



ECCENTRIC



Replication Package: Efficient Supply Chains

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Abstract

CIVITAS ECCENTRIC work package 7 comprised seven measures aiming to increase the efficiency and to reduce environmental impact of urban freight in Madrid, Munich, Ruse, Stockholm, and Turku.

The report summarizes specific experiences, lessons, and recommendations of demonstration measures of WP7 cluster focused on Efficient Supply Chains, which includes five measures that target different urban logistics solutions as consolidation schemes and off-peak deliveries. The report aims to maximize the replication potential of the different measures tested, describing critical challenges and success factors to consider.

Project Partners

Organisation	Country	Abbreviation
Ayuntamiento de Madrid	Spain	AYTOMADRID
Grupo de Estudios y Alternativas 21 SL	Spain	GEA21
Consortio Regional de Transportes de Madrid	Spain	CRTM
Empresa Municipal de Transportes de Madrid SA	Spain	EMT
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Domagkpark Genossenschaft EF	Germany	DOMAGK
Green City EV	Germany	GC
Green City Projekt GMBH	Germany	GCP
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Obshtina Ruse	Bulgaria	RUSEMUN
Club Sustainable Development of Civil Society Association	Bulgaria	CSDCS
ICLEI European Secretariat GMBH	Germany	ICLEI

FM Logistic Iberica SL	Spain	FMLOG
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List of Acronyms

ACM	Adaptive City Mobility
ca	<i>circa</i> (around)
CO ₂	Carbon Dioxide
D	Deliverable
EC	European Commission
EU	European Union
EFV	Electric Freight Vehicle
EV	Electric Vehicle
FCEV	Fuell Cell Electric Vehicle
e.g.	<i>exempli gratia</i> (for example)
H2020	Horizon 2020
i.e.	<i>id est</i> (that is to say)
LEV	Light Electric Vehicle
MIT	Motorised Individual Transport
ML	Measure Leader
NGO	Non-Governmental Organization
NOx	Nitrogen Oxides
TCO	Total Cost of Ownership
SM	Site Manager
WP	Work Package
WPL	Work Package Leader

Executive Summary

Demonstrate and test innovative solutions for cleaner and better urban freight in urban centres has been identified as a main need that remains unresolved even in cities that have developed a comprehensive set of actions and policies on sustainable mobility. The freight companies face emerging challenges to design efficient supply chain schemes as city centres show an increasing conflict in public space use, the tolerance for noise and pollution leads to more demanding requisites and, at the same time, digitalisation is inducing a disruptive change in customer behaviour through e-commerce.

This document summarises and integrates the main findings and conclusions of the five measures of the CIVITAS ECCENTRIC Work Package 7 “Towards better and cleaner urban freight logistics” that are focused on Efficient Supply Chains (Cluster 1). It is intended to provide key information for the replication and upscaling of the measures tested, which cover different approaches to achieve economically viable and efficient goods delivery operations, according to the European integrated perspective for urban logistics:

- Consolidation centres in the periphery: consolidation centre with EVs and local regulations for clean urban freight logistics and waste logistics from urban civil works.
- Consolidations solutions in the inner city: microdepots combined with cargo-bike deliveries and a neighbourhood-oriented concierge system as collection point.
- Off-peak deliveries: Night delivery with clean and silent vehicles, carried out in Stockholm.

This report - D7.4 - is part of the Replication package produced as a result of the work carried out in the ECCENTRIC WP7, which also includes the report D7.5 - Clean Vehicle technologies and D.7.6 - Innovative policy tools for freight logistics.

1. Introduction

1.1. Purpose of this document and target groups

In CIVITAS ECCENTRIC, five cities (Turku, Stockholm, Ruse, Munich, and Madrid) have implemented in total 51 innovative sustainable urban mobility measures. The measures were addressing a variety of urban mobility challenges, organised in different thematic clusters. This document is intended to equip practitioners and decision makers with the information needed if they want to replicate measures of the thematic cluster “Efficient Supply Chains” or aspects of these measures, considering always the local context to achieve a feasible and reliable transfer of experiences.

This document is tailored following the practical needs of project developers and planners / technical staff from cities to develop innovative measures, to consider

potential barriers and to be able to select the appropriate solutions to match their contexts. This document provides evidence that measures have been successfully implemented in a city and have a good replicability potential.

2. Summary of the Cluster: Efficient Supply Chains

In the last decade, European cities have made significant steps forward in the delivery of sustainable urban mobility policies, proving that major impacts in terms of congestion and reduced emissions can be achieved through ambitious measures.

At the same time, peripheral districts remain largely unaddressed, with the effects of flagship projects being rarely transferred to these areas. Recent or future urban growth processes are posing additional pressure to peri-central areas. The main common challenges are to relieve central areas through clean and efficient urban logistics, as well as to increase the attractiveness and sustainable mobility of suburban districts.

The cities of Madrid, Stockholm, Munich, Turku and Ruse are the CIVITAS ECCENTRIC city partners, being part of the whole consortium formed to achieve two overall objectives: to demonstrate and test the potential and replicability of integrated and inclusive urban planning and sustainable mobility measures that increase the quality of life of all citizens in urban areas, with a particular focus on suburban districts and the clean organisation of urban freight logistics.

Demonstration and testing of innovative solutions for cleaner and better urban freight in urban centres has been identified as a main need that remains unanswered even in cities that have developed a comprehensive set of actions and policies on sustainable mobility. The freight companies face emerging challenges to design efficient supply chain schemes as city centres show an increasing conflict in public space use, the tolerance for noise and pollution leads to more demanding requisites and, at the same time, digitalisation is inducing a disruptive change in customer behaviour through e-commerce.

The CIVITAS ECCENTRIC measures dedicated to tackling the specific challenges of logistic supply chains for urban freight in the city centre cover a variety of potential approaches to develop and analyse economically viable and efficient urban goods delivery operations, new business models in urban logistics and freight consolidation solutions, thus reducing heavy and light duty traffic, energy consumption and emissions.

The UE Communications “A European Strategy for Low-Emission Mobility” and “Europe on the Move”, COM (2017)-283 and COM (2016)-502, respectively, highlight the importance and challenges represented by freight transport, that is expected to grow by 60%, in achieving sustainable mobility systems and how the success in the shift to low-emission mobility will very much depend on how cities address urban logistics issues.

The CIVITAS ECCENTRIC project has applied the topics recommended by the European Commission to tackle urban freight challenges and develop enabling

innovative policy tools. The different six topics defined are the subject of a non-binding guidance series primarily aimed at public authorities such as municipalities, developed by the European Commission's Directorate General for Mobility and Transport (EC Study on urban logistics – The integrated perspective, DG MOVE 2018) and, regarding the realm of efficient supply chain, these two topics, plus the approach in the SUMP 2.0 process, are specially relevant:

- Treatment of logistics activities in Urban Vehicle Access Regulation Schemes
- Logistics schemes for E-commerce
- Sustainable Urban Logistics Planning Topic Guide SUMP 2.0

This guidance documents give advice to the local policy makers on urban logistics and have been used during the CIVITAS ECCENTRIC project for an overarching analysis of the measures and other info exchange.

The “ecosystem” generated within the CIVITAS ECCENTRIC brings together local policy makers, vehicle manufacturers, freight transport companies, retailers, and real estate developers, providing an opportunity to formulate cooperation schemes to reach better and cleaner urban freight logistics.

Table 1 Measures of WP7- Cluster 1 – Efficient Supply Chains in urban freight

Measure	City	Partner(s)
MAD 7.1 – Consolidation centre with EVs and local regulations for clean urban freight logistics	MADRID	AYTOMAD/FMLOGISTIC/UPM
MAD 7.2 – Consolidating Stockholm municipal freights	STOCKHOLM	STO
MUC 7.3 – Combining Cargo-Bike-Delivery with a flexible package system	MUNICH	LHM/MVG
STO 7.4 – Night delivery with clean and silent vehicles	STOCKHOLM	STO
MUC 7.5 – Neighbourhood oriented concierge system	MUNICH	DOMAGK

Those different measures address different approaches to improve the efficiency of supply chains and provide experiences that could be useful in the implementation of solutions that can help to mitigate undesirable side-effects of logistics or that can be helpful when associating to other policy tools as Urban Vehicle Access Regulations schemes (UVARs).

According to the EC Study on Urban Logistics, the Figure 2 shows potential policy options that can mitigate the impact of UVARs or the E-commerce on the logistics sector, while still allowing for the achievement of the objectives set for decreasing congestion and emissions to be applied in urban contexts, related to the measures explored in ECCENTRIC project.

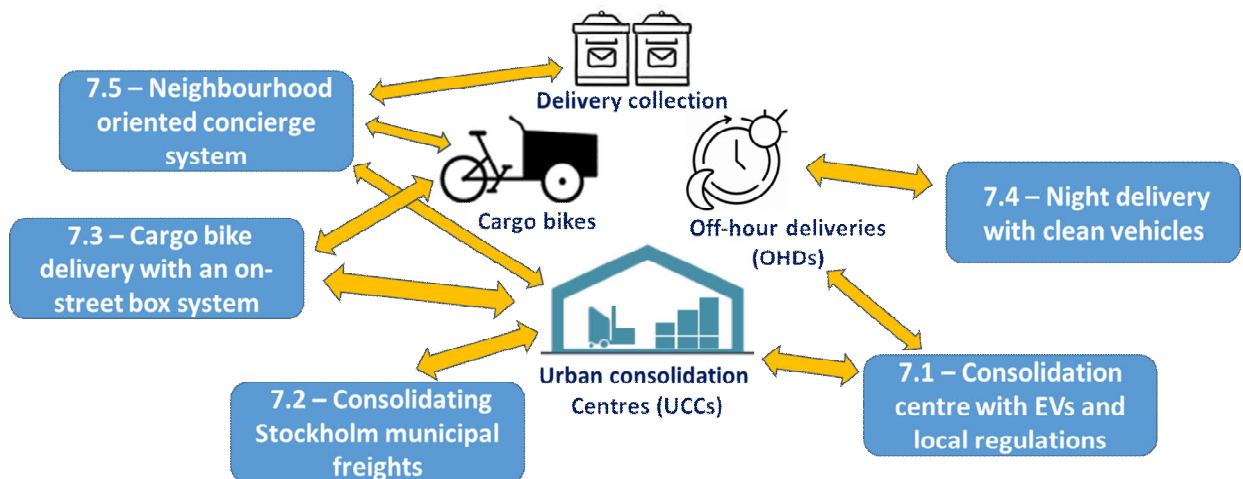


Figure 1: Potential logistics solutions and related Measures of WP7- Cluster 1

Apart from these measures included in this WP7, other CIVITAS ECCENTRIC measures could also provide useful information for other cities interested in implementing innovative freight policies, for example the measure STO 4.9 “Offering test fleets of e-bikes and e-freight bikes”, the measure STO 6.1 “Offering EV-test fleets to selected target groups” and also the measures of the WP7 Cluster of “Clean Freight Vehicles”.

3. From ECCENTRIC cities to replication in other places

3.1. Evaluating the replication potential of measures

Drivers and barriers of Consolidation schemes

Most of the measures aimed to improve the efficiency of supply chains are based on the principle of consolidation as 'connecting individual sender and receiver via efficient hubs', even more now when the evolution of economies and technologies make the origins and destinations of production and consumption became more scattered. In the logistics sector, the bundling and unbundling principle means put together goods that need to be transported over (partly) the same route and separate them to bring them to their different final destinations. In the framework of CIVITAS ECCENTRIC Project different approaches of consolidation schemes have been tested and the barriers, levers and general findings could be useful for many other cities facing similar freight challenges.

The high concentration of delivery points in combination with many small deliveries in urban context, where each singular home has practically become a delivery target due to the e-commerce, rationalises why last mile logistics is the least efficient stage and is responsible for a significant portion of supply chain costs, and a significant contribution

to urban congestion and source of air pollutants. This inefficient situation in which multiple vehicles not fully loaded from different suppliers send goods separately to a destination using similar routes is shown in Figure 3.

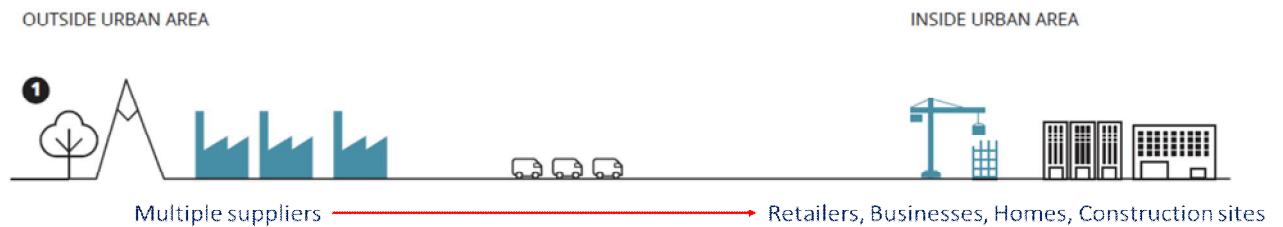


Figure 2: Usual urban freight transport Source: Adapted from VCF et al. (2018).

Therefore, the consolidation schemes in urban areas are targets of special interest, despite the potential extra cost that implies an artificial loading and unloading. According to the European Environment Agency 2019 report “The first and last mile — the key to sustainable urban transport”, which provides useful information about the challenges to set up sustainable business cases and policies that contribute to the economic sustainability of first/last mile option in freight transport, an Urban Consolidation Centre (UCC) is defined as a logistics facility situated in relatively close proximity of 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 and homes within that area.

Consolidation centres outside the urban area

The Figure 4 represents a “standard” scheme of a consolidation process: an urban consolidation centre in the periphery of the urban area where different providers send goods, in combination with efficient urban freight vehicles for the last mile. The transport burden in the urban area significantly reduced by using this approach. This is the method of measure MAD 7.1: “**Consolidation centre with EVs and local regulations for clean urban freight logistics**” (see Figure 5), tested in Madrid, in which the implementation of associated access regulations to city centre looks for ways to cover the extra cost for the trans-shipment at consolidation centres or micro-hub. Due to fact that is the most conventional approach to consolidation centres, it is likely to have a high replication potential in other cities, and therefore it is described with more detail in the chapter 4 of this document.



Figure 3: Urban Consolidation Centre in the periphery. Scheme of measure MAD 7.1



Figure 4: Consolidation centre with E-freight vehicles in Madrid

There can be different configurations of this general scheme, for example, the consolidation centre could be designed to provide different goods to a single customer with multiple delivery points. This case has been analysed in the ECCENTRIC project developing a pre-study to outline the potential to consolidate goods purchased by the City of Stockholm (measure STO 7.2: “Consolidating Stockholm municipal freights”). This pre-study outlines a variety of alternatives and makes suggestions about the types of activities, product groups and steps required to realize consolidation. This pre-study serves as a basis for political decisions about the future consolidation of municipal goods in Stockholm, but its findings are relevant to other cities.

The key steps of this study were the analysis of other cities consolidation centres, interviews with transportation and city stakeholders, and goods distributors. Finally, it includes a proposal of implementation steps for the City of Stockholm politicians, the key stakeholders to support the project. Regarding timeframe, the implementation of the consolidation centre needs some years. The feasibility study shows that the City of Stockholm should first implement a more logistics-oriented procurement, instead of opening a physical consolidation centre.

Other alternative is focused on waste logistics, with material flow in the opposite direction, avoiding the environmental impact of many trucks transporting waste from civil works of the inner city. This is the case that was included as an extension of the scope of measure STO 7.2, to consolidate heavy mass from excavation in tunneling and other construction sites using barges instead of trucks as was shown in Figure 6.

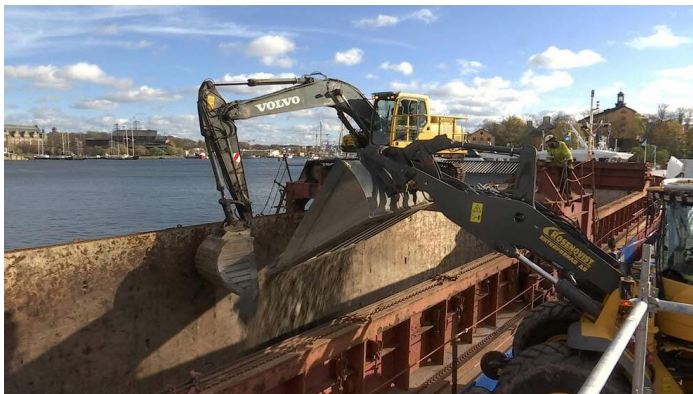


Figure 5: Waste Consolidation Centre in the periphery. Scheme of measure 7.2

Transportation of such heavy masses accounts for a large part of heavy goods vehicle road traffic in Stockholm and is likely to increase soon, as the City metro and sewer systems will be expanded. For this reason, the City of Stockholm is keen to test and evaluate the potential of using barges to consolidate heavy masses for trans-shipment out of the city. The demonstration results in evaluation of noise impacts from loading uncrushed material to a barge in central Stockholm, a cost-benefit analysis between transport by barge or truck, and the mapping of potential loading areas in the Stockholm region.

The implementation key steps were the following:

- Collect all the pros and cons using barges and using trucks from one location, consulting an inland shipping company and a company expert in aggregates.
- Get the project owner (who decides which transportation will be used in the end) interested in doing this investigation.
- Investigate noise impacts from loading aggregates on to a barge and noise impacts from using trucks, through a subcontractor with expertise in acoustics to conduct the noise tests.
- Do a cost-benefit analysis. The Swedish Maritime Administration has provided information about costs and regulations on water.
- Map potential loading areas in the Stockholm region. The Stockholm Port has provided information about ports and possible offloading sites.



The implementation of using barges will not be able to be fully operational until late 2020 when the project of extending the underground is advanced, but since October 2019 the waste transport by barge has started. (See Figure 7).

Figure 6: Waste from inner city civil works transported by barges in Stockholm.

The solution is not exclusive for this project waste management, in the future it should be available for every project that has potential to use barges. The City of Stockholm will use the final report with its results for other projects within the city. The feasibility study is financed through CIVITAS ECCENTRIC, but the public authorities will finance the actual implementation.

Convincing the public authority that is responsible for the project of extending the Underground infrastructure, to investigate possibilities of using barges instead of trucks more deeply than before was indeed a key challenge. There is a general prejudice

against water transportation, with the main reason that “trucks are more reliable”. A huge focus in this action has therefore been to convince them that water transport might be more reliable than land transport.

As a recommendation for using barges instead of trucks, it is important to push for an early investigation about the feasibility and that decisions are made on facts rather than prejudices. Before implementing a project that involves heavy masses land transport, it is recommended to initially look into the possibility of using waterways depending on its location. If possible, the authorities should then put it as a criterion for implementing the project. For example, the government of Sweden imposed that the heavy masses had to be transported using barges/ships instead of trucks, when building the new highway southwest of Stockholm. In the case developed in CIVITAS ECCENTRIC: the construction of the new Underground infrastructure in Stockholm, there were no such requirements, and the change has been more difficult.

The results of the pilot study show that a switch to waterways transport addresses the environmental sustainability goals most significantly. The CO₂ emissions would be reduced from 3.7 kg per transported ton on land by using trucks, given loading capacity of 11 ton and 30 km trip, to 1.1 kg per transported ton when using waterways, provided that loading capacity is 2000 ton and the receiving port is about 50 km away.

This relates to the fact that more material can be transported on water when using barges, i.e. 2 ton per km instead of 0.18 when using trucks on land. The exterior noise levels would not necessarily be significantly higher than in the normal procedures since protective material can be used to reduce noise. The costs are not significantly different. Waterways transport in construction projects can be considered as an alternative transportation in the cities with construction sites near the water.

Consolidation schemes inside the urban area

CIVITAS ECCENTRIC project has tested also new consolidation schemes different to the ones implemented in Madrid and Stockholm and described in the schemes of Figures 4 and 6.

For example, in Munich, two approaches of consolidation inside the urban area have been the topic of two measures: MUC 7.3 – Combining Cargo-Bike-Delivery with a flexible package system and MUC 7.5 – Neighbourhood oriented concierge system. The principle of these centres is the same as that of centres outside the urban area, but these are often smaller and are located closer to the end of the supply chain. Those two measures have the added value of the idea of an emission-free last mile delivery by cargo bikes, other of the main urban freight solutions recommended by the EEA Report “The first and last mile — The key to sustainable urban transport”. The delivery of goods by (cargo) bikes has a great potential to keep the city accessible for freight transport and to improve road safety. Compared to ordinary bicycles, cargo bikes have a higher load capacity and facilitate the bundling of deliveries.

The Figures 8 and 9 represent the scheme and the elements of the measure MUC 7.3: **“Combining cargo bike delivery with a flexible package system”**; this measure has tested the use of micro depot boxes in co-operation with delivery companies in Munich’s urban area.

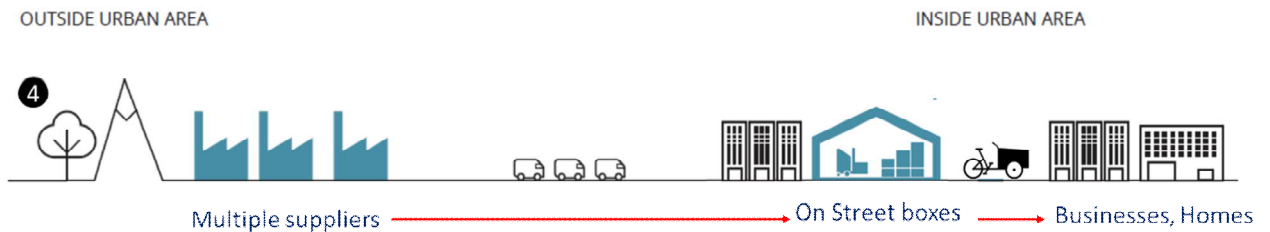


Figure 7: Consolidation with microdepots in the inner city. Scheme of measure MUC 7.3



Figure 8: Micro depot and cargo bike and concept for micro depots (© Nicholas Duesberg and City of Munich)

A flexible storage system serves as an interface where cargo can be handed over from cars to cargo bikes and vice versa. This system developed an innovative concept of keeping delivery trucks outside the city centre by offering them a storage system where they can turn over their parcels to means of transport more suitable for the city centre close to the inner-city boundaries. This served as an opportunity to combine, for the first time in Munich, cargo bike delivery with a flexible storage system. The first key steps for implementing the measure were to scout a logistics partner for the definition of the requirements for the successful implementation of the project and to set the specification of the micro depot boxes and the corresponding IT, to find providers of suitable micro depots through tendering as well as to pre-test the micro depot boxes.

In July 2017, a first test micro depot box was installed West of the city centre of Munich. It has been used for pre-testing by the local partner RAPID courier services. In December 2017, the City of Munich made a tendering for four micro depots, which were installed until March 2018 in the northern, southern, eastern and western part of the inner city. One of the main challenges for the reliability of the system was the door-

opening command of the accompanying app, resulting in delays due to poor functioning. Finally, it was decided to re-launch the measure by starting a new tender for a second set of four micro depots which ended in March 2019. Meanwhile, other CEP-companies with cargo bike schemes or interest in it, willing to use the first set of micro depots, were searched for. After the second tender, four new micro depots were installed, to create a total set of eight properly working storage boxes put up in Munich in five different locations. In July 2019, RAPID started to use the micro depots for their operations again.

Through dissemination activities, the micro depot measure is known regionally and even nation/EU-wide and delivery service providers from Germany and beyond with local activity in Munich showed interest in using the measure concept.

Regarding the business model and contractual partnerships, the City of Munich rents the eight micro depots and delivers the public space where the micro depots are standing on. The rent is financed by CIVITAS ECCENTRIC, the cost of the public space is covered by the City of Munich. If the measure works well, it is intended to continue it by municipal funding or by shifting it to private ground and fund it by the delivery companies (or a mix of both), but more information and monitoring is needed about how the boxes were used, e.g. how many parcels were stored with each opening or how trucks were substituted.

For replication, the storage box system is quite simple and easy to use and could be of interest among courier and parcel service companies. However it is recommended to organize comprehensive stakeholder workshops to define the needs and the design of microdepots and to identify the potential pain points as well as the branch-specific characteristics of the key stakeholders, for example, the acceptance of the measure by the courier drivers could be not as high as expected due to the impact on the pricing scheme in the case of self-employed drivers. Moreover, a functioning hardware and software as well as a good problem solving/service providing company are crucial. If more focus is put on the user of the system when planning the replication of the measure, there might be a positive impact on the emissions, space use and efficiency of the logistic operations in a city.

Along with the use of microdepots used by one or multiple suppliers within their supply chain, another set of consolidation solution could be implemented for the final step of delivery collection, when the final consumer come into play. Automated parcel lockers or proximity delivery points are examples of very small consolidation centres that make it unnecessary for the courier to make final deliveries to the customer's front door. The recipient can/has to pick up their parcel autonomously and even return them if necessary, with flexibility on delivery and collection time windows, this means that the courier can significantly rationalise the trip so the cost and environmental burden are significantly reduced.

In the framework of CIVITAS ECCENTRIC project an innovative scheme for final delivery collection has been tested in measure MUC 7.5: "Neighbourhood oriented

concierge system at the development area Domagkpark”. With the concierge service, goods and parcel deliveries to the Munich’s Domagkpark district (largely residential) are bundled centrally, and residents will be able to pick up delivered goods at the concierge, or even get their goods delivered by the local concierge with an eco-friendly electric cargo bike. The same service can be offered to post goods/parcels. The Figures 10 and 11 represent the scheme and the main elements of the measure.

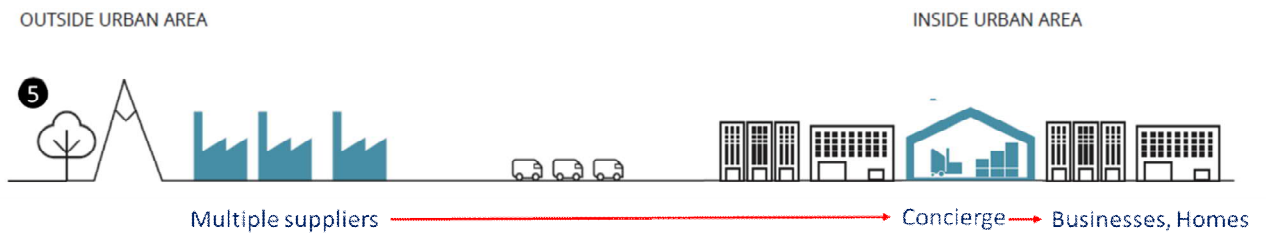


Figure 9: Consolidation concierge as delivery collection point. Scheme of measure MUC7.5

In the innovative “neighbourhood oriented” design of the concierge, it not only functions as the central point of contact for parcel pick-up/drop off and final delivery in the residential district but it also serves as a neighbourhood centre for residents by offering a variety of additional services interesting for residents. It supports the neighbourhoods’ mobility concept providing additional services for the community (for example, bike repair service, bike repair courses, maintaining the neighbourhood e-mobility station, etc.). It is also extended by other services as well, such as energy management advisory, ticket selling, coffee venue, dry cleaning, locksmiths, and other craftsman services. The concierge also acts as a community centre for the district and can operate as an information/contact point and a central location for socialising.



Figure 10: Cargo-bike and store counter at Domagkpark Concierge

The key steps taken from the drawing board to actual implementation are the following ones include:

- Development of the business and operational concept

- Identification of a well-located business premises with service space/rooms and contract agreement for shop premises made with shopkeeper
- Identification of potential logistic and parcel delivery service companies and set up of an official partnership with them
- Development of a product marketing concept
- Integration of other neighborhood and community related business services (laundry, shoe services, handicraft services and facility management)
- Development of a parcel monitoring system and test operation for last-mile delivery service
- Further extension of other neighborhood and community related business services (for example energy management advisory)
- Soft launch as a test-phase

It is important to find synergies with other activities and measures occurring in the area; in this case, other CIVITAS ECCENTRIC measures implemented in the Living Lab have been integrated in the scheme, for example the concierge is advertised on the community portal (Measure MUC 2.7), cooperation to include the mobility app “Luftlotse” and a mobility consultancy and training for services and vehicles of the mobility stations in the living lab (Measures MUC 3.7 and MUC 5.9) and it is planned to take advantage of the findings from measures MUC 6.3 “E-light vehicle” and MUC 5.6 “E-trike).

One of the main barriers of the concierge has been a lack of profit and a financial loss with service for parcel delivery, despite the financial support of the CIVITAS ECCENTRIC project (70 %) for the planning and implementation phase every parcel handled. Business case has been revised along the project, offering additional services to be economically viable.

The main outcomes for replicability of similar schemes could be summarised in the following requirements and success key factors to achieve a sustainable business model:

- A well-founded and ongoing communication campaign to all residents in the area is needed to raise awareness and acceptance. New approach towards end customer interests and consumption behaviors is a long way. Residents and businesses must be made aware that they can directly influence the quality of their environment through their behavior.
- A trustful cooperation with the parcel delivery companies, with participation agreements to secure basic financing. Negotiations with delivery service providers are a basic requirement.
- An efficient service partner offering secondary services.

- Suitable located shop premises and big enough for the integrated services of the Concierge concept.
- Political and administrative support is crucial to set frame conditions and enabling regulations that make the last mile services provided through a concierge attractive or even obligatory for the parcel delivery companies. The important social value of a concierge system for a neighborhood should be recognized by policy makers.

Drivers and barriers of Off-peak deliveries

Off-peak delivery is one of the recognized policy options in urban contexts to mitigate the impact of the logistics sector, decreasing congestion and emissions and improving the efficiency of the supply chain.

Municipalities can set out time-based access restrictions/time windows, with periods of the day during which delivery vehicles are not allowed to enter certain areas of a city. Time windows can support local freight policies to better organise urban traffic flows by banning freight vehicles during specific hours.

Together with restrictions at peak hours, another strategy is based in extending the allowed period for delivery. In this respect, nighttime deliveries with silent vehicles offer the opportunity to reduce traffic congestion in daytime without causing nuisance to citizens during night hours. The critical process of night deliveries regulation to come to a compromise between increasing supply efficiency and avoiding unacceptable noise impact has been the objective of ECCENTRIC measure STO 7.4: “Night delivery with clean and silent vehicles” carried out in Stockholm.

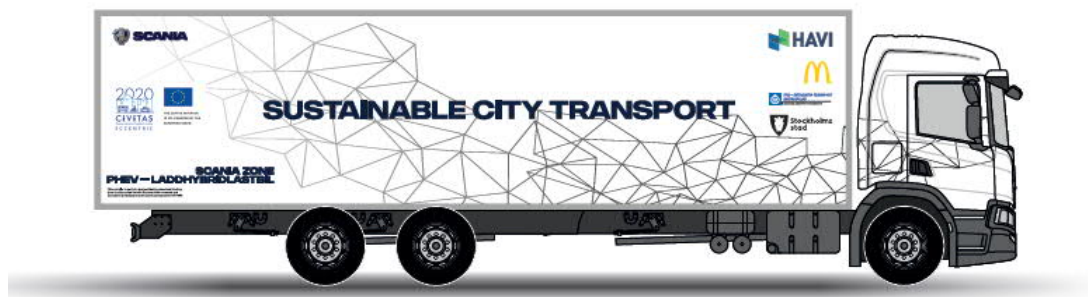


Figure 11: Vehicle used for night deliveries in Stockholm. Measure STO 7.4

Following a previous pilot project on night delivery, the city of Stockholm wants to expand the project with one plug-in electric lorry. The measure aims to investigate the effects of goods delivery during night versus daytime and the implications and regulatory requirements of lifting the ban on night deliveries. Depending on the outcome, the measure could be upscaled to a city-wide night delivery scheme that

includes delivery with silent heavy lorries. In the long term, this could reduce congestion and noise and improve transport efficiency within the city.

The measure is an expansion of the existing off-peak delivery scheme which will contribute to the process of a modified regulation for night deliveries providing more data on noise and transport efficiency. The city of Stockholm's regulation currently bans heavy lorries between 22:00 and 6:00 due to noise, a regulation which could be adapted as a result of this measure.

The key steps that have been taken from the drawing board to actual implementation, night deliveries were finally launched in January the 13th 2019, are the following ones:

- Design of procurement and evaluation process by the city of Stockholm and KTH.
- Procurement of a consortium consisting of a vehicle manufacturer (Scania), a transport company (Havi logistics) and a delivery assignment (McDonald's), done by the City of Stockholm and KTH.
- Procurement of the evaluation of transport efficiency.
- Inspection of delivery sights and change of parking regulations to fit nighttime unloading. All included partners.
- Route planning for the night permit, implemented by City of Stockholm and Havi.
- Noise measurement and evaluation of noise generated by vehicle and loading/unloading in comparison to background noise on different delivery locations.
- Taking part of the overall timeline of the detailed technical development of the vehicle performed by Scania.

An added value of the measure has been the potential for inverse logistics. During the project time line, a recycling company, Ragn-Sells showed interest in introducing waste collection night transport scheme. Since an electric engine is not suitable for the heavy lifts of waste compressors to the trucks, a biogas truck was ordered by Ragn-Sells. Loading of the compressors are done in off street underground facilities in commercial buildings and therefore noise is not an issue in this case. Transport efficiency and emissions were evaluated within CIVITAS ECCENTRIC.

Charging has been made possible at one restaurant with off street loading zone and at the transport operator's terminal. Charging at the terminal is necessary for the PHEV to run electrically while in the City. Geofencing is used so that the vehicle automatically switches to electric propulsion and to limit the speed to 45 km/h when entering urban areas. This application is an important step on the city's long-term work to introduce geofencing for a more well-functioning transport system.

The different agreements and contractual partnerships to define business model are a key issue in this measure. The city of Stockholm decides who can perform night delivery with heavy vehicles. The PHEV is owned by Scania and Havi, the biogas truck

is owned by Ragn-Sells. The procurement of the transport assignment consortium led to a formal agreement between KTH and Scania regulating the economic contribution for the development of the PHEV used in the measure. Development of the PHEV including charging infrastructure were partially EU funded. The transport assignment is a regular business agreement between Havi and McDonald's. Waste collection is part of Ragn-Sells ordinary business agreements.

Bringing different perspectives together on an early stage to predict challenges and obstacles was a successful part of the planning. A group of representatives from all parties went to visit all restaurants and inspect the loading zones early in the planning phase. In this process the city identified necessary changes in the loading zone regulations and design which could be dealt with directly. The project team also inspected the different sites in order to identify suitable locations for charging infrastructure.



Figure 12: Night delivery with PHEV lorry in Stockholm

The main results of the measure implementation indicate that the transport efficiency evaluations compared off peak travel time to peak travel time. Both evaluations indicate a time saving at roughly 30 % shorter travel time during the off peak, while no complaints from residents have been registered by neither the city nor McDonald's or Ragn-Sells.

The results of this measure show that nighttime deliveries are more time and energy efficient, can lead to reduced emissions, while the delivery noise slightly adds to the background levels. Using a hybrid truck for goods deliveries can lead to a 40% decrease in carbon dioxide emissions (about 80kg decrease per operation) while the noise of the actual delivery levels has been observed to add a substantial 2 dBA to the existing background noise level, measured at a façade some 5 meters from the source, during noisy segments of the night, and for a noisy location in the city. Unless the equipment in the final stage of the delivery is improved (to be more silent), nighttime deliveries are more suitable for the areas of the city where background noise levels are already elevated, such as main streets.

Recommendations for replicability could be summarized within the following topics:

- Bring all stakeholders together at an early stage to include different perspectives in the planning and better predict challenges and necessary tasks.
- Make sure to plan enough time for different procurement steps and contractual partnerships. Technical difficulties in the delivery of suitable trucks (e.g. PHEV) could delay the process.
- Preliminary results of the noise research performed shows that added delivery noise can be detected even in busy streets with a high level of background noise. This indicates further studies and tests must be made to gain knowledge on how to reduce delivery noise before scaling up night deliveries on a larger scale.

4. Example measures

4.1. Measure 1: Consolidation centre with EVs and local regulations for clean urban freight logistics

Introduction

The measure carried out in Madrid aims at creating a freight consolidation center to develop a more efficient goods distribution scheme through a consolidation platform to use electric vehicles for last mile delivery and, furthermore, analyze how the authorities can change through innovative policy tools the socio-economic framework so that it takes better account of societal costs and value creation. The consolidation scheme is shown in Figure 4.

The challenge addressed is the intense goods distribution flow in Madrid city center. This activity represents a relevant emissions rate within transport sector (14% of nitrogen oxides) and cause congestion, illegal parking, or nuisance to neighbors. Currently, a lot of these travels are done by heavy and inefficient pollutant vehicles. Mobility regulations tend to constrain and address a more sustainable model. The measure proposes a specific solution that frames in a sustainable mobility scenario for urban freight distribution. Through the consolidation center it is possible to develop a new scheme to improve the efficiency of trips and to facilitate the use of clean vehicles. The results of the measure will show how this kind of facilities can improve supply systems and give some clues on how to replicate in other parts of the city.



Figure 13: Urban freight in Madrid city centre

Implementation

The CIVITAS ECCENTRIC partner, FM Logistics, a logistic operator, has implemented and is managing an urban consolidation center for last mile distribution, operated using clean vehicles. The city of Madrid cooperates with the logistic operator carrying out studies, following the indicators, and taking advantage of the experience to get knowledge and address enabling regulations to give a competitive advantage to environmentally friendly delivery vehicles and methods, such as time-based access restrictions and access rules to the ongoing design of Madrid Central (LEZ).

The measure relates to the MAD 7.6 since the center will be used as a platform to operate with the prototype, 100% electric truck, developed in that measure.

The preconditions to implement the measure include:

- Technology, availability of reliable clean vehicles adapted to the service and economically affordable
- Customers demanding a sustainable service
- Facilities availability, in the right place and economically suitable
- Mobility regulations that foster the improvement of supply chains and fleet renovation

The initial step was to carry out a study to deep understanding of the urban logistics sector in Madrid and the stakeholders involved. The logistic operator FML did its business plan, selected the facility to establish the consolidation centre, hired it and adapted it to the service. The next steps were the exploitation of the centre and the monitoring of a case study to compare different scenarios.

Some changes were made from the original plans. For example, the measure planned the option of operate with EV but finally hybrid vans were used although the facility was

adapted to operate with these vehicles deploying electric chargers. The reason for this was that the current operative was doing with hybrids and was taken as the business-as-usual scenario.

The delay in the implementation of the electric truck prototype (Measure MAD 7.6) also affected the original plans and the prototype is operating just the last stage of CIVITAS ECCENTRIC project. Nevertheless, some electric vehicles are also operating from the centre using the facility. The original location chosen for the centre was changed due to the size of the first option and the economic conditions, besides the selected facility was nearby other logistic centre which let improve certain movements.

The stakeholders that have been involved in the implementation of the measure were: FM Logistic, as manager of the consolidation centre, the city of Madrid, with several departments in different actions (conducting a city freight study, following the measure, making punctual controls related to activity nuisance, connecting with mobility regulations), and the Polytechnic University of Madrid for evaluation and advisory. Final customers, such as Sephora stores, although are not project partners, also have an important role in the scheme as the reference customer which has been used to do the case study, demanding a 100% sustainable service. Other clients, using the centre but in a mixed formula, clean and conventional vehicles.

The measure has mainly an infrastructure content since it requires the facility for the consolidation centre, besides charging points for electric vans and truck have been deployed on it. Project funds have been allocated to hire the center and the human resources for the logistic management. The complementary infrastructure such as charging points and the auxiliary equipment have been also partially funded.

Logistic organisation has required the knowledge of expert personnel and in addition some surveys have been conducted to deepen into the goods distribution activity in the city. The logistic operator has made its business plan to define the operative

Several dissemination and communication actions have been conducted:

- References in CIVITAS ECCENTRIC project website.
- News in papers and specialised journals; IBERIA.es, El Mundo Financiero.com, EcoSector.es, NexoLog.com, Manutencion & Almacenaje, City Login, Logística y Transporte.es...
- Dissemination videos on line; an interview showing the Consolidation Centre and the logistic system was recorded and is showed on the internet:
<https://citylogin.es/madrid-se-lanza-a-la-distribucion-sostenible/>
<https://drive.google.com/file/d/1TWE7kd8ndmPNLc-1jme9lzlyleBBKvgn/view>

- Workshops and national and international events: VEM, Intelligent Cities...

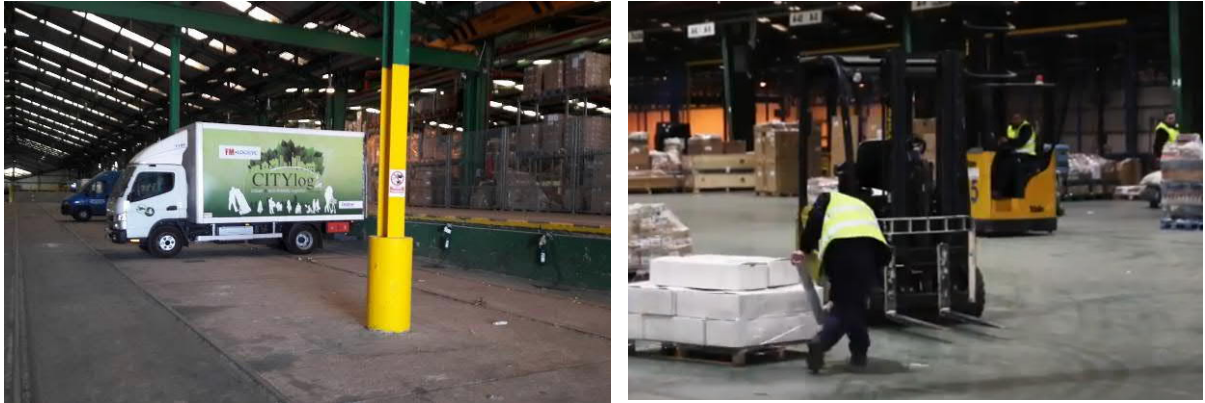


Figure 14: Logistic operations in Madrid consolidation centre

The measure has been used to analyse and shape potential innovative policy and regulation tools in Madrid city regarding public-private partnerships for consolidation centres and mobility regulations to foster clean freight fleets. The creation of the Low Emissions Zone “Madrid Central” and the consequent restriction to conventional vehicles encourage operators to develop other logistic systems that involve clean fleets.

The readiness and the affordability of clean and zero emissions vehicles is another important factor of economic sustainability to consider, the accessibility to vehicles that tailor to the operative of distributions foster this change to sustainable models.

Finally, other sort of measures that trigger the evolution to clean models are those oriented to raise awareness on clients and customers who value and demand a sustainable process.

Implementation timeframe has been of 48 months and this period comprises the following stages:

- Research and planning: 6 months. Freight distributions surveys, business model definition and locations studies.
- Procurement and implementation: 12 months. Hiring consolidation centre, electric charge stations deployment, consolidation centre opening, starting of logistic operations.
- Exploitation. Ongoing action. Logistic operations and management start prototype vehicle operations.
- Monitoring. 12 months. Data collection and evaluation of indicators.

Business model and contractual partnerships

The measure owner is, in one hand, the logistic operator, FM Logistic, partner in CIVITAS ECCENTRIC. Through the measure, the operator can offer a sustainable

service to its customers and comply with the city regulations to keep their routes in restricted areas. On the other hand, the city fosters sustainable model distribution that provide environmental and mobility benefits compared to conventional ones. Therefore, the city and the logistic operator have collaborated within the framework of the measure. Municipality has offered information and support and the private partner has implemented the measure.

The measure has been mainly financed by the private partner (16% public / 84% private), having the economic support of CIVITAS ECCENTRIC project, with a total budget of 603.682 € (consolidation center in operation for 4 years). The consolidation centre has been hired by the operator (there has not been any additional local public concession or support for this element of the measure). After the project ends, it is intended to continue with the hub activity. The economic sustainability depends on operational cost and the existence of customers that are willing to assume the extra cost that currently has the model. However, this extra cost is foreseen to cut down according to the increase of customers, the association of other services to the hub and the reductions of vehicle's prices and the foreseen implementation of stricter environmental regulation.

Critical challenges and recommendations for replicability

To foster this freight distribution model with a significant impact in the city, several barriers must be overcome. The cost of this alternative model is a little bit higher comparing the conventional ones. This condition reduces the competitiveness and therefore the attractiveness for the private operators. The reduction of cost by adding other services to the hubs, the cut down of clean vehicle's price and the demand of customers are some of them, on the other hand, enabling mobility regulations push operators to integrate these new models.

Other sensitive factor is the impact of the hubs to the citizens' life in neighborhoods. In this sense, urban planning needs to incorporate this infrastructure in planning processes and make them compatible with other on street activities. The hub implies intense traffic and its consequences (noise, pollution, safety impact,...) that is a change negative for certain neighbourhoods with residential priority

The consolidation centers to be deployed in new urban developments should be taken into account during the planning stage, applying a strategic land use (locations, dimensions, mobility flows, management, etc.) that integrates logistics as one of the urban needs and avoid conflicts with residents and other activities. The involvement of real state stakeholders in the strategic planning of consolidation schemes could be interesting, since it seems to be the trend of the market for urban micro-hubs, collection points and other logistics solutions. In any case, it is essential to analyse carefully all the circumstances before the authorization of a new consolidation hub.

From the sustainability point of view, according to the monitoring results, the consolidation centre scheme offers relevant benefits in terms of supply chain efficiency and environmental impacts. Emissions have a significant cut down, as well as the energy consumption, number of trips are reduced as well.

5. Conclusions

Different elements that can be applied to improve the efficiency of supply chains and reduce the environmental and traffic impact of the last mile delivery have been identified and tested in the framework of the CIVITAS ECCENTRIC Project:

- Consolidation schemes: from large urban distribution centres in the periphery to micro depots and collection points for the final steps of the urban supply chain.
- Off-peak deliveries that could significantly cut the delivery times and the associated emissions.
- Raising awareness targeted to final customers to increase sustainable consumption patterns, a bottom-up demand of clean services and the acceptance pick-up systems.
- Clean and silent vehicles (see Deliverable 7.5: Clean Vehicle Technologies).
- Partnerships and policy tools fostered by public administrations (see Deliverable 7.6: Innovative policy tools in freight logistics).

Those elements maximize the benefits when applied in an integrated and combined manner, as in measures MAD 7.1: Consolidation centre with EVs and local regulations for clean urban freight logistics, MUC 7.3: Combining Cargo-Bike-Delivery with a flexible package system or STO 7.4: Night delivery with clean and silent vehicles. Regardless of the specific action carried out, the results and lessons learned in the CIVITAS ECCENTRIC Project suggest that there are common key aspects that must be deal with:

- The economic viability of these options is often challenging. Consolidation centres are only viable in niche markets and in areas with a high density of delivery points, so the costs of extra transfer of goods could need specific financing schemes.
- Strong public sector involvement in encouraging efficient and clean freight through enabling regulatory framework. (e.g. access, regulation, incentives, land use, etc.). Certification programmes encouraging compliance with best practises, with benefits for those adhering to the standards, has been found effective in other cases.

- A strong engagement of all the stakeholders and close cooperation between senders, receivers, carriers, logistics providers, etc., increases the likelihood of finding solutions to the challenges.
- A range of other value-added logistics and retail services can be provided in consolidation schemes to create a business model more feasible, for example, of improved return logistics, inventory control or associated services to citizens.

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