting-up of new infrastructure dedicated to the deliveries, the most common measure is the introduction of on-street and off-street delivery areas, which is being applied in cities across the world.

Another innovative approach in this field is the establishment up of a vehicle reception point (or nearby delivery area), which consists in setting-up of a zone where carriers can load and unload the goods destined to the neighbouring receivers. This type of devices have been successfully implemented in several French cities, such as Bordeaux, Rouen, Lyon, Clermont Ferrand and Montpellier under a common denomination Espace de Livraison de Proximité (ELP). The ELP concept has been originally implemented by local public authorities who provided financial aid and necessary infrastructure. Few years later, the ELPs have been privatized and today they are run by private transportation companies. (Browne et al., 2011)

Local authorities can set-up the loading infrastructures directly, as shown in the previous examples, or indirectly, by establishing specific regulations aimed at private stakeholders. An example of such measure can be found in Barcelona (Spain), where building code regulations are used to ensure the building of off-street delivery areas for new private developments. (SUGAR, 2011)

Another solution is not to set up new infrastructures for the loading and unloading process, but rather to make a better use of the existing facilities. In this field, allocating specific time windows for deliveries is a common measure and has been broadly implemented in various countries (Visser et al., 1999), allowing to avoid the negative impacts of loading and unloading during the peak hours of traffic congestion. A more innovative approach in this field are multi-use lanes which aim in adapting the use of public roads to the different operational needs emerging during the day: freight loading and unloading, traffic and parking (Alvarez & Calle, 2011). This concept has been implemented in Barcelona (Spain), where three lanes are used as multi-use lanes installed with VMS technology (variable message signs), which clarifies who is allowed to use the street of the day (Huschebeck, 2005) and later in Bilbao (Spain) (Alvarez and Calle, 2011). Building on the idea of dynamic usage of public roads, another innovative concept consisting in advance booking of a loading bays has been implemented several cities such as Bilbao (Spain), Barcelona (Spain), Winchester (UK) and Lyon (France) (McLeod & Cherrett, 2011) (Alvarez & Calle, 2011)(Gonzalez-Feliu et al., 2013) . In Bilbao (Spain), for example, the Delivery Space Booking service allows booking loading bays via Internet by fleet operators and directly on the parking machine near the delivery bay; the system also contains sensors which can identify vehicles that are not allowed in the delivery space as well as double parked cars (Gonzalez-Feliu et al., 2013).

Finally, decreasing the impacts of the deliveries is possible by applying behavioural and organizational measures that aim in adapting the conduct of the drivers in charge of performing the deliveries. A more efficient delivery process can be achieved for example, by ensuring that there are at least two persons in each delivery-vehicle or by training the drivers to have appropriate behaviour during the deliveries. In a framework of a wider urban freight transport project, such a measure has been implemented in Aalborg (Denmark) where the requirement of having two persons in a vehicle has allowed achieving a faster delivery process. (Kjaersgaard and Jensen 2004)

Measures that aim in reducing total travel distances and time per journey

Another line of action for the local authorities is to aim in reducing the total travel distances and time in urban areas.

A first category of measures is the implementation of preferred or compulsory lorry route/s in an urban area that redirects or forces certain categories of vehicles to use specified trunk roads through the city can affect the distance travelled in the urban area (Allen et al., 2000). Their use can be voluntary or compulsory and can be encouraged or enforced through the use of driver atlases, information portal, through road signing or through the use of vehicle-embedded navigation systems. For example, in Bremen (Germany), lorry routes have been defined and their usage has been reinforced through a map indicating truck routes for the drivers, a guiding system (through signing, with a possibility of variable message signs, and navigation systems), and a set of regulatory measures (e.g. restrictions on through traffic and night traffic) (SUGAR, 2011).

Similar results can be achieved through economic measures, such as road tolls to access the city that would ultimately discourage transport operators from entering urban areas. There are many examples of such applications, including the daily charge that vehicles have to pay to access the city centre in London (UK) or the pay-to-access ticket system in Bologna (Italy) (SUGAR, 2011).

The total distances in urban areas can also be reduced by acting on the distances between the suppliers and the customers by rearranging the supply chain and locating retail activities according to logistical considerations. For example, in Oulu region (Finland), a model identifying optimal locations for retail units (new retail trade projects in the region) with minimal CO2 emissions has been developed (Carling et. al, 2012). In Brussels (Belgium), a MARBRU morning market has been created in order to concentrate all the fresh product wholesalers (ELTIS, 2012).

Acting on the distances between the suppliers and customers can be quite challenging, but a reduction in travel distances and times can be achieved through other measures, such as improved planning of trips. This can be achieved either by providing better information on the transport network and transport conditions (for example, through a use of a paper or electronic freight driver atlas, or freight maps showing freight routes, delivery destinations and access restrictions), or by using advanced IT technologies in order to calculate the optimal routes. For example, in Bristol (UK), a commercial vehicle driver's atlas allows the drivers to find most appropriate routes to main freight delivery destinations (ELTIS, 2012). In Ljubljana, an online routing tool is being developed to support delivery companies (CIVITAS, 2012). In Malmo (Sweden), small delivery firm have been able to optimise transports and reduce unnecessary trips by using the GPS (satellite) and GPRS (mobile phones) techniques - the control centre gets updated positions of the vehicles twice a minute, enabling them to deal with fast unplanned city distribution (Konstantinopoulou, 2010).

Finally, a reduction in time and distances needed to perform journeys for urban freight deliveries can also be achieved by introducing regulations that aim in enhancing the use of transport network.

One of such options are the night deliveries: in fact, several cities across Europe including Barcelona (Spain), Paris (France), Rome (Italy), Dublin (Ireland), Turin (Italy) and London (UK) have implemented night delivery schemes, which ensure faster deliveries and limit the impact of the congestion. Since the main problem of night deliveries is the noise for the residents, these schemes involve the usage of silent trucks with special equipment (Daganzo, 2005).

Another option is to introduce specific regulations aiming in developing a sub-network for freight vehicles, such as a permission to use bus lanes, which are commonly found in the cities. Vehicles benefit from higher speed especially if permission applied to peak hours. For example, in the city of Groningen (Netherlands), freight transport is allowed along the bus lanes during some time windows. (Comi, 2011)

Besides the regulations, an enhanced use of the transport network can be achieved through the use of the technologies that allow optimal traffic conditions (for example, a system where cars, signs, traffic lights can communicate in order to avoid bottlenecks in the transport network). For example, in the FREILOT project, energy efficiency optimised intersections guarantee that priority is being given to eligible vehicles, therefore reducing the time they spend in traffic (C-LIEGE, 2012). In London (UK), new technologies are being tested to enhance urban traffic information, road capacity and safety by using a so-called cooperative system where traffic lights, signs and cars can communicate with each other by enhanced technologies (ELTIS, 2012).

Measures that aim in reducing the environmental impact per km or hour

The reduction of the negative impacts per km travelled on per time spent in traffic can be achieved through the use of cleaner vehicles.

Local authorities can first of all increase the use of cleaner vehicles by using them in their own fleet, like in Stavanger, Norway, where electric vehicles have been introduced for goods transport for the municipality (ELTIS, 2012). Local authorities can also encourage their usage by making clean vehicles available to parties that need to transport goods. Examples include the city of Trento (Italiy) that provides ten new electrical cars that are free of charge and that can be used by anyone that needs to transport packages or heavy objects (ELTIS, 2012). Another example is Ariamia (Italy) where the municipality rents electric delivery vehicles in order to spread the use of electric vehicles between retailers and traders in daily activities (SUGAR, 2011). Another example of innovative clean vehicles can be found in Utrecht (Netherlands) where the local authorities have collaborated with a private transport operator in developing the Cargohopper, which is a multi trailer, solar powered road train riding on pneumatic tyres used deliver parcels in inner city quarters (ELTIS, 2012).

Finally, the municipalities can introduce regulatory measures (such as access restrictions based on the emission standards) in order to promote the use of clean vehicles. Among many European examples, we can mention the Emilia-Romagna region in Italy where regional traffic limitations by Euro standards are being applied (SUGAR, 2011).

The use of clean vehicles can also be promoted by acting on the physical infrastructure (for example by installing a network of charging stations for electric trucks and vans), or by providing financial incentives for their use.

Another way of reducing this type of negative impacts is by using the same vehicles but by enhancing their use. A possible option for this is eco-driving which can be achieved either though the training of the drivers either through technological changes on the vehicle (for example adaptive speed limiters) which will ensure that the vehicle is used at the best of its possibilities. In Greece, in the framework of TREATISE project (2005-2007), professional drivers received training in eco-driving (ELTIS, 2012). In the framework of FREILOT project, experiments have been made with the adaptive speed-limiters (ELTIS, 2012).

CONCLUSION

The analysis of case studies in Europe and worldwide has led to highlighting many different urban freight measures that can be implemented by local public authorities, through a range of different instruments.

As evidence from case studies show, the role of regional and local public authorities is often crucial for the success of urban freight initiatives. They have a primary role in setting-up of new administrative and regulatory measures aiming in improving the city distribution. In fact, in many cases, the success of a particular urban freight initiative will depend on the pre-existing regulatory conditions: for example, the authorization to transport goods over the network of tramways, or the possibility for freight vehicles to use bus lanes or to perform night deliveries. They can also introduce new economic measures, such as road tolls or parking charges, which force private stakeholders to rationalize their urban freight operations. Local authorities are also in charge of urban planning, and can use measures in this field such as building code regulations for new real estate developments as a powerful instrument to improve the freight distribution in cities where a scarcity of space is an important issue. Local authorities also have an essential role in setting-up and financing new infrastructures attended to increase the efficiency of the urban deliveries, such as Urban Consolidation Centres, specific infrastructures for loading and unloading of goods, or intermodal terminals. Finally, they have a significant role in establishing the coordination between the urban freight stakeholders and enabling their cooperation.

This paper provides local public authorities with a range of solutions in term of urban freight measures that they can implement, according to the objectives that they are pursuing. The classification used in this paper highlights the variety of instruments that can be applied by the local authorities in pursue of the same environmental goals. Practice shows however that in order to obtain best results in reaching these goals, it is often necessary to combine several types of measures into a coherent strategy for the urban freight transport. The synergies shall be created between the different measures implemented allowing leveraging the resources put into the implementation of this strategy.

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