Final Report

Treatment of logistics activities in Urban Vehicle Access Regulation Schemes

Non-binding guidance documents on urban logistics

N° 2/6

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Glossary and definitions

ANPR:	Automatic Number Plate Recognition System
CC:	Congestion Charging
CO_2:	Carbon Dioxide
DVLA:	United Kingdom Driver and Vehicle Licensing Agency
EU:	European Union
GVW:	Gross Vehicle Weight
HC:	Hydrocarbons
HDV:	Heavy Duty Vehicle are
ICT:	Information and Communication Technologies
LDV:	Light Duty Vehicles
NBGD:	Non-Binding Guidance Document
NGO:	Non-Governmental Organisation
NO_2:	Nitrogen Dioxide
NO_x:	Nitrogen Oxide
OCR:	Optical Character Recognition
OHD:	Off-hour Delivery
PM_{10}:	Particulate Matter smaller than 10 microns
$PM_{2.5}$:	Particulate Matter smaller than 2.5 microns
PM_1:	Particulate Matter smaller than 1 micron
UCC:	Urban Consolidation Centre
UVAR:	Urban Vehicle Access Regulation

Chapter 1 Introduction

Non-Binding Guidance Documents

This document is one of a series of six Non-Binding Guidance Documents (NBGDs) prepared within the scope of the Study on Urban Mobility - Preparation of EU guidance on Urban Logistics (MOVE/C1/2014-370) as commissioned by the European Commission. The documents aim to help stakeholders understand the challenges brought about by logistics activities in an urban context, and identify the most suitable measures and actions to overcome these challenges.

This NBGD (N° 2 out of 6) covers the issue "How to structure the logistics sector in Urban Vehicle Access Regulation Schemes". The document provides specific information on the most important schemes used to achieve more efficient and sustainable urban logistics operations.

Treating Logistics Activities in Urban Vehicle Access Regulation (UVAR) Schemes

Emissions and road congestion have been ranked as the two most important issues raised by freight transport and logistics in urban areas[2]. Additional issues for urban logistics are (i) the lack of parking areas for loading and unloading, (ii) lack of space for logistics facilities leading to relocation and concentration in suburban areas (logistics sprawl), (iii) regulatory procedures, (iv) noise, (v) poor livability in urban areas, (vi) costs for logistics suppliers, (vii) poor enforcement of regulations, (viii) energy costs, and (ix) infrastructure wear and tear.

More and more European cities are developing and implementing UVAR schemes to guide the mobility within their urban areas. These schemes typically encompass all mobility to, from and within urban areas. **Specific solutions need to be identified for integrating freight transport and logistics activities**, given the particular nature of the issues these activities may raise and/or encounter in an urban area.

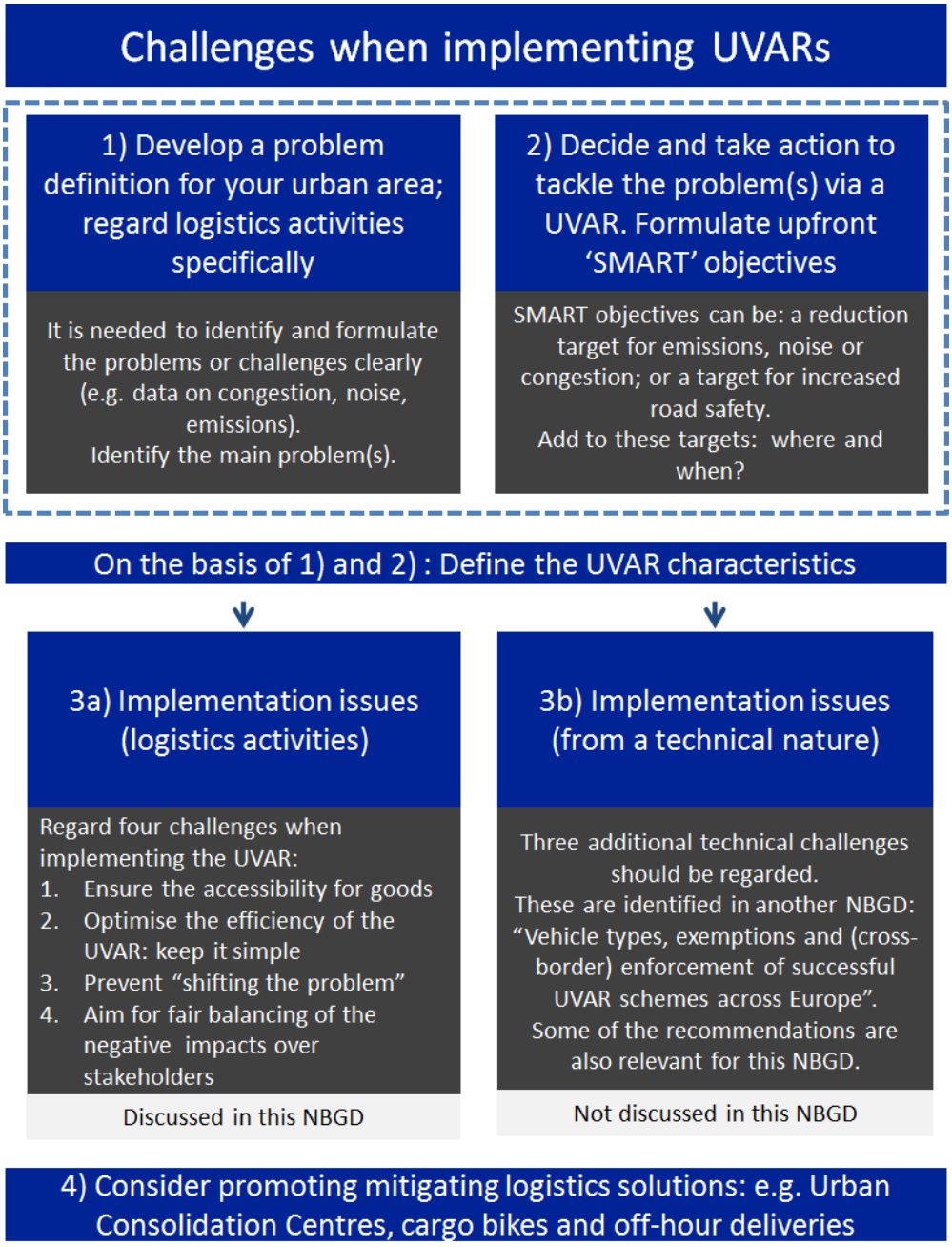
This NBGD aims to assist the policy maker by offering current best practices for the treatment of Logistics in UVARs, and suggesting proven solutions to alleviate possible side-effects of the UVAR. This document (i) describes the major challenges to frame the logistics sector within a UVAR, (ii) offers various options to address these challenges, (iii) describes the advantages, disadvantages and impacts of these options, (iv) helps choose the optimal policy approach, and (v) offers guidance on the main implementation issues as well as some solutions to mitigate undesirable impacts of the scheme.

The goal of these Non-Binding Guidance Documents (NBGD) is to support local authorities who are planning to introduce an access regulation scheme, by providing guidance. The guidance is primarily aimed for use by public authorities such as municipalities or local agencies responsible for the management of the traffic, transport and transport infrastructures within urban areas. Logistics and freight transport operators with operations in cities may also benefit from this document. No background in logistics or freight transport is required to understand this document. More in-depth examples, references and practical guidance can be found in the fully referenced Technical Report on which this less technical NBGD is based.

Chapter 2 The challenges

Decreasing the current road congestion and transport emissions in urban areas will improve overall living conditions for both residents and visitors. Moreover, when properly implemented, a UVAR can also create economic benefits (via an increase in the commercial attractiveness of the urban area, a reduction of delivery costs to customers and a reduction of overall logistics costs). However, to achieve the UVAR objectives in an efficient way, a set of implementation steps should be followed. These are illustrated below and discussed on the next page.

Figure 1 Implementation process for UVAR schemes



The first step is **to clearly identify and formulate the issues** (logistics and freight related emissions, congestion, noise, safety or other issues). Where and when do they occur? What are the causes and drivers of these issues? What is their magnitude? How are they expected to develop over time? It is best to map the city logistics activities in your city or region before implementing a UVAR using general trends identified in international sources; these might differ due to, for example, the structure, location, or terrain in your city.

Once the issue(s) are established, the second step is to discuss and **formulate,** upfront, a clear set of **SMART[1] objectives** that should be achieved by the new **UVAR** scheme**.** These can be, for example: a specific reduction target for logistics emissions, noise or congestion; or a target for increased road safety. Add to these objectives a clear timeline: where and when do you want to achieve the change?

Thirdly, **two types of UVAR implementation challenges** need to be mitigated**.** These may be of an economic nature (e.g. UVARs might have a negative impact on the costs of urban logistics activities) or of a technical nature (e.g. installing cameras to enforce the UVAR might require new legislation).

The following four specific **economic challenges** (3a.) need to be addressed:

- *Ensure the accessibility of retail stores, offices etc.*: Define how the region/municipality/city will ensure freight vehicle access to retail locations after the implementation of the UVAR. Make sure that freight flows originating outside of the urban area, but with a final destination inside the urban area can indeed reach their clients. These vehicle drivers can be motivated or encouraged to change behaviour, and in so doing they will contribute to the achievement of the SMART objectives (e.g. if a city does not ban all freight vehicles, but allows only the best performing fleets (hybrids, electric, etc.) via exemptions awarded on environmental performance; reducing congestion can reduce logistics costs).
- *Optimise the efficiency of the UVAR*: strive as municipality or city to minimise unnecessary economic costs for the logistics sector or other urban user groups. (Links also to the first challenge. Freight should still find its way to the final consumer. If the UVAR is too strict, logistics costs and consumer prices are likely to rise significantly).
- *Avoid "shifting the problem"*: Make sure the municipality or city ensures that any changes in traffic flows (freight vehicles only passing through the urban area, without having an origin or destination in that area) caused by the scheme do not create congestion problems just outside of the UVAR-zone. Remember that logistics activities are flexible; vehicle routings can be adapted in real time. In that way, the UVAR might induce logistics sprawl, which may result in an overall increase of delivery distances and a rise in (CO_2) emissions; or in logistics staff having to move to a different location for work (relocation of economic activities and jobs out of the city). At the same time, local congestion may become more manageable if decentralisation of warehouses in suburban areas takes place.
- *Aim for a fair stakeholder balance of the negative impacts:* Negative impacts of policies can often be spread across stakeholders via pricing; to avoid a situation in which just one of the supply chain actors bears all costs.
  In many cases, citizens complain to the municipality regarding large trucks, and request that these HDVs be banned from their neighbourhoods. However overly-harsh regulations for trucks and logistics services would put the viability of businesses in urban

[1] SMART objectives stand for: **S**pecific – target a specific area for improvement; **M**easurable– quantify or at least suggest an indicator of progress; **A**ssignable – specify who will do it; **R**ealistic – state what results can realistically be achieved, given available resources; and **T**ime-related – specify when the result(s) can be achieved.

areas at risk. The challenge in urban areas is to strike an optimal and fair balance between mobility, freight transport, economic activities, people's safety and liveability.

In addition to the impact on the performance and costs of logistics activities, **three technical challenges** need to be considered before and during implementation (3b.). These are identified in the NBGD, "Vehicle types, exemptions and (cross-border) enforcement of successful UVAR schemes across Europe" [2]. Some technical challenges are also relevant for the logistics sector. The three additional technical challenges to be considered are.

- Trading-off between, on the one hand, technological costs and data protection concerns for vehicle identification, and on the other hand, more effective enforcement, cheaper enforcement for large vehicle numbers and more efficient management of exemptions.
- Defining criteria for vehicle identification consistent with vehicle retrofitting.
- Determining the treatment of non-local and foreign vehicles in the case of cross-border movements.

These technical challenges fall out of the scope of this NBGD. For assessing how to deal with these we refer to the specific NBGD "Vehicle types, exemptions and (cross-border) enforcement of successful UVAR schemes across Europe" .

The fourth and final step in the implementation process is: consider promoting **mitigating solutions** for urban logistics activities. The logistics sector is crucial for the liveability of urban areas, as the vehicles supply freight to urban consumers. Simply banning all freight vehicles will therefore impede economic activities such as, hotels and restaurants, retail stores, e-commerce etc. The NBGD therefore suggests three mitigating solutions to help the logistics sector to cope with UVAR. Three solutions were retrieved from existing literature and considered to be the most relevant: Urban Consolidation Centres, cargo bikes and Off-peak deliveries and can be promoted by the government implementing the UVAR.

[2] The goal of this set of six NBGDs is to support local authorities planning to introduce an access regulation scheme by providing guidance. Six aspects of UVARs are regarded, from planning to successful implementation.

Chapter 3 Available policy options

UVAR schemes can be shaped on the basis of different access restriction criteria. The majority of European examples take account of emissions and vehicle weight; these are often called Low Emission Zones (LEZ). Some also consider pricing as a separate or additional access restriction policy, the so-called congestion charging schemes (CC). Policies or schemes that combine Low Emission Zones and Congestion Charging are also possible. Some examples are outlined here, more details on these and the over 500 schemes in Europe can be found on urbanaccessregulations.eu, and summarized in the corresponding Technical Report.

3.1 Main characteristics of UVARs of relevance for the logistics sector

As defined in the European Commission Staff Working Document "A call for smarter urban vehicle access regulations[3]", UVARs are measures to regulate vehicular access to urban infrastructure. Access regulations for freight transport can be differentiated by:

- Access time.
- Vehicle characteristics (tonnage, dimensions, age, Euro emission category).
- Load factors.
- Access charges.

Access regulations generally fall within three categories: **prohibitions**, which are command control measures; **charging** (pricing), which gives the freedom to adhere to the standards; and **prioritisation**, providing incentives to use best practices.

It is with regard to these aspects that the policy maker can make choices when specifying the scheme (the UVAR's characteristics), and ensure that the scheme is optimally adjusted to both local circumstances and the nature and size of the issues at stake. Moreover, a choice also needs to be made on how to enforce the UVAR scheme.

Access time

Access time regulation to urban areas is one measure that has become increasingly popular; especially in Europe. Access time regulations for delivering goods in urban areas, or so-called **'Time windows',** have become a fairly common local phenomenon, especially in larger agglomerations. In some cities, the time windows have become gradually more strict following implementation [3].

For example, in **Bucharest**, freight vehicles over 5 tonnes can access the city centre only within a certain time window, and if granted a permit. The cost of this permit depends on the zone to access and the weight of the vehicle. The UVAR's main characteristics:

- From 1 July to 31 August: Between 20:00 to 07:00, vehicles over 5 tonnes can access and circulate the area only when possessing a permit; outside these hours, the vehicles cannot access the area.

- From 1 September to 30 June: Between 19:00 to 08:00, vehicles over 5 tonnes can access and circulate the area only when possessing a permit; outside these hours, they cannot access the area.

[3] SWD(2013) 526 final.

Vehicle characteristics

This scheme should specify very clearly how each individual freight vehicle is treated, based on transparent characteristics such as **vehicle weight, size, and/or Euro norm emission class**. There is a trade-off between the effectiveness of the scheme in terms of achieving its objectives and the overall efficiency of the logistics system.
The logistics sector will react to the time windows via changing behaviour. For example: businesses can invest in Light Duty Vehicles (LDVs), often UVAR-exempt, for organising their last-mile deliveries.

A number of Europe's UVARs target larger freight vehicles only. If larger vehicles are banned, this can lead to an increase in the total number of freight vehicles in cities or in their surrounding regions, if the freight is transported with larger numbers of LDVs, thus increasing congestion. Such UVARS themselves may thus form an obstacle to better freight consolidation.

Load factors

Load factors have been used as a criterion for UVAR, with the aim being to reduce the number of LGVs and HDVs running below their maximum payload capacity, thereby increasing the consolidation of shipments. However, it is very hard to enforce. Consolidation increases logistics efficiency, reduces freight traffic and congestion, and improves overall environmental performance.

For instance, a UVAR in the city of **Göteborg** allowed access in its first years (from 2007 on) to freight vehicles above 3.5 tonnes only if the driver could demonstrate that the vehicle's payload exceeded 70% of its maximum%[4]. This criterion was abandoned after one year, as enforcement proved to be too complex.

Combining UVAR and Congestion Charging

Access regulations based on vehicle criteria generally do not charge vehicles for entering the UVAR zone. Other access regulations charge certain vehicle types when entering the pre-defined zone. An important consideration is whether the city wants to combine the access regulation based on clear vehicle criteria, with pricing strategies. The city of London, for example, has both a Low Emission Zone (LEZ) (supported by a Toxicity Charge as of 23 October 2017), a UVAR based on vehicle characteristics, and a Congestion Charging scheme (CC). The first applies to most of the Greater London area, and the latter applies only to London's central area.

In **Milan**, the "Area C" access regulation scheme combines an LEZ with CC. The policies apply to both passenger and freight vehicles, and restrict less environmentally friendly vehicles' access to the city's urban area. Access is free for electric and hybrid vehicles. Entrance is prohibited for Euro 0 petrol vehicles and diesel Euro 0, 1, 2, 3 and 4 without filters. Access is also banned for vehicles longer than 7.5 meters (valid prohibition from Monday to Friday from 7:30 to 19:30[5].

3.2 Preferred schemes for addressing Logistics in UVARs

In the Ecorys 2015 stakeholders consultation[6], as part of the study behind this NBGD, stakeholders identified two preferred UVAR schemes for addressing local challenges related to urban logistics:

1. Low Emission Zones (LEZs) and **2.** Congestion Charging (CC).

This section of the document describes the two schemes in more detail. There are a limited number of combined LEZ-CC schemes in existence, current examples include London, Milan, Palermo and Rome. Göteborg and Stockholm both have LEZs and CCs.

3.3 Low Emission Zones: a great variety with some common characteristics

LEZs define an area with controlled access for certain vehicles. Specific access regulation criteria are based on vehicles' emission levels and vehicle characteristics. Some LEZs only restrict access during certain hours of the day, but most operate 24 hours a day. LEZs have been implemented as a result of increased public health concerns and policymakers who pay more attention to clean air policies. LEZ policies have targeted particulate matter, starting with PM_{10}; which are significant contributors to pollution from vehicle emissions, current developments focus on NO_2. Local policies follow European policy trends. E.g. Directive 2008/50/EC on ambient air quality and cleaner air for Europe also included air quality objectives for PM10, $PM_{2.5}$ and NO_2; including limit values and exposure objectives.

Models of treating the Logistics sector in LEZs

The implementation of LEZ schemes in Europe has followed different approaches, as can be seen from implementations in the UK, Sweden, Greece, Germany and Italy. These are briefly introduced below.

The implementation of the LEZ in London (**United Kingdom**) took place in four phases: in 2008, it applied to diesel vehicles weighing over 12 tonnes. Six months later, all vehicles with a gross vehicle weight (GVW) of over 3.5 tonnes had to comply with the Euro III PM standard which applies to HDVs only. In 2012, vans with an unloaded weight of over 1,205 kg had to comply with the Euro 3 PM standard, which applies to LGVs, while the standard for heavy goods vehicles was raised to Euro IV PM. What defines the London LEZ, apart from its size and its inclusion of light goods vehicles, is its extensive use of Automatic Number Plate Recognition cameras[7](ANPRs). Future phases include the emissions surcharge from October 2017 for pre-Euro 4 vehicles and the Ultra-Low Emission Zone which is planned for 2020 and which intends to heavily charge all diesel vehicles (including private vehicles such as passenger cars, ~16€ light duty, ~130€ heavy duty) which do not meet the Euro 6 standard in the zone currently covered by London's Congestion Charging Zone[8]. (Recent regulations can be retrieved via www.urbanaccessregulations.eu).

In Göteborg (**Sweden**), an LEZ was introduced in 1996, introducing emission controls for diesel PM and HC. In 2002 NOx control was added. Swedish LEZs are intended to avoid vehicles of more than 3.5t that do not comply with current emission standards from entering cities. The basic requirement for entering the Environmental Zones was that all heavy goods vehicles Euro 2 and 3 must not be older than eight years. Currently, the age limit is 6 years. Vehicles certified for compliance with Euro 4 classification will enter the environmental zone until 2016 (inclusive)[9]. Vehicles certified for or complying with Euro 5 classification will enter the zone until 2020 (inclusive). The vehicle´s year of registration is irrelevant for Euro 4 and 5 vehicles. Adapted vehicles must meet all the emission standards of the set Euro standard. It is possible to upgrade a Euro-2 and Euro-3 vehicle to Euro-5 by retrofitting emission control devices such as particulate traps with Selective Catalytic Reduction, approved by the Swedish Transport Agency[10]. (Recent regulations can be retrieved via www.urbanaccessregulations.eu).

The Athens LEZ in **Greece** is only effective from September to July each year, with different access regulations for the city centre and for the rest of Athens. Vehicles up to 2.2 tonnes are allowed to enter the city centre on alternating days depending on the last digit of the licence plate. In the whole of Athens, vehicles over 2.2 tonnes first registered before January 1991

were banned in 2013, when the LEZ was established. Each new calendar year the banned vehicle registration date is increased by one year, gradually exempting only the newest vehicles (Recent regulations can be retrieved via www.urbanaccessregulations.eu).

In **Germany**, the first LEZs were introduced in Berlin, Cologne and Hannover in 2008. The German government has categorised all vehicles into four mutually exclusive classes, according to PM10 emissions. Coloured stickers showing the emission group of a vehicle were introduced in order to identify low-emission vehicles. Every vehicle in an environmental zone in Germany must display the required sticker on the windscreen, making it easy to monitor the environmental zone. The stickers apply in every low emission zone in Germany. Each city specifies which sticker is required to drive in its environmental zone. As of 2015, 83 German cities had implemented LEZs, restricting access of vehicles to the LEZ based on the emission class, as indicated by the colour of the windscreen sticker. Only two out of the 83 LEZs did not require the green sticker equalling EURO 4. (Recent regulations can be retrieved via www.urbanaccessregulations.eu).

The **Italian** LEZ regulations are diverse, even within a city, because each municipality has the freedom to select its own criteria. For example, in Rome, some LEZs require payments while others impose night-time regulations on certain types of vehicles. Moreover, zonal boundaries vary according to the time of the day and to the day of the week. This regulatory diversity leads to overlaps and there are a large number of exceptions[7].

Milan LEZs include the Area C (Circle of Bastions) and a city-wide LEZ and the limited traffic zones of Paolo Sarpi and Naviglia. Area C is delimited by entrances with 43 cameras. From the 14th February 2017, diesel freight vehicles Euro 4 without a particulate filter can no longer access the Area C. In the limited traffic zone Paolo Sarpi the transit and parking of vehicles used for freight is forbidden between 00.00 and 24.00 on all days of the week[5]. (Recent regulations can be retrieved via www.urbanaccessregulations.eu).

Enforcement models for Low Emission Zones

European solutions and techniques for the enforcement of LEZs vary considerably from city to city. More detailed examples are included in the technical report substantiating the analysis when writing this NBGD. The choice of specific enforcement techniques will impact the rate of compliance. Two dominant European LEZ enforcement models can be identified: (i) **visual surveillance using windscreen stickers** and (ii) **cameras with ANPR technology.**

The analysis substantiating this NBGD resulted in an overview of enforcement strategies in different European countries and cities. Cities in the Netherlands, the UK, France, Germany, Italy, Denmark and Norway enforce LEZs in the following ways:

- The Netherlands started surveillance of its LEZs manually, until the ANPR cameras were able to be put in place.
- In Germany and France however, data protection legislation restricts the use of ANPR cameras.
- In most countries with ANPR cameras, authorities have been given access to the complete DVLA (UK Driver and Vehicle Licensing Agency) national vehicle registration database and compares all data collected by ANPR cameras with the said database.
- The main Italian LEZs (Rome and Milan C), have ANPR cameras.
- In Denmark, all LEZs set out three coordinated manual enforcement methods:
  - Municipal inspectors when lorries are visiting a company;
  - Town traffic wardens checking vehicles parked on the street;
  - Police at routine roadside checks.

- The planned Norwegian LEZs intend to expand on the EU enforcement model by using the same electronic device system as is currently used for Norwegian motorway tolls (Autopass), and supporting it with both ANPR cameras and manual enforcement.

Impact of introducing a different system of enforcement: when the city of Amsterdam put a system of ANPR cameras in place for its LEZ in 2009, the compliance rate rose from 66% (2008) to 97% (2010).

The fine for illegally entering an LEZ depends on various criteria. Owners of non-permitted vehicles in London, for example, are allowed access upon payment of a charge which ranges from £100 to £200 per day. If a non-compliant vehicle is caught accessing the zone, a fine is levied which ranges from £250 to £1,000 per day. In Denmark, the fine is linked to the cost of compliance – i.e. fitting a filter.

Impacts of LEZs

In general, determining the impact of local LEZs on air quality is difficult, due to (i) meteorological influences, and other factors such as (ii) the amount of traffic, (iii) the changing nature of the total vehicle fleets regardless of LEZs, (iv) other policies such as the introduction of vehicle scrappage schemes (i.e. stimulus schemes to entice consumers to buy newer vehicles and scrap their old ones), (v) the changed composition of traffic close to the monitoring stations as well as (vi) dynamic changes in vehicle flows. However, the following table 1 describes some local impacts of Low Emission Zones, as identified in literature.

It is also necessary to point out that LEZs can have a local impact, in that they might influence non-complying vehicles (in this case the most polluting vehicles) to drive around the zone, as such polluting more in the surrounding areas.

Table 1 Local impacts of LEZs[11]

Impacts	Low Emission Zones
CO_2	Milan (-22%. 2002/2008)
	London (-19%)
	Stockholm (-18%. 1996/2007)
PM	Berlin (-58% 2007-2010)
	Stockholm (-60%. 1996/2000)
	London (-12%)
NO_x	Berlin (-20%. 2007/2010)
	Milan (-10%. 2002/2008)
	Stockholm (-10%. 1996/2000)
	London (-12%)

In Göteborg (Sweden), the LEZs had the greatest effect on heavy goods vehicles with a total weight of under 16 tons: PM_{10} from these lorries declined by 67% between introduction and 2006[9]. In Germany the average LEZ led to a decrease in PM_{10} of approximately 9% in traffic areas, ranging from 0% for smaller LEZs such as Tübingen to a significant 15% in the case of a more populated LEZ (Berlin, with 1.1 million residents) [12]. It can also be observed that the decrease in PM_{10} has been larger inside the LEZs than outside[12].

3.4 Congestion Charging (CC)

Congestion charging is the second most-preferred way to regulate freight flows in an urban area. Current analysis shows that, in Europe, this pricing policy is implemented less often than the LEZ schemes. Why is CC applied less often than LEZs? Researchers have observed that especially low stakeholder acceptance of road pricing is the main obstacle to implementation, although its potential efficiency is generally appreciated.

Models of CC schemes

An overview of Congestion Charging schemes shows the different approaches which have been implemented across the EU for freight, illustrated by examples from London, Rome, Milan and Göteborg. More details can be retrieved in the technical report substantiating the analysis preceding this NBGD.

In the UK, **London,** in February 2003, introduced a CC covering the city's central business district; an area of eight square miles. All vehicles entering the zone are required to pay a daily fee during business hours (07:00 to 18:00). There is an exemption for vehicles which emit 75g/km or less of CO_2. Operators using automatic payment have a discount of £1 per vehicle per day (2017).

In **Milan**, a CC scheme - called ECOPASS - was introduced in January 2008. In 2012 ECOPASS was replaced with AREA C, a CC combined with an LEZ. The area under the scheme covers 8 km^2. Vehicles are granted access between 7.30 am and 7.30 pm if they have paid the daily charge. The charge varies according to the emission class of the vehicle identified on the basis of the Euro class. Charges apply to both passenger and freight vehicles.

In **Göteborg** (**Sweden)**, a CC was introduced in 2013 for all vehicles. Its operating cost, including costs for maintaining the technical system, customer service and invoicing, was approximately €12 million for the first year of operation. This corresponds to 17% of the revenue generated by the scheme on a yearly basis.

In **Rome** there is a CC scheme in the inner area including the historic centre. The area covers 4 km^2 and is subject to access regulations between 6.30 am and 6.00 pm. Freight vehicles pay the same charge as passenger vehicles. To be granted a permit for goods delivery and/or maintenance work, operators must provide documentation which includes signed contracts with the customers located in the CC area.

Enforcement of CC schemes

Enforcement of CC schemes is generally achieved by ANPR schemes. The enforcement of the charging schemes in Rome and Milan is automatic, thanks to electronic checkpoints at the CC zone entrance points[13]. The CC schemes in Norway use a transponder for automatic payment, linked to the motorway charging schemes, together with ANPR for enforcement.

The Göteborg CC uses ANPR, (the same technology as in Stockholm). In Göteborg, the accuracy of number plate recognition improved during the first year with the percentage of correctly identified passages increasing from 80% in January 2013 to 94% in the autumn of 2013[14]. London also uses ANPR technology.

Impacts of CC schemes

The first ex-post evaluations of Milan CC scheme, requested by the city, have shown by 2008 a decrease of approximately 18% in the number of freight vehicles entering a charged area

compared to the pre-scheme period (probably mainly due to a reduction in transit traffic). There is also evidence of a change in the composition of the circulating fleet, with an increase in the number of vehicles in the less polluting classes. Since 2008 the share of freight vehicles and private buses exempted from payment (low emission types) has increased from 26.5% to 43.1% (of the total number of commercial vehicles). This indicates that the incentives created by the schemes to encourage operators to use less polluting vehicles have been effective[13].

Freight traffic in London has, however, proven to be quite price-inelastic. For 2005 to 2006, when there was a 60% increase in price, a 3-10% decrease in goods vehicle traffic was observed, implying price changes do not have any effect on goods vehicle traffic. From 2010 to 2011, after a price increase of 25%, the number of LGVs declined slightly, but HDV traffic increased, implying that they are still inelastic to the price levels at that stage, and/or that several LGVs were replaced by a single HDV so as to compensate by economies of scale. Furthermore, average travel speeds inside the CC have fallen back to pre-CC levels over the decade since it was implemented, mainly due to road space reallocation to bicycles and signal timing changes prioritising pedestrian safety[15]. The number of bus passengers, cyclists and pedestrians has also increased.

As the London case demonstrated, it is not easy to set effective prices in a CC scheme for HDVs. HDV charges are more difficult to set than charges for passenger cars because of the complexity of devising charging schemes which cover the cost of transporting freight in terms of time - also known as 'transport value of time' – while taking into account multiple externalities such as pollution, damage to infrastructure or potential costs of accidents.

3.5 Choosing a fitting scheme; main considerations

The individual choice of a city for a UVAR scheme, and the access regulations therein, depend on the size and nature of the issues, and the objectives of the scheme.

The following Table aims to structure the main questions to be answered before opting for a specific policy. For example: when the issue is congestion, and the car share in the urban mobility is high, and when these are on average new, a CC scheme is the better choice.

Table 2 Choosing the best UVAR policy for your local issue

	LEZ		CC
Enforcement	ANPR	Manual	ANPR
Main issue of the urban area: Congestion or emissions?	Emissions		Congestion
Number of entry points to the UVAR zone	High	Low	
Size of the UVAR zone	Small	Large	
Share of freight transport in the zone (% of vehicle flows)	High		Low
Population density within UVAR zone	High		Low
Characteristics of urban area: commercial, housing, mixed	Housing/mixed		Commercial/mixed
Share transit in % freight vehicles in total vehicle flows	High		Low
Availability of alternatives (e.g. a ringroad, other modes)	Yes		No
Characteristics of the freight fleet: old, new, mixed	Old, mixed		New

Chapter 4 Implementation of Urban Vehicle Access Regulation Schemes

Balanced urban freight transport policies like UVARs require the engagement of all relevant stakeholders. However, meeting the conflicting and diverging interests of multiple stakeholders is highly challenging. To make these schemes successful requires policy makers to be engaged and other business stakeholders to disclose their needs, in order to jointly develop optimal city logistics solutions[16].

4.1 Implementing Low Emission Zones

Stakeholder involvement

The specific access regulations when implementing LEZs can be specified in or encouraged by a country´s national legislation[17]. Countries such as Germany, The Netherlands and Sweden have developed national LEZ frameworks to ensure a consistent approach and to increase the ease of driving across their country. However, each municipality has the option of establishing an LEZ or not, and of determining its scope and in Germany its standard. In other countries, such as Italy, no national framework exists and for that reason each municipality determines its own criteria. Comparing access regulation schemes between EU cities remains difficult as the LEZ regulations differ from city to city.

According to urbanaccessregulations.eu, in France, national legislation was passed in 2010 allowing large urban communities to introduce LEZs. After failing to promote LEZs, the law was changed in 2015, with more options provided to encourage municipalities to implement LEZs. In July 2015, an LEZ was introduced which covers the whole area inside Paris' ring road. From 8.00am to 8.00pm heavy goods vehicles over 3.5 tonnes below Euro I are banned. Standards in January 2017 are Euro 2 and 3. The emission standards required for all vehicles will be increased year after year until 2020.

Before any decision is taken regarding the implementation of an LEZ, it goes without saying that the various stakeholders need to be consulted. The main reasons for this are illustrated in Table 3.

Table 3 Stakeholder involvement when implementing an LEZ

Stakeholders	Involvement when implementing LEZ
Shippers/ Producers	Need to be consulted over existing shipments, and the related logistic procedures and routing.
Wholesalers	Idem.
Logistics providers	Most directly affected by new schemes. They should be consulted on existing solutions for last mile deliveries, on existing use of transportation vehicles and on the feasibility of the proposed transition scheme.
Retailers	To be consulted on flexibility of delivery times and mechanisms.
Consumers	To be consulted on possible impacts on shopping behaviour or other logistics-related issues.
Authorities	Fine-tuning of UVAR is the overall institutional framework.
Citizens	Residents and visitors. To be consulted on balancing possible negative impacts (in and outside the UVAR-area).

Key Success Factors for implementing Low Emission Zones

Four key success factors for implementing a LEZ successfully can be identified:

1. **Good preparation**: experience gained from research carried out within the EU, for example in London and Berlin, clearly shows that before LEZs are implemented, drivers' feedback on the LEZ's characteristics is needed[18, 19].

2. **Create Acceptance:** stakeholder acceptance has been obtained in London because the London LEZ has been the subject of a particularly strong awareness and public relations campaign, as well as because of the severity of the original problem. Transport companies were warned about the system a long time in advance (about seven years), which meant that the system was better received, because the companies were able to plan and prepare. Some businesses also admitted that the introduction of an LEZ benefitted them, as it forced them to improve their efficiency, optimise their vehicle routing, and become involved in projects to increase the size of their vehicle fleet[7].

3. **Communicate impacts**: Transport for London reports significant reductions in PM, Black Carbon and nitrogen oxides (NO_x). More negative impacts on shipping costs, organisation of business, or the transport industry are as yet unknown[20].

4. **Keep improving**: there is currently an ongoing debate about the necessity of measuring LEZ's benefits through $PM_{2.5}$ emission reduction instead of PM_{10}, however the $PM_{2.5}$ monitoring network is not extensive. Some experts are also suggesting that it may be more appropriate to assess the impact of LEZs in terms of the reduction in elemental carbon, black carbon (a fine carbon powder produced by the incomplete combustion of hydrocarbons) or black smoke (a marker for diesel soot or the organic fraction of particles) rather than PM_{10}, $PM_{2.5}$ or even PM_1[22].

4.2 Implementing Congestion Charging

Stakeholder involvement

The **initial absence** of sufficient **public and political support** may explain why many cities have not introduced CC despite high congestion levels in their urban areas.

Support can be created by offering incentive schemes. For example, one of the factors for receiving public and political support for CC in Stockholm was an agreement with the national government granting Stockholm a major infrastructure investment package. This package was funded by the CC revenue, and matched by a national grant of an equal amount. This agreement inspired Göteborg's politicians to strike a similar deal, co-funding a large infrastructure package with revenues from CCs[14]. In London and Milan, income is ring-fenced for sustainable transport.

CC has been an effective way of limiting emissions, due to the reducing and smoothing of traffic flows, particularly in London and Milan.
Cities themselves cannot influence demand for pick-ups and deliveries, and consequently CC has demonstrated in some practical situations more limited effectiveness[20]. Two important reasons for this are:

- One concern amongst businesses in the CC area, particularly small businesses, is that CC imposes additional direct and administrative burdens both on them and on their customers/clients who may choose to shop/eat or do business where travel costs are lower[23].

- There is also concern among retailers that CC adds to their customers' household expenditure, thus reducing the customers' disposable income. However, CC is beneficial in helping to reduce both delays and the unreliability of journey times caused by congestion, two factors that also discourage customers/clients from travelling to the charging area[23].

The stakeholder involvement for implementing a CC system is similar to the involvement as described for LEZs (see table 2). Two additional issues of attention are to be considered:

1. To ascertain the necessary pre-CC-scheme support from public and politicians.
2. To pay special attention to the impact of the scheme for transit-flows.

Key Success Factors for implementing Congestion Charging

Various success and fail factors can be identified. These are grouped in three clusters:

1. A key factor for sufficient public support for CC is to **present it as a tool beneficial to society**, rather than an instrument to generate revenue for the municipality[24]. Hence, the vital role of communication, marketing and information dissemination in the implementation process of a CC must not be underestimated[25].
2. Key success factors of the implemented London CC scheme are[26]:
   - Lengthy **participatory process** which involved continuous and extensive public consultation.
   - Visible **responsiveness** where the views of stakeholders were taken into account and led to modifications in the scheme.
   - Range of **exemptions** is limited; which further smoothed the introduction of CC in the eyes of the stakeholders.
   - **Willingness to adjust price levels** when impacts deviated from the objectives.
3. In addition to the well-known successful example of London, there have also been **failures**. One example was the rejection of Congestion Charging by the citizens of Edinburgh in 2005, two years after the London Congestion Charging started. Lessons learned from the Edinburgh case suggest[27] the need for:
   - Drafting clear enabling legislation.
   - Appointing a political sponsor[4].
   - Establishing clear objectives.
   - Keeping the CC scheme simple.
   - Engaging stakeholders from the beginning.
   - Maintaining the active promotion of congestion charging benefits.

Table 4 on the next page summarises the measured local impacts of Congestion Charging Schemes in some EU cities.

[4] The sponsor is an individual or a group who acts at the senior level to be as an advocate for the project and ensure that the project delivers the desired outcomes, under the allocated resources. The sponsor provides internal political support and ensures right prioritization of available funds and resources.

Table 4 Local impacts of Congestion Charging [11]

Impacts	Congestion Charging in European cities
Road congestion	London (-39 %. 2003 vs. 2007)
	Milan (-28.6%. 2015 vs. 2011)
	Stockholm (-29,1%. 2006 vs. 2011)

The London case, which reduced road congestion by over 30%, is an interesting example of how the freight industry negotiated with "Transport for London" regarding the fee for HDVs. The industry wanted to be exempted from paying, as there is no alternative mode of transport (goods cannot be carried by public transport). Transport for London argued that HDVs should pay more than cars because they damage roads to a greater extent. The final decision was a compromise where trucks pay the same fee as cars do. Nevertheless, this compromise clearly explains the observed price inelasticity afterwards.

4.3 Solutions that can help to mitigate undesirable side-effects of UVARs on the performance of the Logistics sector

Three types of solutions have been identified to assist in mitigating undesirable side-effects of UVARs:

1. Urban Consolidation Centres (UCCs)
2. Cargo Bikes (CBs)
3. Off-hour Deliveries (OHDs).

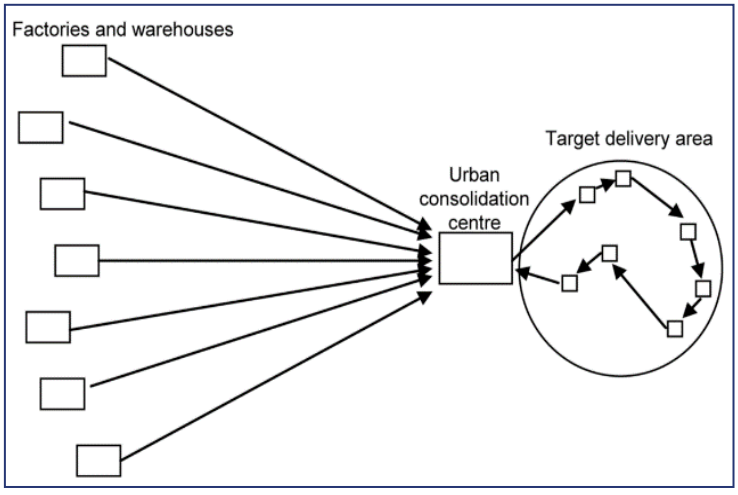
These three solutions can mitigate the impact of UVARs on the logistics sector, while still allowing for the achievement of the objectives set for decreasing congestion and emissions. In the next section we explore some of the advantages and disadvantages of these solutions, as well as identifying some key success factors, implementations issues and impacts to be expected.

Urban Consolidation Centres

A UCC is defined as a logistics facility situated in relatively close proximity to the geographic area that it serves (be that a city centre, an entire town or a specific site such as a shopping centre complex). Many logistics companies deliver goods to the UCC, and from the UCC consolidated deliveries are carried out to businesses within that area. Within the UCC, a range of other value-added logistics and retail services can be provided [1, 28].

Figure 2 illustrates the urban distribution systems using a UCC.
Urban Consolidation Centres have become more professionally organised (as seen by the involvement of experienced logistics companies), and the legal framework used

Figure 2 Urban distribution systems with a UCC[1]



for setting up delivery consolidation activity is becoming more robust[29].

Notable examples of UCCs are to be found in Utrecht[30], Padua[31], Vicenza[32], La Rochelle, and Monaco[33, 34] among others.

In **Italy**, several still-active UCCs can be identified. Among these, Padua's is one of particular interest. It is an example of EU good practice because it has been in operation since 2004, and moreover, has proven to be financially sustainable while being successful in reducing adverse environmental emissions.

An interesting legal case involving the city of **Vicenza** (Italy) and large parcel transport operators in 2008 demonstrated that there is a precedent for courts, at least in Italy, to accept cities' environmental justifications when imposing the use of a UCC on all external freight companies. A city that is actively considering implementing a scheme for consolidating urban deliveries must take additional financial and regulatory measures to guarantee a comparative advantage for the UCC. It is particularly important to accompany plans for a UCC with regulations favouring its use [32].

Two important factors which are critical to the success of a UCC scheme are:

- Level of demand. A sufficient UCC user and product delivery volume is required to drive down the costs per unit handled, thereby making the UCC competitive with traditional urban distribution systems.
- Fair cost and benefit sharing. UCC costs and benefits need to be shared between the various supply chain parties involved in the scheme.

In general terms, UCCs have the greatest prospect for success if they meet one or more of the following criteria[35]:

- Availability of funding, since there is strong evidence to suggest that many UCCs without funding may fail.
- Strong public sector involvement in encouraging their use through the regulatory framework.
- Significant existing congestion/ pollution issues within the area to be served.
- Bottom-up pressure from local stakeholders (e.g. retailers in a Street Association).
- Locations with a single manager/landlord.

However, many UCC case studies indicate that residents living close to a UCC are often the main opponents of UCC development, for a number of rational reasons. The concentrated freight transportation may negatively impact the local community in terms of increased noise, reduced community vibrancy and safety despite the fact that a UCC creates employment in the local area[32]. Addressing these issues and mitigating them as much as possible in the project development phase will enhance the support of this group of stakeholders.

The following table describes some empirical impacts of European UCC Projects.

Table 5 Local Impacts of UCCs[11]

Impacts	Urban Consolidation Centres
CO_2	Brussels (-23%)
	London (-75%)
PM	Brussels (PM2.5 -58%; PM10 -22%)
Noise	Monaco (-30%)
Liveability	Monaco (-42% space used)
Road congestion / reliability	L'Hospitalet de Llobregat (load factors > from 68% to 73%)
	London (-70% freight journeys)
	Monaco (-38% congestion)
Commercial attractiveness	Bristol (100% on time delivery)
	London (delivery reliability 97%
Logistics costs	L'Hospitalet de Llobregat (-25%)

Cargo Bikes

Cargo bikes are used for final freight deliveries of smaller items. They can reduce congestion in cities and can be a second solution for logistics operators to cope with UVARs. The vehicle characteristics range in payload from approximately 25kg for conventional two-wheeled bicycles with a front basket or tray, to approximately 250kg for three- and four wheeled cycles (equipped with rear-mounted boxes, cages or trailers). Electric bicycles can reach a speed of approximately 15 kilometres per hour in free-flow traffic[36]. The move towards shifting more goods by bicycle has led to a new range of different cargo bikes, some of which can carry up to 400-500kg of goods and 2m³. Some are lengthened bicycles so a large container can be fitted between the handle bars and the front wheel, while others have been fitted to take items that require refrigeration.

In Europe, examples of the use of cargo bikes for urban freight transport have, for example, been documented in France (especially in Paris), The Netherlands (Arnhem, Lochem, Nijmegen and Apeldoorn), Belgium (Antwerp and Brussels), Germany (Berlin), the UK (London, York, Nottingham, Cambridge) and Spain (Barcelona).

In Paris, over the past 10 years, 700 kilometres of bicycle lanes have been constructed. After legal discussion, these lanes have now been officially opened up to electrically assisted tricycles and cargo bikes. Companies such as "La Petite Reine" or The Green Link estimate that this enhances the productivity of their delivery operations. La Petite Reine (a subsidiary of Groupe Star's Service) operates approximately 100 cargo cycles, from several consolidation centres throughout the city. In 2010, an assessment study showed that, at that time, 30 cargo bikes were operating from a 600m^2 terminal, and this saved emissions equivalent to those produced by running diesel vehicles for 660,000 km[37].

DHL Netherlands replaced 33 trucks with 33 cargo bikes, thus saving 152 metric tons of CO_2 and € 430,000 per year, and 10% of their vehicles are cargo bikes[38]. In Brussels, the example of Ecopostale can be noted, which began with four bicycles, seven cycles and one electric van, delivered 400 packages per day to banks, lawyers and other corporate customers and reached savings of 13 tonnes of CO_2.

In Central London, research shows that replacing diesel vans by electric vans and tricycles operating from a micro-consolidation centre would lead to a decrease in total distance travelled

and the CO_2-equivalent emissions per parcel delivered by 20% and 54% respectively. The research is based on a trial experiment, similar to the aforementioned Paris assessment, carried out by Office Depot between 2009 and 2010. This experiment tested six cargo bicycles, three electric vans and one truck and resulted in a total decrease of 62% in CO_2 emissions (kg/parcel)[39].

Barcelona has estimated savings of 912 kg CO_2/year/bike with the implementation of such a system[37].

Given the advantages and disadvantages of cargo bikes, it would appear that they are most suited for the distribution of products with a relatively low bulk density and size, and which have simple storage or handling requirements.

Off-hour Delivery (OHD)

Another solution for the logistics operators to mitigate UVARs is the use of off-hour deliveries. Retailers generally want to receive deliveries of goods during their normal work hours. As a result, most lorry traffic occurs during the most congested (daytime) traffic periods.

If enough businesses are able to adjust their schedules to accept deliveries when there is less traffic congestion, it could enable transport companies to deliver goods more quickly and at lower cost. This would result in less traffic congestion, reduced cost of goods, economic benefits and would also be better for the environment[40]. Many of the benefits of off-hour delivery, such as reduced congestion, improved air quality and safety, would serve the greater community, not just the carriers or customers.

To make an OHD scheme a success, investments in silent equipment by retailers or the logistics sector are a necessity.

E.g. in **The Netherlands**, silent vehicles and delivery equipment for OHD is developed (PIEK technology). The government promoted and organised an independent certification the equipment. The maximum noise level fir the equipment is regulated by law, certification was organised by TNO[5]. The PIEK technology is currently being exported to other European countries. More information can be retrieved via: http://www.piek-international.com/english/

The most recent large scale study on the benefits of PIEK silent equipment can be retrieved in a **Belgian study** (2011). The final report discusses four main benefits: given a more stable engine use, the off-peak deliveries reduce the fuel consumption and hence also emissions. In the pilot, the following reductions were realised: CO_2 -23% till -67%, NO_X -41% and PM_{10} -42%. In off-peak hours, an increase in the average speed per delivery round, due to less congestion towards the city, was noted. Organisational benefits are also important. Vehicles and equipment can be used more efficiently. The final benefit for the company deploying silent equipment is the positive public image, especially in terms of citizens living close to the retail location, often the most frequent customers.

An OHD program steered and promoted by the city could switch more than 20% of the (currently congested) daytime freight traffic deliveries to off hours; and could achieve sizeable pollution reductions[41] . The OHD scheme can fit perfectly into an UVAR zone, where the UVAR regulates access during day and off-peak times on different access criteria. Noise reduction can be attained by the use of newer, quieter delivery vehicles and equipment. Behavioural changes to reduce noise requires training however, especially own goods-vehicle drivers and reception staff employed by the customer at the site[42].

[5] TNO is the Netherlands' Organisation for Applied Scientific Research

Mercadona, a supermarket chain in **Barcelona**, has tested OHD and expanded its use to over 100 of its store locations throughout Spain. London began its OHD implementation in preparation for the 2012 Olympic Games and has continued since then. In the Netherlands, silent vehicles and delivery equipment for OHD (PIEK technology) are promoted and the maximum noise level is regulated.

A study of OHD in **New York City,** in 2009 and 2010, showed that implementing various OHD policies could generate a total savings of between $100 and $200 million/ year in travel time and pollution reduction[43]. OHDs were estimated by the 2010 study to be 30-40% cheaper for carriers than regular daytime deliveries[44, 45].

Pedestrians and cyclists experienced increased safety and an improved quality of life with less interference from deliveries; daytime non-freight travellers benefitted from faster travel speeds; freight carriers saw increased productivity; and customers enjoyed increased reliability[44].

Businesses that are most receptive to OHDs are those that are likely to be open during off hours, such as restaurants, bars, hotels, convenience stores, 24-hour supermarkets, hypermarkets and medical facilities[45]. "Unattended deliveries" (deliveries made in the absence of the customer's staff, for example in buffer zones) are also a potential solution, although they require trust as well as a clear legal framework[43].

Aside from the benefits, there are some specific challenges. OHD is a simple concept, but it can be challenging to implement it because the benefits and costs are not always evenly distributed. The most significant negative social impact of OHD is the noise produced by unloading operations at night[46]. Transport providers favour OHD since it facilitates operations and the use of uncongested roads. Retailers (customers) would, on the contrary, prefer to have the goods delivered during regular opening hours, with citizens more interested in having a quiet environment during the night and fully re-stocked shelves when shopping. Policy interventions[47] should then aim to re-balance social costs and benefits.

Chapter 5 Recommendations

Well thought out structuring of the logistics sector in a UVAR scheme can lead to a reduction in congestion and emissions, whilst safeguarding the economic and social interests of the area concerned, as well as its surroundings. Table 6 summarizes the pros and cons of the various schemes and solutions studied in this document.

Table 6 Summary of pros and cons of UVAR schemes and solutions

Scheme	LEZ	CC	UCC	CB	OHD
Pro	Good impact on emissions	Good impact on congestion and emissions	Allows bundling of cargo	Good impact on congestion and emissions	Good impact on efficiency
Contra	Potential shift of issues to other zones	Potential shift of issues to other zones	No economically self-sustainable best practices	Limited potential share of overall traffic	More costly operations (labour cost)

The main choice lies in the decision to implement either an LEZ, a CC or combined LEZ-CC scheme. In order to make the right choice, the specific situation of the city and the size and nature of the issues involved are key concerns to be addressed. The individual choice of city for a UVAR scheme, and the access regulations therein depend on the size and nature of the issues, and the objectives of the scheme.

The first step is therefore to clearly identify and formulate the issues (logistics and freight related emissions, congestion, noise, safety or other concerns). Where and when do they occur? What are the causes and drivers of these issues? What is their magnitude? How are they expected to develop over time? It is best to map the logistics activities in your city or region before implementing a UVAR from general trends identified in international sources. These might differ due to, for example the structure, location, and/or terrain in your city.

Once the issues(s) are established, the second step is to discuss and formulate upfront a clear set of SMART objectives that should be achieved by the new UVAR scheme. If the main concern is vehicle emissions, then UVARs discriminating on emission classes (Euro norms) might be the best choice. If the issue is congestion, then Congestion Charging might be the best policy option. UVARs that combine both access regulations banning certain vehicles and pricing also exist.

Based on all the success and fail factors as observed in examples from EU cities, we have identified seven basic recommended steps for cities considering the implementation of a UVAR specific to logistics: Investigate the issue, listen to and engage stakeholders, analyse costs and benefits of enforcement, do pilot tests, think beyond the scheme, evaluate and consider adjustments if needed. And think about helping to create more UVAR commonality in Europe.

Step 1: **Investigate the issue thoroughly before implementation**
A policy intervention as invasive as a UVAR, considered in a specific city, should target the right challenges. It should be aimed at tackling the challenges while undesirable effects on freight transport and logistics activities should be clearly and unequivocally connected via a well-described issue definition. Formulating this issue definition, defining the UVAR characteristics and understanding its implications are the first steps towards success. The issue analysis might entail various forms of qualitative and quantitative data collection techniques, including:

- Gathering objective field data: emissions, numbers of vehicles (types, time patterns), congestion data.
- In-Depth Interviews (IDIs).
- Focus groups. The advantage of using focus groups is that information is obtained from individuals affected by the situation or close to its solution. Best practice can be taken from the airline industry.
- Ex ante behavioural surveys. Whilst the previous two techniques are qualitative in nature, behavioural surveys tend to produce quantitative estimates of how the scheme considered for implementation would be affected by a given policy or program.

Step 2: **Listen to and engage stakeholders** in order to solve issues
To solve an issue that has been identified as a market failure, it is vital to engage and listen to the key stakeholders. Effective engagement of stakeholders (e.g. residents, local retailers and regional logistics operators) brings multiple benefits, such as:

- Common confirmation (or adjustment) of the issue to be solved, or mitigated, by a policy intervention.
- Provides the public and private sector with a full understanding of the constraints and expectations of the various stakeholders.
- Enables the policy maker to chart implementation paths that have a better chance of succeeding.

Both public and private sector representatives need to feel that their points of view are being heard and taken into account.

Step 3: Carefully **analyse costs and benefits of enforcement** approaches, running costs and investment needs.

The choice for a specific enforcement model will impact the **rate of compliance** that can be expected. Two dominant enforcement models can be identified for LEZs in the EU: (i) visual surveillance using stickers and (ii) cameras with ANPR technology. The first requires limited investment, although more staff and costs are required for enforcement than the second approach. The latter demands high investments upfront of the implementation.

Moreover, the fines and fees for entering the zone need to be defined. Some schemes allow non-compliant vehicles access after payment of an entrance fee, but the majority ban certain vehicle types and enforce compliance via fines.

Summarising the brief European LEZ examples depicted above leads to the conclusion that before travelling to an LEZ in Europe, a road user must find out which vehicles (often differentiated on type, age and/or weight) are included in the UVAR; which emission standards are demanded, and how access is enforced.

This information should be made easy to find, especially for companies carrying non-recurrent transport flows towards a specific urban area they visit infrequently. Information can be found EU-wide on www.urbanaccessregulations.eu, and cities should use this as a dissemination route. Transparency on the UVAR criteria and multi-lingual information on the LEZ access conditions are a prerequisite for efficient functioning and maximal impact.

Step 4: Consider **well-designed pilot tests or introduction phases**.
Although general ex-ante ramification of the expected impacts of a scheme will be obtained in steps 1 and 2, the specific outcomes of a scheme for a specific city will remain uncertain until the scheme is actually implemented.

It can help the implementation if the design of the implementation process allows for changes to be made either before the scheme is implemented or once it becomes operational. The main benefits of such flexible implementation are that:

- It can identify issues which need to be ironed out before full-scale implementation.
- It can develop new, unexpected insights into aspects of the scheme that may have been overlooked earlier.
- If flexibility is allowed for, this can be an excellent means of increasing support from both public sector decision makers, the private sector and city residents.

Pilots can be costly and risky, as they must be as like the full scheme as possible, so the pros and cons should be well considered.

Step 5: **Think beyond the scheme itself**

The following two questions should be answered satisfactorily before deciding on a specific policy intervention, the introduction of a UVAR:

- Can we mitigate some of the undesirable impacts of the scheme **within** the UVAR area? We have described three commonly used solutions and their tools; Urban Consolidation Centres, Cargo Bikes, and Off Hour Deliveries. These instruments can ensure the continuity of the necessary logistics flows in the UVAR area. It might be necessary for the municipality or city to develop a policy aside from the UVAR for these three solutions.
- Can we control the impacts of the proposed scheme **outside** the area itself? The whole scheme should of course include appropriate measures to ensure that the benefits of the UVAR scheme eventually are not nullified by similar societal costs of the scheme outside the UVAR area. This second question is more relevant for city regions, or the national policy level.

Consider promoting mitigating solutions for the logistics sector

Three solutions that can help to mitigate the undesirable side effects of UVARs on the Logistics sector have been identified. These are: (i) Urban Consolidation Centres (UCCs), (ii) Cargo bikes (CBs) and (iii) Off-hour deliveries (OHDs). These three solutions can mitigate the impact of UVARs on the logistics sector, while still allowing for the achievement of the objectives set for decreasing congestion and emissions.

Step 6: **Help to create more UVAR commonality in Europe**

We recommend two areas in which local policy makers could also help to create more UVAR commonality in Europe, thereby preventing fragmentation of schemes and corresponding inefficiencies:

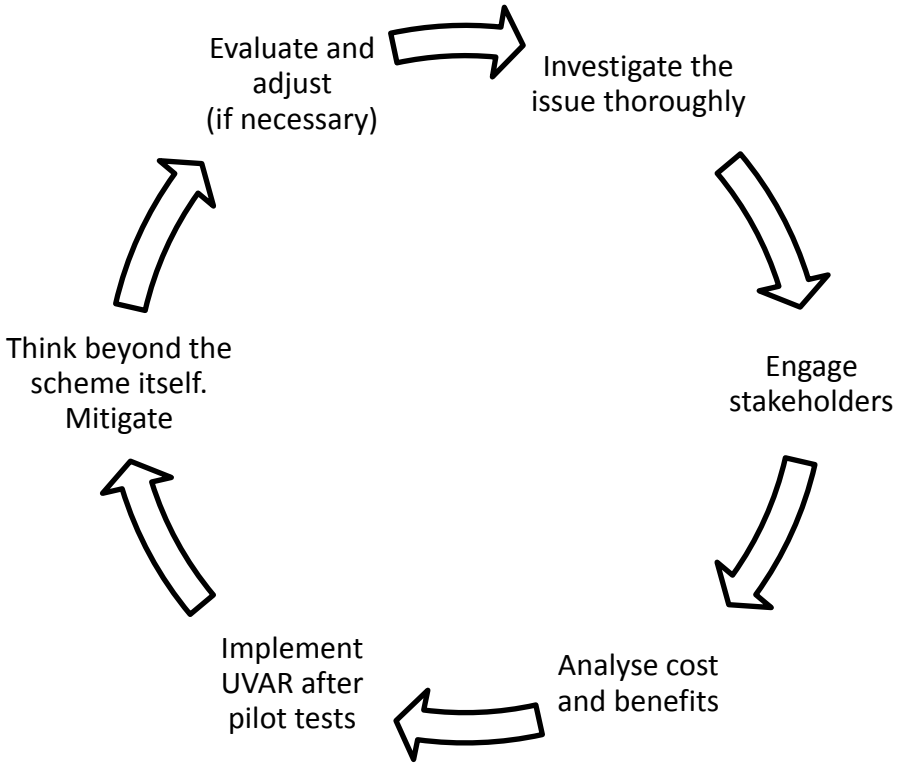
- When implementing a UVAR, it is helpful to start from a regional or national viewpoint and develop a coherent existing access **typology for freight vehicles**, ideally aligned with the criteria of neighbouring cities or municipalities. Adhering to commonly accepted and broadly used vehicle classifications (e.g. N1, N2, etc.) and emission levels (e.g. measured via the Euro norms) can avoid lack of clarity and undesirable inefficiencies.
- Consistent **regional, national and EU communication** on the access regulation schemes is important. For example, cities need to make sure that LEZs and CC schemes, when applicable to a certain city/area, can be easily retrieved on the municipality websites with common search words. The cities might consider making access regulations available at least bilingually (e.g. local language and also English, German, French or other European languages). E.g. the website www.urbanaccessregulations.eu can support with dissemination.

Step 7: **Evaluate and adjust** (if necessary)

As the LEZ or CC UVAR might have a decreasing impact on emissions and congestion it is important to organise evaluations of the schemes. The evaluation compares the data retrieved in step 1, where the issues are mapped and examined, with the current congestion and

emission levels. It becomes necessary to alter or suspend a scheme (e.g. when all vehicles in the country meet the access regulation criteria).

Over time, fleet emissions will become similar to those which would have occurred without the introduction of an LEZ. The introduction of the LEZ can decrease emissions faster. For further benefits, it will be necessary to periodically tighten the criteria. Assessment of the impact of LEZs needs to take into account other policy measures implemented within the same time frame.



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