VIAJEO PLUS

D2.2 Consolidated Virtual Solution Book

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Abstract	This deliverable consolidates best urban mobility solutions in five specific topics identified in WPs 3-7 into a Virtual Solution Book, as part of an online toolkit. These solutions are assessed using the guidelines defined in task 2.1 and the methodology developed in task 2.2. This activity leads to a comprehensive uptake matrix that underpins the tasks related to the city mobility weeks and more critically, the recommendations for executive implementation plans and strategies. The uptake matrix re-groups similar and comparable practices, and allows both common and specific objectives to be achieved.
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Summary

Viajeo PLUS is designed to be a co-ordination and support action (CSA), with a focus on "implementing innovative and green urban transport solutions in Europe and beyond". The project aims to address global challenges and contribute to objectives established by the European Union in terms of sustainable urban mobility, energy efficiency and the continuing fight against climate change. The Viajeo PLUS project delivers significant positive impacts in the field of green and sustainable transport, and these impacts can be understood with respect to the work program objectives, policy developments and international cooperation particularly with East Asia (China and Singapore), Latin America, and the Mediterranean Partner Countries (MPCs).

At the core of the Viajeo PLUS project is the identification and knowledge transfer of best practices in smart and sustainable solutions for urban transport and mobility across the world, in particular focusing on existing practices in Europe, East Asia (China and Singapore) and Latin America. Each of these practices across the five areas (network management, clean vehicles, public transport, transport infrastructure, city logistics) is reviewed and analysed in-depth with regard to the assessment methodologies and strategies defined in the project, especially in WP2.

To meet these targets, successful experiences of implementing innovative urban mobility solutions across the world are identified and shared. Experience and knowledge are exchanged through showcases, site visits, workshops and dissemination learning materials. The Viajeo PLUS consortium develops a 'Virtual Solution Book' to provide a detailed description of these initiatives and executive implementation plans for greater uptake by cities intending to implement any of these solutions.

Contribution to sustainable transport policy (Latin America)

Viajeo PLUS invests significant efforts into the Latin America countries, having core team partners from Brazil who have shown great interest in moving forward based upon EU examples of sustainable urban transport and to seek for its transferability to their own cities. This partnership approach enables the Viajeo PLUS consortium to conduct effective exchanges of best practices, assessment of the existing solutions and implementation of City Mobility Weeks including site visits, transfer of knowledge and meetings with local transport professionals.

Contribution to innovative public transport development (China)

The Viajeo PLUS project contributes to these existing collaborations and also helps meet the Ministry's objectives, by encouraging greater momentum for sustainable transport activities and initiatives in the region, creating a wide range of comparable assessments for innovative solutions which relate to cleaner, safer and more efficient transportation systems for the future.

Contribution to a future land transport system (Singapore)

Viajeo PLUS works closely with the Singaporean LTA and its Academy through the various knowledge exchange mechanisms to help promote healthier and more

environmentally-friendly transport modes whilst continuing improving the efficiency of the current public transport and city logistics management.

1. Introduction

1.1. The Viajeo PLUS Project

The goal of Viajeo PLUS (http://viajeoplus.eu/) is to benchmark outstanding solutions, in the context of *mobility management, clean vehicle, public transport, infrastructure and city logistics*, for innovative and green urban mobility in Europe, Latin America, China and Singapore, subsequently facilitate the uptake of these solutions across different cities in these regions and Mediterranean Partner Countries (MPCs), and fostering collaboration between these regions on a global scale.

1.2. WP2 – Technical coordination, Methodology and Recommendations

To achieve this goal, WP2 aims to implement the VIAJEO PLUS methodology, coordinate key and necessary inputs from the relevant WPs identified, and lead to the definition of executive implementation objectives, plans and strategies for innovative sustainable solutions for urban transport in Europe and beyond.

1.3. Aim of Task 2.3 and Deliverable 2.2

Based on the best practice results from WP3, WP4, WP5, WP6 and WP7 and using the guidelines defined in task 2.1, task 2.3 implements the methodology developed in task 2.2 leading to a comprehensive uptake matrix that underpins the tasks related to the city mobility weeks and, more critically, the recommendations for executive implementation plans and strategies. The uptake matrix re-groups similar and comparable practices, and allow both common and specific objectives to be achieved.

This deliverable describes the consolidation of the best practice results which are used to create a new web-based 'Virtual Best Solution' book to facilitate wider uptake of solutions across more cities and regions. As an outcome of the assessment process, host cities are identified from the success examples included in the matrix.

2. Innovative Integrated Network Management

WP3 identifies the best current solutions involving integrated urban road network management at both the strategic and operational (control) level in different cities. The solutions are grouped into cities to show their implementation and operations in local environment and conditions.

2.1. Verona - Cooperative System

General description

Cooperative systems are systems in which a vehicle communicates wirelessly with another vehicle (V2V – vehicle-to-vehicle communication) or with roadside infrastructure (V2I – vehicle-to-infrastructure communication or I2V – infrastructure to vehicle communication) with the ultimate aim of achieving benefits in many possible areas of traffic management and road safety.

Cooperative systems provide a technology that helps in solving current transport challenges. The benefits of cooperative systems, as described in different EU funded project results such as CVIS (www.cvisproject.org), Safespot (www.safespot-eu.org), Coopers (www.coopers-ip.eu) and recently Compass4D (www.compass4d.eu), include:

- Improvement in management and control of the road network (both urban and inter-urban);
- Increase in traffic efficiency;
- Reduction of congestion;
- Improvement of the efficiency of public transport systems;
- Improvement of the efficiency of freight vehicles;
- Reduction of emissions and pollution caused by road transport;
- Improvement of traffic safety for all road users;
- More efficient logistics management;
- Better and more efficient response to hazards, incidents and accidents;
- Shorter and more predictable journey times;
- Improvement in quality of real-time traffic data.

Due to their benefits cooperative systems are a huge opportunity in the field of traffic and transport and they gain increasing momentum particularly in Europe, the US and Japan. For the last 15 years a lot of research activities have been carried out in Europe on cooperative systems (e.g. the projects CVIS, Coopers and Safespot). The last 3 years industrial deployment has been started by the big ITS leading companies in Europe, based on the results achieved in different large field trials funded by the EC.

Cooperative systems can be performed using the long range communication media (UMTS/LTE) or short range communication using ITS-G5. ITS G5, also known as IEEE 802.11p (and DSRC in the US) is a short range WLAN standard developed for ad hoc broadcast communication between vehicles and to the road side infrastructure. The specification is derived from the well-known Wi-Fi specification (IEEE802.11), specially adapted to the vehicular environment, supporting high driving speeds and low latency

requirements- In the US this technology is called Wireless Access in Vehicular Environments (WAVE) and in Europe ITS-G5.

Long range communication is mostly used for efficiency applications whereas the ITS-G5 is designed to support time critical road safety applications where fast and reliable information exchange is necessary.

Cooperative system in urban context

In the urban context, cooperative applications can be implemented at three different system levels:

- Cooperative network management: area traffic management is optimized by recommending the best route to the drivers according to their destination and the current traffic conditions on the network;
- Cooperative area routing: in case of local disturbances in the traffic condition (e.g. due to accidents or special events) cooperative applications can make it possible to alert approaching vehicles and suggest a new route.
- Cooperative local traffic control: the cooperation between vehicles and enhanced local intersection control make the creation of green waves simpler. At this level information provided to the users is related to speed profiles and to the condition of the neighboring intersections.

A good example of deployment of cooperative systems in the urban context is the pilot actions carried out by the Compass4D project, which concerns urban mobility and addresses needs for safety, as well as emission and congestion reduction in cities.

Example of cooperative system in Verona

The cooperative system deployed in Verona is a good example of deployment in the urban context as described above. In order to give a full response to the European ITS Directive with the law on Growth & Development issued on the 17 December 2012 (and in particular article 8 which is dedicated to "telematics linking between vehicles and transport infrastructure") the city of Verona participated in a private public funded project (partners Swarco, Verona city and Audi) and EU funded project Compass4D.

In the city I2V tests were carried out in 2012, as part of the collaboration project between Verona city, Swarco and Audi. Based on the architecture shown in Figure 4 a traffic light assistant application that provides a speed advice and time-to-green to the driver was developed for the smart phone (that can be used as OBU).

This application informs the driver in real time, at which speed he or she can pass through green lights, or about the remaining waiting time while at the red traffic lights. See Figure 5 for a picture of the application. The speed advice application is designed to produce green waves, with the aim to have environmental benefits for citizens. By communicating with the infrastructure, vehicles can travel at optimum speed so that they are not required to stop-and-start at traffic lights, thus reducing the stop-and-start behaviour which produces more emissions and congestion than a smooth traffic flow does. This is not only of interest to small private vehicles but also to heavy goods vehicles. Another aim of the project was to potentially reduce or avoid accidents.

2.2. Beijing – Traffic Demand Management

General description

With the rapid economic development, population growth and sharp increase in the demand for transportation, the traffic congestion in Beijing increases. A simple increase of transportation supply cannot solve this problem anymore. Instead a strategy for managing the demand for transportation must be implemented. There are various possible measures for managing the transportation demand. In terms of policies, measures such as alternate peak hours, congestion charging, parking charges, restrictions on the purchase of automobiles and traffic control may be taken. In terms of technologies, monitoring, control, induction, scheduling of traffic, etc. may be carried out, so as to effectively adjust the distribution of traffic in the whole transportation system.

In terms of intelligent transportation construction, Beijing has already established the Integrated Traffic Monitoring System and the Real-Time Traffic Induction System to guide the balance between supply and demand of transportation and solve the problem of congestion. The Integrated Traffic Monitoring System includes eight major subsystems, namely the Comprehensive Traffic Detection System, the Traffic Video Surveillance System, the Stationary Illegal Behavior Detection System, the On-Bus Illegal Behavior Detection System, the Police Car Mobile Enforcement System, the Traffic Flow Detection System, the Smart Roadside Parking Management System and the ITS Internet of Things Demonstration Project. The Real-Time Traffic Induction System receives real-time traffic speed from the Traffic Monitoring System and provides real-time congestion alters to travelers via websites and radios so that travelers can optimize their routes before traveling. The system would also present travel speed for alternative routes to on-road travelers via VMS (Variable Message Signs) so that travelers can choose optimal routes while driving (see the figure below).

In addition, Beijing has also established the Beijing Municipal Transportation Operations Coordination Center8 to help operate traffic demand management strategies, including three sub-platforms, namely the Decision Making support and Information Service Platform, the Transportation Monitoring and Operation-Coordination-Direction Platform, and the Traffic Safety Emergency and Command Platform, and three systems, namely the Network Operation System, the Operation and Maintenance System, and the Machine Room Management System. The Beijing Municipal Transportation Operations Coordination Center is necessary for the operation, coordination and direction of intelligent transportation and plays an important role in the scientific organization of transportation, enhancement of road capacity, handling of emergencies, alleviation of traffic congestion, improvement of rapid reaction, etc.

Traffic management strategies

In order to balance the limited infrastructure recourse and the dramatically increasing demands of automobile traveling, the government of Beijing has taken a series of traffic demand management measures including, alternate peak hours, differencing parking charges, restrictions on the purchase of automobiles, restrictions on the usage of automobiles, etc. All these measures have some positive impacts on reducing automobile

travelling. To evaluate the effect of these traffic demand management measures on the transportation system of Beijing, the Traffic Operation Performance Monitoring System9 was developed in 2008. This system applies the floating car system to monitor real-time traffic operation and adopts the traffic congestion index (TCI) to evaluate and track the performance of traffic operation.

The traffic congestion index (TCI) is a conceptual value that comprehensively reflects the smoothness or congestion of the road network created by Beijing Transportation Research Center (TRC). It is obtained through the deep processing of floating car data (dynamic vehicle information) collected everywhere in the city and the analysis of dynamic data passed back by vehicle-borne GPS on 66,000 taxis in Beijing to the Data Processing Center.

The key to the acquisition of the traffic congestion index is the floating car system. In 2003, for the first time in China, Beijing conducted technical research on floating car data. It then established the first floating car system in China in 2005. This system has a large scale and a full range of vehicles, including 40,000 sample vehicles, consisting of 33,000 taxis, 5,000 vehicles for rent, and 2,000 tourist vehicles for rent. The coverage of the road network reaches 90% and the estimation accuracy for congestion tops 86%.

The traffic congestion index is an index reflecting the overall congestion of the road network in a quantitative manner with congestion intensity, congestion duration, scope of congestion, frequency and other factors taken into consideration.

In Beijing, traffic restriction is an important transportation demand management strategy, including “traffic restriction based on even- and odd-numbered license plates”, “let your car rest for one day in a week”, “car prohibition during peak hours for one day each week”, etc.

The traffic congestion index can reflect the effect of this transportation demand management strategy directly.

Research shows that in the period of traffic restrictions based on “even- and odd-numbered license plates” for the Olympic Games, the traffic congestion index decreased to the largest extent and the demand management measures were most effective during peak hours. The effect of the traffic restriction of “let your car rest for one day in a week” and that of the “car prohibition during peak hours for one day each week” are basically the same, during which period of time the traffic congestion index is significantly brought down. Accordingly, the transportation demand management strategy is quite effective in the reduction of the road network load.

The traffic congestion index can clearly reflect the condition of the road network operation. The traffic congestion in Beijing has been aggravated year by year, and the implementation of the “traffic restriction policy” is significantly effective in the reduction of the traffic congestion index.

2.3. Amsterdam – Practical Field Test (PPA)

General description

In the Netherlands there is a lot of congestion, and the government tries to diminish this in different ways. One way to spread traffic over the network in a more balanced way is with personal navigation systems that try to achieve a system optimum. Personal navigation systems in itself are not highly innovative; they are around for quite some time (to give an idea, TomTom launched their first commercially available navigation system in 2002). Nowadays different types are available. All navigation systems provide route information, but they differ in the amount and type of data they base their advice on (historical data, real-time data), whether they take into account for example information about road works and weather, and whether they use input from road users (e.g. Waze). What all navigation systems have in common is that they are working towards an optimum for the individual user.

The system or solution that is presented in this chapter is a personal navigation system that tries to achieve a system optimum. In that way the available infrastructure is used in the most optimal way, so it can provide shorter travel times for more users. The system has an algorithm to come up with the personal route advices. This algorithm uses historical data and real-time data and makes a prediction of the travel times for the coming hours. In the end, this leads to advices that can be different from the ones given by navigation systems currently available. Of course the acceptance of the route advice given by the navigation system is important, especially since the advices that are best for the 'system' are not always best (fastest) for the individual user. If advices are not complied with, the system optimum might not be obtained. The developers of the system are aware of that and have incorporated some 'sanity checks' to try to achieve high compliance (e.g. the advised travel time cannot be x minutes longer than the shortest travel time) and have enabled personalization of the system. People can enter some personal preferences when using the system for the first time, for example on whether they like to stick to the same route all the time (also when that route is congested) or whether they are very open for other route suggestions even if it is just one minute shorter.

Examples of PPA in Amsterdam

The system as described above is brought into practice in the Practical field test Amsterdam (in Dutch: Praktijkproef Amsterdam or PPA). More information about this field test can be found on their website (http://praktijkproefamsterdam.nl), and more information about the specific part of the field test where the navigation system as described is tested can be found on the website of that specific consortium (https://www.amsterdamonderweg.nl). The field test was issued by and is paid for by Rijkswaterstaat (the Dutch motorway operator), the city of Amsterdam and the province of Noord-Holland. The test with the navigation system started in January 2015 and ran till the end of 2015.

The personal navigation system that is developed is presented to the road user by distributing a smartphone application (named 'Superroute') that is available for Android and iOS smartphones and can be downloaded. Download is open to everyone (the system in principle also works outside of Amsterdam although the information used in and around Amsterdam is for a more detailed network), and people driving often in and

around Amsterdam were approached directly. The test is still running but up till now, more than 30,000 people registered to use the application.

For some specific events (such as large fairs, concerts and football matches) where a large crowd is expected, a special version of the Superroute application is working, which also provides parking advice. For these events visitors are approached to use the application through ticket agencies.

The application makes use of the GPS system of the smartphones to track the location of the road user. The users can ask for a trip advice and the application gives them turn-by-turn navigation. The route that is suggested by the application is calculated in a back-office. This back-office monitors the current road situation, and based on this current road situation and historical data the road conditions of the coming hours are predicted. The back-office processes the expected travel time, and gives a route suggestion to the user based on their personal preferences. Floating device data flow back from the user to the back-office, and these data are used to improve the functionalities of the system and the back-office.

2.4. Hamburg – smartPORT Logistics

General description

An average day in Hamburg's port sees more than 40,000 journeys made by lorries across the port area. Almost ten million standard containers were trans-shipped in the port in 2014. Freight companies, port operations, port management and staff involved in transport have one common goal: to get the goods through the port as quickly and reliably as possible.

How can 145 million tons of goods make it through the Hamburg port more quickly? In cooperation with Hamburg Port Authority (HPA) and SAP, T-Systems have developed the smartPORT logistics concept (SPL). SPL, as part of smartPORT logistics, connects all parties involved in the logistics chain for their mutual benefit, which means that transport business can be planned better and coordinated more effectively. In this way, SPL supports the development of the port into a smartPORT and helps to preserve its competitiveness, ensuring that it remains an economic powerhouse.

SPL is a cloud-based information and communication system, with the goal of staggering the high volume of everyday traffic on the port's roadways and optimizing goods flows. Using a central public cloud, the HPA collates all relevant real-time information and enables all parties involved in the transport chain – trucking businesses, haulers, parking space operators, Port Road Management and port operations to react flexibly to the traffic situation.

2.5. Worldwide Implementation – University Travel Plan

General description

There are about 55 UK universities which have a student population of more than 20,000 and which are large employers in many cities. For example, the University of Leeds has 31,906 students and 7,517 staff in 2015, which makes it the third largest employer in Leeds. The travel plans developed by the UK universities are therefore an important part

of local transport planning in the UK cities. They address needs and opportunities in relation to transport and travel made by the staff and students, set out a vision and a framework for the future development of the campus towards sustainability.

A travel plan is a package of both physical and behavioural measures that encourages sustainable travel within an institution, increases travel choice and reduces reliance on single occupancy vehicles. It aims to promote and develop a range of alternative travel options and maximise access to a site by sustainable modes of transport.

UK Universities are growing student numbers, expanding degree course provision and increasing research activity. Despite management measures, parking demand exceeds supply. At a national level, documents such as the government's white paper "A new deal for transport" and planning policy guidance notes acknowledge the fact that congestion is not solved by building new roads. The government promotes company travel plans to encourage changes in travel patterns.

The objectives of a University Travel Plan are:

- To capture commuter and business travel data for carbon foot-printing purposes in order to satisfy the Planning Process and set the baseline for future reductions;
- To improve the choice of transport options and facilities available to staff, students and visitors travelling to and from the University and between sites;
- To implement travel initiatives through behaviour change that reduce transport-related emissions and thus meet our strategic targets to reduce the environmental impact of the University's travel demand locally, nationally and globally;
- To reduce the use of private motor vehicles by staff travelling to and from and between, University sites and increase the use of cycling, walking and public transport use;
- To promote more sustainable ways of working;
- To improve the health and fitness of staff and students through the promotion of walking and cycling;
- To make changes to University vehicles to reduce their environmental impact.

The benefits of an effective Travel Plan to the University community are wide ranging and include improved accessibility, air quality, safety, health and wellbeing; reduced local congestion and climate change mitigation:

- Increased travel choices improves accessibility which can help to recruit staff and students otherwise excluded and make it easier for visitors;
- Reduced vehicle emissions have a positive effect on a range of illnesses, while walking and cycling are linked to healthier lifestyles;
- Reduced car use reduces congestion and demand for parking spaces, this in return improves local air quality and benefits the local community;
- CO2 reductions from travel contributes to targets set by the University and the Government and the travel plan has a positive impact on the University's environmental performance.

In the UK, city councils require their local universities to produce a travel plan for new developments that generate traffic movements. Many positive changes have been achieved at many UK Universities since the adoption of the 2003 Travel Plan. A couple of cases are described as follows. In Case 3, a similar scheme implemented in Europe was presented.

Leicester – University Travel Plan

University of Leicester's travel plan[2] hails 'best in City' as its 2013 Travel Survey showed the considerable reduction in single occupancy vehicles to the university's sites from 49% in 2009 to 38% in 2012. This exceeds the Travel Plan target and puts the University in a great position to meet the target of a 15% reduction by 2015. The following figure shows the staff travel mode changes between 2011 and 2012.

Besides single occupancy car use, the main shift is in both walking and cycling, which is probably due to factors including fuel price increases, denying parking permits to staff that live close to the university sites, the introduction of flexi permits to encourage cycling and the opening of the underground bike park in the centre of Main Campus. Train use has also increased despite fare increases. The offer of a 10% discount on annual season tickets has been popular, although there are still many requests for assistance in purchasing these. Work is on-going to source a credit company to facilitate this. The survey also indicates that measures such as improved local street lighting and cycle routes in the city, cycle hire, and discounted bus tickets with more frequent and direct routes to Campus would encourage them to walk, cycle, use public transport and car share as an alternative to driving.

Belfast – University Travel Plan

The University Travel Plan[3] produced by Queen's University was named the winner of the 'Most Sustainable Travel Plan' at an awards ceremony in Titanic Belfast in 2012. These awards recognise excellence and reward innovation by local companies who are leading the way with renewable energy technologies and sustainability and awareness raising initiatives.

Queen's Travel Plan 2010-15 outlines the University's strategy for reducing single car use by staff and students travelling to the University. Since it was first launched in 2005, the University's Travel Plan shows the number of staff using sustainable travel to commute to and from work has increased as follows:

- Bus: 8% to 10%
- Train: 6% to 13%
- Walk: 13% to 15%

[2] University of Leicester Travel Plan (2010), available at: http://www2.le.ac.uk/offices/estates/environment/travel/thetravelplan/Travelplan%20draft%20May%2010.pdf

[3] Queens' University Belfast Travel Plan (2010), available at: https://www.qub.ac.uk/directorates/EstatesDirectorate/FileStore/Travel/Filetoupload,198641,en.pdf

- Cycle: 3% to 7%

Ibaeta – University Travel Plan

In the ARCHIMEDES project (http://civitas.eu/content/archimedes) a Mobility Management Plan was implemented for the university campus of Ibaeta (Spain) as an example of the "Mobility Management for University Campus" measure defined in CIVITAS. It aims to promote changes in the organisational model of the University, wherever possible, in order to ease the use of collective transport and other energy-saving transport means for its staff and students.

In this survey, students and University staff were asked whether they believe that accessing to the Ibaeta campus in each mode of transport is perceived as easy or not (i.e. perceived accessibility levels). Whilst cycling and rail received positive perception of accessibility, access to the campus by bus appeared to be less easy after the mobility management scheme. The latter may be caused by the construction works in the campus and low perceived security of bus accessibility. Above all, car accessibility is the worse perceived mode.

With reference to modal split, the greatest achievement was made in the share of car trips changing from 1.3% of all trips before the scheme to more than 25% after.

2.6. Summary

Table 1: Best solutions in urban mobility

Solution	Description	KPIs	Example City
Cooperative systems	Systems in which a vehicle communicates wirelessly with another vehicle (V2V) or with roadside infrastructure (V2I or I2V) with the ultimate aim of achieving benefits in many possible areas of traffic management and road safety	• Efficiencies of general traffic, public transport, freight transport, and logistics management; • Vehicular emissions and air pollution concentrations; • Time to respond to hazards, incidents and accidents; • Journey time variability and predictability; • Quality of real-time traffic data	Verona
Traffic management strategies	Strategies that can solve urban transport problems fundamentally	Traffic congestion index (TCI): • 0-2: Very smooth • 2-4: Smooth • 4-6: Slightly congested • 6-8: Moderately congested • 8-10: Seriously congested	Beijing
PPA	PPA (Praktijkproef Amsterdam, or Practical	• Travel times • Spread of traffic over the	Amsterdam

solution	field test Amsterdam) is a personal navigation system that tries to achieve a system optimum	network in a more balanced way • Personal route advices	
SmartPORT logistics	A cloud-based information and communication system, with the goal of staggering the high volume of everyday traffic on the port's roadways and optimizing goods flows	• Waiting time • Trips • Transport volume through optimized timing of trips • Traffic and infrastructure info in real time; • Quick, direct communication between driver and dispatcher; • Visualized port situation for monitoring and coordination of fleets; • Fuel consumption and CO2 emissions	Hamburg
Effective university travel plan	A package of both physical and behavioural measures that encourages sustainable travel within an institution, increases travel choice and reduces reliance on single occupancy vehicles. It aims to promote and develop a range of alternative travel options and maximise access to a site by sustainable modes of transport	• Increased travel choices • Improved accessibility • Reduced car use, congestion, vehicle emissions • Walking and cycling • Healthier lifestyles; • CO2 reductions	Leicester Belfast Ibaeta

Solution Assessment

In WP2 of Viajeo+, an assessment methodology for the identification and uptake of the most promising solutions for inclusion in the project outputs was developed[4]. A series of common factors from the previous body of work were identified and analysed, and a framework for prioritising the solutions is put forward.

Following this methodology, Task 3.2 carried out case studies of existing practices and solutions used in effective mobility management, in order to benchmark current practices, assess the lasting effects and impacts of previous projects and tools, and gather relevant

[4] http://viajeoplus.eu/wp-content/uploads/sites/4/2013/11/VIAJEOPLUS_D2.1_BestSolutionMethod.pdf

experiences to identify and assess best practice solutions for urban network management in cities across Europe, Latin America, China and Singapore.

The Viajeo+ assessment methodology consists of eleven common criteria (i.e. innovation degree, policy relevance, civic delivery team, maturity, global potential, localised applicability, complementarity, expected impacts, measurability, public acceptance, and expandability). WP3 carried out a review of state-of-the-art innovative integrated network management and identified a new set of mobility-specific criteria based upon social, economic and environmental factors. A UG dissertation report detailed the results of this multi-criteria analysis (MCA) on mobility and infrastructure[5].

However, due to the complexity of this MCA method and lack of a common assessment framework and data to carry out the analysis on all five topics in this project, it was decided that a simpler method needs to be developed and used as shown in Table 2.

Table 2: Assessment of Mobility Solutions

Solutions	Key Success Factors	Key Enablers	Key Barriers
Cooperative systems	• Permit data to be shared between different types of ITS applications; • Achieve more efficient management of transport as a whole; • Make more and better quality information available to operators as well as to final users (travellers)	The city authorities working to make the cooperative system data available to be used by consumers and others who can use the information to create value to the community.	To get critical mass to use the app is challenging.
Traffic management strategies	• Public support • Improvement on public transport service quality • Reduced congestion	• Beijing Municipal Commission of Transport • Beijing Traffic Management Bureau • Beijing	• Unpopular public transport service • Increased traffic volume and congestion • Poor coordination and cooperation of the three

[5] University of Leeds, "Assessment of Innovative and Green Urban Transport Solutions in Europe and Beyond", UG Dissertation by Thomas Lightfoot supervised by Dr Haibo Chen, 2014.

		Transportation Research Center	departments • Lack of investment in transportation information service
PPA solution	• Availability of device data from end users to improve the functionalities of the system and the back-office • Strong correlation between the number of end users and the reduced congestion • A large volume of users	Funding available	Difficult to obtain and maintain a high number of participants
SmartPORT logistics	• Efficient control and use of existing infrastructure; • Intelligent infrastructure in the port area; • Optimised supply of information for the handling of goods streams.	Use of internet-based freight exchanges.	Willingness to use the SPL APP and Web UI by logistics service providers and truck drivers
Effective university travel plan	• Awareness raising campaigns • Restricted parking • Car-sharing support • Financial incentives	• The university sustainability teams • City authorities • Travel information providers	• Irregular or indeterminate working hours make car sharing difficult • Feeling unsafe on cycling roads, and lack of cycle training • Need to carry heavy or bulky items on business trips

3. Clean Vehicle Deployment

WP4 of the Viajeo+ project benchmarks and evaluates a number of case studies of clean vehicle deployment in different cities worldwide. The case studies examine the deployments considering the local characteristics, and provide key information about users, stakeholders, success factors, enabling factors, barriers, and possible future developments. This work is summarised in Table 3 and its detailed descriptions can be found in Deliverable D4.1 which also provides a concise overview of the current trends in clean vehicle deployment, and aims to inspire policy makers and researchers to develop suitable solutions for their own cities.

3.1. Gothenburg – Hybrid Buses

General description

Hybrid buses have been in operation in Gothenburg since 2008 with very good experiences in increased fuel efficiency and emission reduction. This has formed a base to further expand and develop both the technology and bus public service offering.

In June 2015 a new bus service started between Chalmers/Johannesburg Science Park and Lindholmen Science Park in central Gothenburg. Three fully electric buses run on renewable electricity for very energy-efficient, quiet and entirely emission-free operation. On board the buses, passengers have free internet access. The bus stop at Teknikgatan at Lindholmen is indoors. Quiet and emission-free public transport can operate in areas currently closed to traffic, thus opening up new opportunities for planning in cities and towns. Apart from the three full-electric buses, the route is also served by a number of electric hybrid buses powered by electricity for about 70 % of the route.

Users and stakeholders

The following key organizations are partners in the Electricity initiative: Volvo Group, Region Västra Götaland, City of Gothenburg, Chalmers University of Technology, Swedish Energy Agency, Johanneberg Science Park, Lindholmen Science Park, Business Region Göteborg, Göteborg Energi, Västtrafik, Älvstranden Utveckling, Akademiska Hus and Chalmersfastigheter.

3.2. London – Hybrid Buses

General description

More than 1200 hybrid buses operate on 64 routes in London. The first hybrid bus was introduced on route 360 in March 2006 and over 300 were in passenger service by July 2012. The world's first double-deck hybrid bus was introduced in London from January 2007. Transport for London (TfL) initially stated that it intended to make all new buses delivered for use in London hybrids from 2012.

Users and stakeholders

Transport for London, bus manufacturers including BYD, Volvo, Wright Bus, Mercedes and Alexander Dennis, The World Bank and Green Investment Bank.

3.3. Hamburg – Hybrid Buses

General description

The public transport company in Hamburg, the Hamburger Hochbahn AG, is using the route to run comparative tests of innovative drive technologies under the strict everyday conditions of scheduled services, utilising Volvo vehicles. Alongside three 7900 Electric Hybrid buses, diesel hybrid buses in both 18 metre articulated and 12 metre versions will also be tested on the route, as well as battery fuel cell buses and fuel cell buses from other manufacturers. The Innovation Route 109 of HOCHBAHN will be almost exclusively served by buses with innovative drive technologies. Different types and drive modes for the sustainable buses of the future are to be tested in parallel and under identical conditions. Conventional diesel buses will also be used on the route to serve as reference vehicles in the scientific comparison of the innovative drive concepts.

The Innovation Route 109 runs from the new Electric Bus Terminal near Hamburg Central Station to the final stop at the underground station in Alsterdorf. With a length of about ten kilometres, it is highly suitable for the electric hybrid buses with plug-in technology that permits full electric operation over at least seven kilometres. Charging takes place at the two bus terminals. With the newest vehicles, the HOCHBAHN is expanding its rolling development lab for modern drive technology to a total of about 65 vehicles.

Users and stakeholders

The bus service is operated by HOCHBAHN, the public transport company in Hamburg. The EU project HELD “Hamburger Elektrobus Demonstration” with HOCHBAHN as Coordinator and Institut für Kraftfahrzeuge der RWTH Aachen as partners. Volvo Bus provides buses and Siemens provides the charging station.

3.4. Shanghai – Electrified Buses

General description

Two types of electrified buses are in operation in Shanghai. Double layer capacitors have been introduced to increase the range and there are some lines in operation with fast-charging stations using buses equipped with super-capacitor on-board energy storage systems (ESS).

In 2010, 120 fully electric buses where delivered for the 2010 Shanghai EXPO. During the EXPO, these buses were used to transport visitors to/from and within the EXPO park area. Each bus contains batteries for full electrical operation. An automated battery swapping station was constructed at the EXPO in Pudong.

A remote battery information system was deployed to monitor the charging status and notify the drivers when batteries need to be replaced. When notified the bus needs to transfer to the battery swapping station. The battery swapping takes less than 10 minutes. After the world EXPO 2010 the buses are in operation in central Shanghai, both in Puxi and in Pudong.

Users and stakeholders

The deployment required cooperation between vehicle manufacturers, bus operators, energy providers and the local government. The project was funded jointly by the government and the EXPO organization. The Shanghai based bus supplier Sunwin provides the buses and State-Grid provides the batteries and electrical energy. The bus operator is Bashi.

3.5. Paris – Electric Vehicle Sharing Schemes

General description

Car sharing as a transport concept appears to be gaining increasing importance in meeting urban transport demand. Through the membership of such a scheme a traveller can get access to a vehicle on demand without the needs for ownership of the vehicle, together with the costs and responsibilities attached to it. These concepts were initially referred to as car clubs and their origins can be traced back to the 1960s. The trend has been facilitated by ICT development over the last ten years. In recent years, vehicle manufacturers have seen car sharing as a new business model and have used it to promote their clean vehicles. Many cities are cooperating with vehicle manufacturers to implement car sharing schemes using electric vehicles in order to influence travellers' mode choice, in effect enabling electric shared cars to be considered as part of a suite of 'public transport' options.

Autolib' Car Sharing in Paris

Autolib' is an electric car sharing service in Paris, which launched in December 2011. The scheme uses a fleet of all-electric Bolloré Bluecars, four-person electric vehicles built around a lithium metal polymer battery. The vehicles are available for public use on a paid subscription basis, utilizing a citywide network of parking and charging stations. Over 2500 Bluecars have been registered for the service, and the scheme has more than 155,000 registered subscribers with over 4000 electric car charging points available in the city.

The technology for the Autolib' program consists of:

- Registration kiosk. Seventy freestanding enclosed kiosks enable new users to join the program within minutes. Users scan a credit card and valid driver's license, connect to a customer service agent via videoconference, and within minutes receive an RFID-enabled membership card that grants access to the Bluecar fleet;
- Rental kiosk. Autolib' members check in with a membership card and use the touch-screen system to reserve the most fully charged car near their location. The kiosk provides a map and directions;
- Charging station. Each station has parking spaces for four to six cars. Display lights at each charging station indicate if a car is available (green), reserved (blue) or unavailable for technical reasons (red). Waving an Autolib' membership card at the driver's door unlocks the car and the cap to the charging cable. The driver can then disconnect and stow the charging cable, start the car, and drive away;
- In-car system. The in-car system greets the driver by name upon arrival and sets the temperature and radio station in accordance with the driver's saved preferences identified during the registration process. The driver can access GPS

navigation via touch screen or be connected to a customer service agent to find a parking place or report any problems;

- Centralized Autolib' data management system. A team of 400 mobile ambassadors, using Ambassador handheld devices running Windows Embedded Handheld to connect to the Autolib' data system, circulates through the region to inspect and repair cars and assist members who are involved in accidents. Cars and kiosks are connected to a management system, enabling ambassadors to monitor car locations and charging levels in real time so that they can locate drivers who need assistance or move charged cars to locations where they are needed.

Users and stakeholders

The users and stakeholders of the Autolib' Car Sharing include Bolloré – operator, the city government – scheme originator, and IER – technology and infrastructure.

3.6. Berlin – eMio Share-a-Scooter

General description

eMio Share-a-Scooter is the first all-electric scooter sharing scheme in Germany. It operates the same business model as car-sharing companies and is based on the premise that people would like to use a scooter from time to time, but would never own one because it is too complicated or not viable.

The scheme, developing during 2014-15 will run initially during the summer months only, and will see 200 electric scooters which may be driven with a 'normal' car driver's license within the 88 km² Berlin S-Bahn ring. A user must prove they have a valid license, then register via the mobile eMio app, and connect a bankcard. Once registered, a nearby scooter can be rented (they will be scattered around the city) and dropped off anywhere within the network. The scooters travel up to 45 km/h on the road and come with two helmets sizes, as well as disposable helmet liners. The billing method is also pioneering: After the ride, the amount billed is either 19 cents per minute or 59 cents per kilometer, whichever is cheaper for that particular ride.

The scooters have two exchangeable batteries, each with a capacity of 1.8 kWh (37.5 Ah at 48 Volt), which is the reason behind the restriction within the S-Bahn ring. Flat batteries are to be changed by company staff driving around the city with depleted batteries taken back to the eMio workshop on the EUREF Campus in Berlin to charge. Recharging the batteries from zero to full takes around three to four hours. It is deliberate policy not to ask drivers to charge the scooters themselves. Whether this policy will still be possible as the scheme continues to expand remains to be seen.

Users and stakeholders

eMio was set up by Electric Mobility Concepts UG, a start-up founded by three university students. eMio, received support from VC Fonds Technologie Berlin, which is managed by IBB Beteiligungsgesellschaft, as well as two private investors from Hamburg and Berlin. The start-up was initially funded by Climate-KIC Accelerator

eMio targets three groups of potential users: citizens - mostly students and young professionals; tourists; businessmen, including businesses that use scooters already e.g. pizza delivery.

eMio has developed partnerships with many Berlin-based companies in the transport, energy, IT, communications, and service industries. It has developed additional networks at the regional, national, and international levels.

Vehicles are supplied by electric scooter manufacturer emco. The telematics unit is Cloudboxx, supplied by Invers.

3.7. UK Cities - Electric Cars

General description

In the UK the decision was taken as early as 2010 to invest in the widespread deployment of charging infrastructure in order to boost demand for electric cars and other electric vehicles. The result was eight Plugged in Places (PIP) projects in several regions located across the UK: East of England, Greater Manchester, London, Midlands, Milton Keynes, the North East, Northern Ireland and Scotland. The projects were designed to take different approaches to setting up plug-in vehicle charging schemes, aided by match funding from the Office for Low Emission Vehicles (OLEV). This was intended to explore the effectiveness of different strategies, locations and charge point types.

The North East England's PiP project, called Charge Your Car (CYC), created an integrated charging network for electric cars spanning a region of 8,600 km2. From 2011 a national network of charge points became available to existing and new CYC members (about 3000 nationwide). One key aim of the CYC programme was to feedback the experience gained by creating and operating charging infrastructure into future policy decisions at both regional and national levels. This included the development of standards, evaluation of technologies, and harmonisation of local incentives, as well as understanding users' behaviour and its impact upon the infrastructure. A secondary aim of the programme was to contribute to the development of the emerging electro-mobility sector, which is seen as having a crucial role to play in the future sustainability of the economy.

A single RFID card (the CYC Lifetime Card) provides access to all charge points on the network, whilst the CYC app became the world's first app (launched July 2013) that lets EV drivers find and use charge points. To use the network, EV drivers simply register a debit/credit card, which connects to their CYC Lifetime Card and app. The CYC telephone helpline provides support and advice.

A recent survey of CYC members revealed some interesting findings about electric car drivers in the UK (http://www.smartcem-project.eu/):

- 96% have a good or excellent opinion about driving electric cars;
- Most trips are short distance (61% drive less than 50kms per trip) and very few exceed 100kms;
- They are experienced electric car drivers (private motorists) who tend to use their vehicles for short range journeys (e.g. commuting) and recharge at work;

- Most drivers rank low running cost and low carbon emissions as the key benefits in driving an electric car;
- So-called 'range anxiety' appears to increase with age: 64% of under 40s is comfortable concerning the range, whilst 42% of over 60s is comfortable with the range;
- Range anxiety may be a product of personality type as well as a direct function of infrastructure availability and battery depletion rates;
- Most users are not willing to pay for additional services like charge point reservation.

Lessons learnt from all the UK PiP schemes can be found at government website[6].

As well as the PIP schemes, UK government has also attempted to incentivise the uptake of electro-mobility in general through tax breaks, exemption from Vehicle Excise Duty and Company Car Tax, as well as a Plug-In Car grant towards EV purchase which has been extended into 2015.

Users and stakeholders

The users and stakeholders of the UK electric private cars include central government, local government, charge point owners, energy providers, original equipment manufacturers (OEMs), infrastructure suppliers, EV drivers (and Non EV drivers, to understand the wider potential market), and CYC.

3.8. Beijing – Electric Tricycles for Urban Delivery

General description

e-tricycles are numerous in China mostly in places such as Shanghai, but are more visible and diverse in Beijing city centre. In Beijing's central business district they are used for parcel delivery. The customers walk to meet the driver. The parcels are laid on the pavement (sidewalk). Each driver is a kind of profit centre managing his own business. The parcels are identified by tags and the driver registers it with a barcode reader, then provides the customer with an invoice. The full transaction takes place on the street and lasts a few minutes.

Around markets hundreds of these vehicles are used as light duty vehicles and can be seen parked on the sidewalk. They are made of a steering front wheel, the seat upon the battery, and a flat tray behind over the carriage two wheels. In any situation no charge point is available. They are recharged elsewhere.

The e-3-wheelers were quite rare until about 2014. In 2015 according to manufacturers' and dealers' statistics there were about 100,000 e-tricycles in Beijing, 15 to 20,000 used for parcel delivery.

Users and stakeholders

[6] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/236750/plugged-in-places-lessons-learnt.pdf

A multitude of small urban delivery companies use this kind of vehicle. A prominent and fast-developing parcel delivery company named SF Express uses it in Beijing but not in other cities.

Shunfeng Express (Group) Co., Ltd. is a Chinese delivery services company based in Shenzhen, Guangdong, China. It is one of the two leading couriers in China, and provides domestic and international express delivery solutions to a wide array of customers. SF

Express has a fleet of 31 cargo aircraft, of which 13 are owned by its subsidiary SF

Airlines. SF Express has opened 500 Heike, an online shopping service community store, across all Chinese provinces except for Tibet and Qinghai. The company had plans to open 4,000 Heike stores nationwide in 2014.

3.9. Summary

Table 3: A summary of clean vehicle solutions

Solution	Description	Benefits	Example City
Hybrid buses	Including series hybrids, parallel hybrids, and blended hybrids. A series hybrid has no mechanical connection between the engine and drive axle. The engine powers a generator that charges the battery pack. In a parallel hybrid the engine powers the drive axle and a generator in parallel that can either charge the battery pack and/or directly propel the bus. A blended hybrid is a combination of the two types of drive systems.	• 30-40% fuel reduction • Silent take-off • 40% lower on-road emissions • Improved passenger capacity	Gothenburg London Hamburg
Plug-in hybrid buses	Powered by a battery that can be charged from an external power source and/or from the internal combustion engine. The plug-in hybrid bus offers full flexibility for the bus operator as it can be used in battery mode for zero-emission operation and benefit from the range as a	• 75% fuel and 60% energy reduction • Electrical drive 70% of route = silent • 75% CO2 reduction • Charging 6 minutes at end stations	Gothenburg London Hamburg

	diesel bus. The fuel economy can also be drastically improved due to operational flexibility depending on route characteristics, charging frequency and vehicle and energy system configuration		
Full electric buses	Powered only using a rechargeable battery used to power an electric engine to propel the bus, have no need for an internal combustion engine.	• 80 % energy reduction • Electrical drive 100 % of route = silent • No local exhaust emissions • 99 % CO2 reduction • Charging 6 minutes at end stations	Gothenburg London Hamburg Shanghai
EV sharing scheme	Allowing members to get access to a vehicle on demand without the needs for ownership of the vehicle, together with the costs and responsibilities attached to it, similar to car clubs but facilitated by ICT development. Examples of such a sharing scheme include Autolib, and eMio Share-a-Scooter.	• Savings for users who share the costs of car ownership; • A new public transport (PT) opportunity with greater flexibility for users, especially at times when other modes are not running; • A complement to existing PT systems by providing the first or last leg of a journey, with integrated ticketing solutions; • Reduced private cars on the roads, and hence less traffic; • Reduced congestion and delays; • Less pollution i.e. emissions and noise, due to less traffic and use of electric vehicles; • Reduced requirement for parking spaces, with the opportunity to reclaim the land for other uses; • More sustainable transport and improved quality of life in the city.	Paris Berlin
Electric cars	Electric cars for private use	• Increased energy security • Improved fuel economy, lower	UK Cities

		fuel costs, and • Reduced emissions	
Electric Tricycles	Electrified tricycles for urban logistics	• Lower costs (e.g. purchase, tax, insurance, storage, parking) • Speed despite congestion • Allowed in car-free areas • Lower environmental impact • Green image • Better quality of life and health for postmen	Shanghai Beijing Shenzhen *etc*.

Solution Assessment

Table 4: Assessment of Clean Infrastructure Solutions

Solutions	Key Success Factors	Key Enablers	Key Barriers
Electric/hybrid buses	• Public demand for clean, silent and efficient public transportation • User acceptance • Considerable energy consumption reduction • Electrical drive 100 % of route equalling silent operation • Zero local exhaust emissions • Considerable CO2 reduction • Charging at end stations to optimize operational time • In-door bus stops	• Strong collaboration between the key actors • New developed electric buses • Batteries and super-capacitors as storage media • Bus-stop charging stations • Battery swapping stations, swapping robots and remote battery monitoring systems • Innovation of new services and solutions	• Investment costs for new buses and charging stations • Technology development of key components • Innovation of new services and solutions • Competence development • Organizational changes
EV sharing scheme	• Compact electric cars and flexible services • Reduced traffic congestion and emissions • Decreasing reliance on privately owned ICE cars • Increased number of members • Smarter travel choices	• City government and municipalities, • Support from key stakeholders interested in supporting sustainable, emissions-free mobility	• Car availability • Street vandalism • Bad weather • Limited charging points • No on-board charger

	• Save time in city traffic (e-Scooter)		
Electric cars	• Widespread deployment of a dense charging infrastructure • Political 'buy-in' of stakeholders including local authorities, (OEMs) etc.	• Up-front deployment of a dense network of charging infrastructure • Government subsidies (e.g. vehicle purchase and tax incentives) • 'Buy-in' by a large number of early adopters • 'Buy-in' by other stakeholders	• Lack of charging infrastructure • Possible impact of removing government subsidies for purchasing electric cars, as well as loss of discounts and tax breaks • Fall in the price of fossil fuels
Electric Tricycles	• Meet real-time delivery demand and need for responsive solutions • High quality of service and low tech design • Affordable investment • Emission-free • Allow parking of vehicles on the pavement • Proximity and density of customer clusters • Multiple applications of the wheelbase: parcel delivery, goods delivery, street vendor display, etc. • Adapted to non-asphalted roads, suburban, and rural infrastructures • An efficient vehicle dealer network, to be surveyed and informed	• Type of activities, the rate of tertiary jobs, intensity of exchanges, the network of companies and customers in a defined cluster. These ratios should be assessed and monitored more precisely	• Point of charging

4. Innovative Public Transport

As stated in Deliverable 5.1, "*public transport is a key driver to reduce urban congestion and promote car independent lifestyles. It is a very efficient option in terms of space consumption per traveller and the best answer to mobility needs in densely populated areas*". WP5 aims to select best practices in the field of public transport already implemented in the four project's target regions and investigate as well as report on their planning, implementation and operating processes. The selection leads the identification of five best solutions which deal with measures or policies proven to advance both the level of service and the quality of service of PT systems. They show the need to take into consideration both aspects to maximize the potential of PT systems as a key driver to reduce urban congestion and promote sustainable and car-independent lifestyles.

4.1. Barcelona – New Bus Network

General description

It has been proved that the reorganization of a bus network can improve in a significant way not only the performance of the bus services, but also the operating costs. Generally, the new network design has to reduce the need to travel on an existing radial network, by means of new orbital lines that link directly attraction poles both existing and newly planned outside the city centre. It is based on few lines with few transfers, high frequencies and few stops, and is in line with the hierarchical organization of the bus network, which has to be different in each site depending on local characteristics and needs to be meet.

The solution implemented in the city of Barcelona is the redesign of the bus network to reach a higher connectivity from one end of the city to the other, but capitalizing on the good links from the city centre to the outskirts already existing. The main criteria behind the new design are ease of use and efficiency (i.e. to have a more understandable, effective & efficient bus services capable to reduce travel time and increase PT modal share) but also resource management, since the scheme is based on improving the network without adding many resources. Once fully implemented, PT users will benefit of a more intelligible bus network with shorter waiting times and improved links between modes of transport, all of which makes for a more attractive and sustainable public transport system.

The project was started in 2009 because the city bus network, although highly-valued, was characterized bus some inefficiencies, among them:

- Good connections mainly from the city centre to the outskirts;
- Redundancy of routes, which leads to a less efficient system;
- Need of additional resources to increase patronage;
- "Illogical" layout due to extension or implementation of bus lines according to local needs without a systematic approach.
- Network not up-to-date: when the project started in 2009, no significant changes concerning the bus network layout had been implemented since the establishment of the Integrated Fare System in Barcelona Metropolitan Region (in 2001).

4.2. Singapore – Travel Smart Programme

General description

Travel Demand Management (sometimes referred to as Transport Demand Management or Transport Mobility Management) can be defined as the application of strategies to reduce demand on the road or public transport network by redistributing journeys over time to other modes/routes or remove the journey altogether, e.g., encouraging people to work from home. When we focus on public transport systems, the main goal is to shift commuters to off-peak periods or to encourage a switch to other modes complementary to public transport (e.g. car-pooling, car sharing, walking and cycling) in order to reduce crowding, optimise public transport capacity and ultimately increase the passengers' level of comfort and the related perception of quality of the public transport system.

Travel Demand Management (TDM) is based on 'soft' measures that generally include engagement, marketing and information provision which complement and reinforce infrastructural measures to enhance the PT network. Therefore TDM is often used to maximise the potential impact of infrastructures measures.

The Land Transport Authority (LTA) of Singapore launched in 2012 the Travel Smart programme as a two-year pilot that involved 12 organisations (BP Singapore, CapitaLand, Citi Singapore, Ernst & Young, IBM Singapore, JTC Corporation, KPMG Singapore, Public Service Division, Rajah & Tann, SPRING Singapore, Urban Redevelopment Authority and LTA itself). The pilot was designed to reduce the heavy congestion on the Mass Rapid Transit, the rapid transit forming the major component of the railway system in Singapore, during morning peak period and result in more comfortable and smooth journey for everyone.

Travel Smart is based on the concept of travel planning, which is widely implemented by companies worldwide. Essentially, travel planning is a means of evaluating how the employees of an organisation currently travel to work, or during the day as part of their work, and identify measures to influence the travel behaviours towards more sustainable patterns.

The 12 organisations which joined the LTA pilot implemented several measures; accordingly they can be grouped in three categories as shown in Table 3. The pilot was successful and totalize about a 12% of employees shifting out of the morning peak hour (8.30am-9:00am). The most significant shift was registered within the organisations grouped within category A (≈23% shift), followed by the organisations who decided to review the internal working-from-home rules and implement FlexTime arrangements to support employees who may want to travel D5.1 Best Solution report on Global Innovative PT during off-peak periods (≈10% shift). A more qualitative evaluation of the pilot shown a greater awareness of LTA travel demand management initiatives within the pilot organisations and a good acceptance of the measures among the staff which made register an overall improved staff wellness and productivity.

4.3. Brazilian Cities – Bus Rapid Transit Systems

General description

Cities often host large events, such as sport competitions, concerts, cultural festivals, demonstrations, religious pilgrimages and business conventions. Large events require major changes to the transport organisation of the host city since the existing transport infrastructure needs to cope with considerable additional traffic flows that are very intense and highly polarized. To give an idea of the potential impact of a large event on the host city, in terms of extraordinary additional transport demand, the Summer Olympic Games hosted in 2012, 2008 and 2004, respectively in London, Beijing and Athens, registered a daily attendance between 550.000 and 750.000 people.

Common to all cities hosting large events is the need for planning and implementing exceptional measures studied to satisfy the expectation and minimize operational risks, giving to the transport sector a crucial role for the success. The main challenges for the whole transport system are to manage considerable additional traffic flows with fully accessible, efficient, comfortable transport services for all users category and to cover the day by day transport demand without getting into conflict with the event, as well as to respect or improve environment quality and to promote a more sustainable mobility for the future.

To reach these goals, temporary transport services designed for the "event's clients" need to be set up but, at the same time, the permanent city transport system has to be re-enforced by implementing new transport services or adding new lines to the existing network of the host city. As a matter of fact, hosting a large event can be the opportunity for a city to accelerate the implementation of transport projects by making additional resources available for structural development.

In Brazil, 9 of the 12 cities (Belo Horizonte, Rio de Janeiro, Porto Alegre, Curitiba, Natal, Fortaleza, Recife, Salvador and Manaus) selected to host sport events in the frame of FIFA World Cup in 2014, chose to introduce or further develop BRT systems to ensure a high capacity public transport service. The BRT systems planned for the Word Cup were mainly committed to allow football fans easy access to the stadia from the city centre; for example, in Belo Horizonte where the system is in place since March 2014, getting to the World Cup via BRT takes approximately 20 minutes, whereas travelling via car takes approximately 1 hour and 30 minutes. In Rio de Janeiro, two BRT corridors are already operational, with two more expected to be completed by the 2016 Olympic Games.

Bus Rapid Transit (BRT) is a mass transit system with the flexibility of buses, and the speed, comfort and reliability of rail. BRT systems circulate on exclusive lanes with special attributes, such as multiple positions of stops at stations, the possibility of overtaking, level boarding, universal accessibility, capacitive vehicles, payment and control outside the bus, good spaces at stations and information systems for users. Moreover BRT are normally integrated with land use policies in order to substantially upgrade the bus system performance. Benefits of such a system are reflected in the fluidity and high average commercial speed of operations, and therefore the improved quality of the journey, which is more comfortable, reliable and efficient and also cleaner and safer from an environmental point of view.

4.4. Madrid – Public Transport Interchanges Plan

General description

Transport interchanges are a crucial part of each public transport system, allowing travellers to make multi-leg trips both comfortably and pleasantly. Madrid is one of 17 autonomous regions of Spain, formed up by 179 municipalities, with 6.5 mill inhabitants (3.5 mill inhabitants only in Madrid city) in an area of 8,030 km^2. The backbone of the metropolitan transport system is the Madrid metro, which is complemented by the urban and metropolitan bus network as well as suburban railway and Light rail.

Since the mid '90s there has been an important change in the concept of public transport in the city of Madrid, replacing above-ground bus terminals with underground interchange infrastructures with exclusive tunnels for the buses. Such an ambitious plan, Madrid Transport Interchanges Plan (2004 - 2008), aimed at finalizing the unification process between the interchange points of the metropolitan transport services and the Circular Metro line, which provides interchanges with all the other metro lines 9expcet line 12).

With the adequate construction and improvement of the interchange stations, an effective modal interchange network has been organized all around Madrid in relation to the 7 important highways that connect the region with the city. At present 5 interchanges have been built up in the nodes where the main road infrastructures are linked to the Circular metro line, namely Moncloa, Prinicipe Pio, PLaza ELíptica, Avenida de America and PLaza CastiLLa.

These interchanges are big-sized infrastructures which act as access gateways to the city public transport system, optimizing the transfer between different transport modes (e.g. high speed rail, long distance rail and commuter railway, with the metro network and city and intercity buses) with extremely good conditions of safety and accessibility.

A step forward has been taken to improve the Level of modal integration within the municipal area by developing complementary smaller interchange infrastructures called "Intermodal areas" (e.g. Canillejas). These intermodal areas have less restrictive construction requirements than the big-sized transport interchanges and provides solutions to make easier and faster the transfers between mainly urban bus and metro Lines.

Overall, the Madrid Transport Interchanges Plan achieved a significant improvement in the quality of the transfer as well as in the quality of the whole metropolitan public transport service which experienced an important increase in demand. Location within the city, integration with the public transport system and concentration of terminals are the three core elements of the Plan. The interchanges nodes have been design according to the following functional requirements to meet users and stakeholders' needs:

- To act as points of confluence for the radial bus Lines that enter the urban area of Madrid and at the same time as access gateways for the Metro and urban bus network;
- To reduce the journey times and improve the quality of the service;

- To create nodes that simplify the conditions of transfer: shorter time and distances when transferring between modes (either public or private, motorised or non-motorised);
- To reduce the costs of exploitation of the transport services and allow an increase in the journey frequencies.

All in all, the Madrid Transport Interchanges Plan is an extremely ambitious plan which has developed a network of interchange stations that today can move more than 1 million users per day and manage the passenger flows accessing the city from all its main entries.

4.5. Rome – Integrated Mobile Ticketing System

General description

Over the last two decades the city of Rome has undergone a significant urban sprawl, with the population which has gradually moved to the outskirts of the city and, in many cases, even in the hinterland municipalities. The causes (high living costs and the housing shortage) have come to target urban areas for working versus using the peripheral areas and the municipalities adjacent to more properly residential uses. In fact, the average distances of systematic trips home-work have increased with the resulting amplification of congestion on the roads toward Rome.

Another phenomenon related to the Roman mobility, is the continued growth of the vehicle fleet, which in 2012 reached the target of 2.5 million vehicles, with a motorization rate of the entire vehicle fleet of 856 vehicles per 1,000 inhabitants, the highest among the main Italian towns. The use of private vehicles is prevalent and accounts for the 65% of the urban modal split, while public transport reaches almost the 28%.

The mobility system of Rome is run by ATAC which, with nearly 12,000 employees, is one of the largest public transport companies currently operating in Europe (the first in Italy). The company serves Rome Capital (approximately an area of 1,300 square kilometers and a catchment area of nearly 3 million people) and in 2012 produced 161 million vehicle kilometers, with more than 2,400 vehicles, including buses, trolley buses, trams, subway trains and underground railways. In addition to public transport and parking, the mobility supply in recent years has been enriched with additional services such as tourist transport and rental (car-sharing, bike-sharing). The surface transport operated by ATAC is based on 320 lines operated by bus, among which 4 are served by electric buses, 1 trolley bus line and 6 tram lines 4 for a total network length of over 3,600 kilometers.

The Rome Metro network opened in 1955, making it the oldest in the country. The Metro comprises three lines which operate on 60.0 kilometres of route, serving 73 stations. The oldest lines in the system, Lines A and B, form an X shape by intersecting at Termini Station, the main city train station. Line C opened in 2014 and it is not yet connected to the rest of the Metro network. Plans have also been announced for a fourth line. Rome's local transport provider, ATAC, operates the Rome Metro and several interurban rail services.

ATAC is also the parking service provider in Rome. The parking payment scheme throughout the municipality is active in the areas of the city that can be defined, for population density and land use (mixed commercial and residential), high urban significance and therefore characterized by particular traffic patterns and parking behaviours. The parking payment scheme is one of the main tools of mobility demand management applied in city areas served by public transport. Currently, 76,048 parking lots are charged and 18,204 are free of charge with a 3-hour limit for non-residents. On-street parking is subject to payment of an hourly rate that differs between internal and external areas to the LTZ (limited traffic zone) of the historical center, but also special rates are provided for short stays, for daily and monthly parking. It is well-known that the opportunity to ease inter-modality between public and private modes depends also on the availability of exchange parking located at the outer perimeter of urban areas.

In this context, the electronic ticketing system of Lazio Region provides a fare integration between 3 operators, i.e. ATAC, Cotral5 and Trenitalia6, since 2000. Although the system evolved over time, it is mainly based on magnetic cards and with different coverage levels of service in the various provinces of Lazio.

In the second half of 2015 a new service called BIPiù has been launched in Rome. The new service allows the purchase of "dematerialized" bus and metro tickets via smartphones.

4.6. Summary

Table 5: Assessment of Innovative PT Solutions

Solutions	Key Success Factors	Key Enablers	Key Barriers
Barcelona new bus network	• Maximum connectivity • High frequency routes • Only one route per corridor • Reasonable distance between stops • 90% of journeys can be made with 0-1 transfers	• The provision of priority for buses • Integration of PT modes (e.g. metro, tram, suburban rail)	• Lack of funding • Lack of cooperation between jurisdictions or stakeholders • Lack of support (especially political) to implement priority measures
Singapore Travel Smart	• Initiatives able to meet the needs of different target groups	• Awareness • Marketing campaigns	• Lack of awareness of Travel Demand Management. • Need to quantify the potential benefits • Lack of TDM experience

Brazil Bus Rapid Transit	• High performance, and quality • Low cost	• Meet the users' needs • Flexibility for future capacity	• Low passengers' comfort due to overcrowding • Lack of Integration with soft modes • Lack of integration with the traditional bus services
Madrid Public Transport Interchanges Plan	• Location and urban integration • Integration of different modes and mobility demands • Reduce transfer time • Information and signalling • Quality of waiting areas and environment • Accessibility • Additional services • Operating needs • Interchange management and operation • Safety and security	Cooperation between all relevant stakeholders (including city council, administrations, public transport authority and transport operators)	• Integration of the transport interchanges within the already-consolidated city plan • Numerous contracts and agreements with various authorities and privates • Viability of funding • Lack of dedicated regulations
Italy integrated mobile ticketing system	• Multichannel and interoperable technological platform supporting development in a Smart Territory • A suite of evolved and innovative services for businesses, characterized by easy and prompt access for citizens	• Mobile payment offered by the service • A single sign on the service • Efficient and effective processes • Willingness and commitment of city authorities and transport operators	• Lack of standardisation and interoperability among transportation related services • Lack of stakeholders collaboration • Usability • Security • Consumer mind-set

5. Innovative Infrastructure

This WP analysed a number of examples of innovative infrastructure in Europe, China, Singapore and Latin America are analysed and assessed using the methodology developed in WP2. Those examples were selected either because of their innovative nature, effectiveness or transferability. This benchmarking assessment exercise aims to provide information about best practice solutions in innovative infrastructure to policy makers and city planners to find the most suitable solutions of sustainable urban mobility for their own cities.

Soft transport modes, mainly cycling and walking, are considered as potential substitutes of the private car in urban areas. A wide diversity of infrastructure supporting soft transport modes can be found in Europe. A good example is the significant difference of implementation of cycling lanes in the Netherland and in Germany, i.e. wide spread of cycling lanes in Netherland and minimal use in Germany. The difference is highly associated with the culture in a country. However, attitude towards more sustainable mobility has been the main stream in Europe in which soft modes play an important role. For example, in Germany, the federal government granted 2% of the total highways budget for expanding cycling network with aims of doubling its cycling network within 10 year time. This changing attitude has also been seen in emerging market countries, where only few years ago people still considered cars as the symbol of social status. This report introduces an innovative and unique cycling lane scheme in São Paulo, Brazil. European cities and cities in other regions may consider to learn from São Paulo and to implement such scheme in their own cities

5.1. Sao Paulo – Flexible Cycling Facilities

General description

São Paulo massively expanded its cycling network since 2009 and implemented exclusive bus lanes. Through improvement of infrastructure for cycling and public transport, São Paulo local authorities aim at increasing share of usage of both cycling and public transport in the urban mobility in the city, in order to reduce congestion, increase efficiency of the transport network and reduce air pollution and noise.

São Paulo has applied an innovative approach to allow flexible use of road space. The approach is called “Leisure Operating Cycling lane” (also called Operational Bike Lane) which converts middle or left lanes on roads into cycling lanes on Sunday and national holidays from 7:00 to 16:00 with vertical and horizontal signs indicating the use as shown below. Such cycling lanes are totally separated from general traffic by pipeline elements such as cones, easels. Currently 120.8 km of roads are converted into Leisure Cycling Lanes every Sunday, and more the 120,000 people use the infrastructure on Sunday. The cycling lanes are dedicated to cyclists only without sharing with motorised traffic and pedestrians in order to maximise the traffic safety and provide a good experience to cyclists.

The first Leisure Cycling Lane was implemented in 2009, with approximately 5 km connecting the Ibirapuera and the Povo Parks. The operation was restricted to Sunday,

from 7:00 – 12:00. It was funded by the private bank Bradesco through a cooperation agreement renewed every year. As a counterpart, the financial institution was allowed to display their brand on the cones, on stands and bicycles available for rental.

The first Operational Bike Lane was a major success. This led to the creation of new routes in 2011 and in 2012, reaching up to 19.5 km and 59.5 km respectively. The success also led to an extension of the operation hours until 16:00 and inclusion of national holidays alongside Sundays since 2014.

5.2. Shanghai – Hongqiao Interchange

General description

A multimodal interchange is a place where travellers can change between different transport modes. An interchange can be a hub for the local transport of a city, e.g. a metro and bus interchange, or a hub to connect long haul travel with the local transport, e.g. an airport railway station. In this report, the focus is on multimodal interchanges connecting interurban and urban local transport modes.

In Europe, some major multimodal interchanges have been playing a vital role in business and leisure travel in Europe. Such interchanges are used by millions of Europeans and International travellers who often begin their travel in Europe there. Charles De Gaulle Airport of Paris and Frankfurt Airport are good examples of such multimodal interchanges. Both airports have railway stations for high speed trains and local trains. They also connect to the city's network through metro and buses. Because of the connection to railway stations, Air France and Lufthansa are able to offer air tickets for combined train and flight journeys.

Multimodal interchange in China

Until very recently, the concept of multimodal interchanges was not widely applied in emerging market countries. As the first generation of private car owners, people often consider using private cars as a privilege and see public transport as the means of transport of 'poor people'. However, in China, two decades of fast growth of levels of private car ownership, resulting in severe levels of congestion and air pollution, have forced the government to reshape their transport policy. The transport policy has been gradually shifted, particularly in big cities, from purchase incentive of private cars which was to sustain the growth of the internal market to encourage the use of public transport. Moreover, China has the ambition to become the global leader of high speed train technology and networks, and its high speed network has been expanded rapidly. In order to facilitate seamless transfer from high speed railway stations to the destination's urban network, multimodal interchanges are essential to meet such high demand, particularly in major cities. Hongqiao interchange is the first comprehensive interchange in China which connects airport, high speed train, local train and the urban transport network.

Shanghai Hongqiao Interchange

Hongqiao Interchange has been in operation since March 2010. The Interchange is currently the biggest interchange and one of the most intermodal changes in the world. It connects airport (two terminals), railway station for high speed and regional trains (with

40 railway tracks), coach station, metro (2 lines), local buses and 4 motorways. The interchange is used by 580,000 people per day (or 212 million per year). The two metro lines (Line 2 and Line 10) carry about 14.4% of passengers of the Shanghai metro network. There are three metro stops within the interchange: Terminal 1, Terminal 2 and Railway station. It also includes a station for future maglev trains even though the project of building maglev to Hongqiao has been temporarily suspended due to growing concerns on investment, environment, land use and safety. The interchange consists of five layers to connect different modes:

- Level B2 (16 m below ground): metro platforms;
- Level B1 (9 m below ground): underground exchange halls and corridors to connect metro, intercity train and high speed train platforms and the airport;
- Level 0: bus stops, coach stations, high speed train platforms and airport arrival halls;
- Level 1 (9 m above ground): above ground exchange halls and corridors to connect the stations, airports and public car parks;
- Level 2 (16 m above ground): maglev stations (planned), airport departure hall and connecting to motorways.

The interchange has significantly improved efficiency of access to the airport and to the railway stations and enabled air and rail passengers to connect local transport network smoothly, thus increasing comfort levels for passengers. It has also improved inter-modality for goods, thus enhancing the competitiveness of the city and the surrounding region.

5.3. Bordeaux – APS Tram

General description

The first tram network using ground level power supply, also called Alimentation par le sol (APS), started operation in Bordeaux (France) in 2003. The city centre of Bordeaux is UNESCO World Heritage for its architecture. APS trams without any overhead lines preserve the beauty of Bordeaux historical city centre while providing efficient and environmentally friendly transport solutions to the city.

The modern tram lines in Bordeaux came into operation in 2003 even though the city's tramways are dated from 1880, when the system was based on cars towed by horses. Soon after the Second World War, Bordeaux and many cities in Europe and US considered trams as an old fashioned means of transport compared to buses. Therefore, the tram services were reduced and eventually, completely terminated in 1958. In the 1970s, Bordeaux had been suffering from high congestion and pollution due to car-dominated traffic. Since mid-1990s, a program of regeneration of the historic city centre of Bordeaux had reconnected the city with its rich cultural heritages. The regeneration program included converted car parks on the left bank of the Garonne to be pedestrian walkways and reduced car traffic by introducing tram lines through the city centre. The following photo shows the city centres before and after the regeneration.

The changes have successfully transformed the quality of the city as a place to live, work and visit. The dirty, car dominated city centre has been made attractive and accessible

through the urban tram system together with pedestrian facilities. The regenerated historic city centre has created a world-class environment that is attracting not only tourists but also business and investments. To preserve the beauty of the historic city centre, the APS trams are used in the section through the city centre. APS trams are powered by surface level electricity supply without any overhead lines. In the other sections of the network, normal overhead lines are used to power trams since APS infrastructure is rather expensive. APS uses a third rail placed between the running rails, divided electrically into ten-metre rail segments with three-meter neutral sections in between[7]. Each tram has two power "collector shoes", next to which are antennas that send radio signals to energise the power rail segments as the tram passes over them. Two consecutive segments under the tram will be live at once.

5.4. Guangzhou – Supercapacitors Tram

General Description Guangzhou is the third-largest Chinese city and the largest city in South Central China, with a population of approximately 12.7 million. Guangzhou has a huge public transport system to provide accessibility for all in this megacity, which includes the second largest BRT system in the world and a 9-line metro system with a total route length of over 260km (which by 2020 will reach over 500km). In 2014, the city's first tram line was built – the 7.7 km 11-station Haizhu Line between Canton Tower and Wanshengwei. This line, Tram Haizhu 1 (THZ1), is operated using seven 100% low-floor trams, each with four sections and a total capacity of 360, and is shown in Figure 4. Trams are capable of a maximum speed of 70 km/h, a maximum gradient of 60% and a minimum curve radius of 25 m[8].

The tram is completely powered by supercapacitors installed on-board, negating the need for a continuous power source above or beneath the tram line. Instead, these supercapacitors can be automatically charged from a ground-level power supply at each station (which takes between 20-30 seconds, depending on the initial state of charge) and can provide sufficient energy to allow for 4km of operation. The distance can vary by ± 1km depending on additional characteristics (loading, gradients, track adhesion etc). According to China South Locomotive & Rollin Stock Corporation (CSR) Zhuzhou, the manufacturer of the trams, the braking energy recovery efficiency is more than 85%. Mobile charging vehicles are to be used in case of faults at the charging points.

5.5. Hong Kong – Rail-Property Approach

General description

Financing public transport includes capital investment and operation cost. Capital investment is for construction of transport infrastructure such as metro lines, metro

[7] BRENDAN FINN, ETTS LTD., 2012, "Tram system in Bordeaux: Report on the tram system and underground power supply (APS) for Dublin City Business Association", available at http://www.dcba.ie/wp-content/uploads/2012/04/Bordeaux-Report-07.12.07.pdf

[8] Rail Gazette, 2014, Guangzhou supercapacitor tram unveiled, available at http://www.railwaygazette.com/news/urban/single-view/view/guangzhou-supercapacitor-tram-unveiled.html

stations, bus stops and bus lanes, purchase of public transport vehicles, etc. Operation cost is for day-to-day operation such as cost for energy consumption, vehicle maintenance, staff salary, etc. Many cities have taken the opportunities to build and upgrade their public transport infrastructure (e.g. metro, interchanges) when the cities host big events such as Olympics Games. For example, for the Summer Olympics Games 2012, London invested around £6.5bn in transportation. This was mostly in upgrading existing infrastructure and services, such as extension of the Dockland Light Railway (DLR) network for longer unmanned trains and major works at Stratford International Station at the heart of the Olympic Park. For the next Summer Olympics Game in 2016, Rio De Janeiro has been constructing three Bus Rapid Transit (BRT) lines to connect the main areas in the city and international airport. The first BRT line was in operation in 2012 which has significantly reduced travel times.

After construction, public transport is also expensive to run, in order for fares to be kept lower than they would be, public transport often receives substantial government subsidies from national government and/or from cities, particularly in developed countries. In the UK, for example, national subsidies on bus and train in 2012/2013 were £5.4bn. Many developing countries may not be able to provide such subsidies, resulting in poor public transport services.

Hong Kong is internationally known for its success on integrated public transport and urban planning. Hong Kong is very dense and suffers from heavy traffic. Hong Kong has been one of the major financial and service hubs in the Far East largely due to its efficient public transport. Its Massive Transit Railway (MTR) consisting of metro, light rail and commuter rail networks carries over 90% of all motorised trips.

Hong Kong is also one of few places in the world where the public transport is profitable. This is due in large part to the integrated "Rail-Property" (R+P) approach. The R+P approach has been considered as a sustainable public transport model that combines finance and urbanism. The main railway operator in Hong Kong, MTRC, indicates that it operates on commercial principles, financing and operating railway services that are not only self-supporting but also that generate a net return of investment. Property development has been the main tool for generating revenues that cover the cost of constructing railways and improvements, operations and maintenance.

Since Hong Kong has high density and hugely congested, land near railway stations is highly valued. MTRC does not receive any government subsidies but it received contribution from the government by the exclusive development rights for the land above and adjacent to its stations. The public transport agency takes this advantage to develop and manage properties above and adjacent to railway stations to provide good quality of living and work environment along the railway lines.

As indicated in the Mission Statement of MTRC's property division, value-capture is not only self-supporting but also creates high-quality, viable communities and enhances station-area environment. Most R+P projects connected passenger corridors and in-station retailers. Such approach creates synergies by enabling public transport users to enjoy surrounding environment and take care of personal needs while also generating retail sales revenues. In some instances, shops generate new public-transit trips by

functioning as rail-served destinations. Typically, convenience retail built as part of R+P projects is placed near station entrances or along sheltered walkways. This not only avoids the cluttering of retail and rail-related functions within stations, but also allows one-stop shopping in temperature-controlled settings, which is particularly valued as weather in Hong Kong is often hot and humid. Tung Chung's 24-hour station area retail and brightly lit footbridge network also brings a sense of security. Below the photo compares a station with R+P and a station without R+P where there are only blank passageways provisions creating a less attractive, less secure and less convenient experience.

5.6. Summary

Table 6: Assessment of Innovative Infrastructure Solutions

Solutions	Key Success Factors	Key Enablers	Key Barriers
Flexible Cycling Facilities in São Paulo	• Severe congestion in the city • General political direction towards more sustainable transport solutions	• High-level political support • Support and acceptance from the public	• Lack of political support and technical expertise • Involvement of local users
Interchanges to support multimodality	• Information service to enable passengers to make informed decisions on choice of modes and to find the modes they need • Meet increased demand in the future and connectivity with more transport modes	• Plan the interchange as a part of infrastructure to support the high demand	• Unpopularity of the interchanges by local residents • Lack of public consultation • Lack of environmental assessment of the infrastructure development
Tram with ground-level power supply and battery	• No need of overhead contact lines • Political drive • Powered solely by supercapacitors	• Support from local politicians and corresponding investment in the public transport systems • Availability of technologies • Mobile charging	• High costs

		stations	
Innovative financing public transport	Fast growing of the Hong Kong in the late 1990s which has brought property market boom and rapid increase in demand of good quality of office and living spaces	Highly dense population and a viable property market	Needs proper city land use law in place to allow public administration to reserve the land for railway companies

6. Urban logistics

The selection of fourteen urban logistics solutions is made in WP7 to illustrate innovative and energy-efficient urban logistics developments in Europe (Gothenburg, London, Paris, and Utrecht), China (Shanghai), and Singapore (Singapore).

6.1. Gothenburg – City Logistics Solutions

General description

Gothenburg is the second largest city in Sweden by population, and situated on the west coast of Sweden. The city has approximately 540,000 inhabitants, the metropolitan area around 800,000 inhabitants and a surface of approx. 2,400 km^2.

The main industries include shipping since Gothenburg is the major harbour in Scandinavia. Trade, logistics have been important since the city was founded 400-years ago when the East-Indian-Company was in operation. Today pharmaceutical, biotechnical and automotive industries are of key importance for the city. Gothenburg hosts the headquarters and factories of both Volvo Group (Trucks and Buses) and Volvo Cars.

In the past decades, the city has been one of the main pilot sites for many national and European R&D projects and has developed and implemented many innovative transport solutions for freight and logistics.

The increasing congestion in Gothenburg is not only a problem to the environment but also for the logistics sector. Hence three solutions for innovative urban distribution have been included in this report; Stadsleveransen, Collaborative city distribution and the Micro terminal.

Stadsleveransen solution

One implemented solution is the City Delivery called “Stadsleveransen” an example of last-mile logistics solution where small deliveries are consolidated and distributed with zero emission vehicles in the city centre. Stadsleveransen is a goods consolidation service, which receives packages to the inner city in Gothenburg and performs consolidated last mile deliveries with electric vehicles. Stadsleveransen also picks up outgoing goods from the businesses in the city centre, source (Bestfact Gothenburg City Logistics Initiatives)

This solution consists of

- Common goods reception for small and midsize shops in the city centre
- Reception check and consolidation of goods
- Delivery to shops according to time schedule
- Trained personnel managing the reception/registration and the deliveries
- Free participation for a limited number of shops

From the perspective of the city this solution has resulted in a reduction of heavy traffic in the area and shorter time periods for unloading/loading by heavy traffic, leading to reductions in congestion and inner city area noise level. At present, Stadsleveransen

receives 300-400 packages daily at the consolidation terminal near the city centre, which is then consolidated and delivered by two electric distribution cars, and two cargo bikes. Almost 400 companies receive goods from Stadsleveransen. The long term future aim is to consolidate all small volume deliveries that arrive to the city centre during daytime. Larger shipments arrive generally before office hours early in the morning in fully loaded trucks, and there are no significant potential benefits for consolidation these volumes. Stadsleveransen has almost eliminated the emissions from the last mile distribution of the goods handled by the service, and the driving distances in the area has been cut by approximately 50%. There are also significant improvements regarding the handling time for the goods.

Climate smart city distribution solution (KNEG)

To secure a vibrant inner city there is a need for efficient freight transports to the city centre stores to compete with the shopping centres in the city outskirts, yet reducing emissions from the transport sector. Hence a collaborative city distribution has been developed, aiming at halving the emissions from the transport sector until 2020. The initiative has expanded to a larger project in Gothenburg called 'Climate smart city distribution' (KNEG) that is a triple helix project where the commercial, authorities and academia actors works together. Collaborative city distribution solution increases transport efficiency, filling-rates improved economic result and lower environmental impact. The solution is provided by DB-Schenker and the fleet operator TGM and involves 100 vehicles involved through one of northern Europe's largest logistics terminals.

The smart logistics solution means packages that ride with "public transport" and optimize routes in city centres through better coordination of parcels and heavy goods.

Micro terminal solution

The local distribution at the Lindholmen Science Park (www.lindholmen.se) has been organised in a micro-terminal concept to minimise the goods transportation and reduce number of vehicles. Fourteen different organisations (mainly education organisations) have been connected to the terminal and share the logistics resources. The micro-terminal has been in operation handling goods receiving, distribution and waste management since June 2008. It has been handling mail since December 2008 and has been in full commercial operation since 2011.

Common for the three solutions is the City of Gothenburg as the authority and the users in the commercial centres in the city. There are also several industrial actors from the transport sector such as DB Schenker and Volvo Group and from the academia in Chalmers University of technology and Gothenburg University.

In common is also the intermediary neutral actor Lindholmen Science Park that operates as a knowledge environment space hosting 350 companies with an international perspective. Its mission is to attract the highest number as possible of companies, students, business, to provide an open innovation environment, the Open Arena Lindholmen. The concept of the Open Arena is to facilitate the collaboration in the 3 aspects i.e. Transport, ICT and Media, between the 21,000 people working for companies

hosted by LSP. The science park is dedicated to research and development in mobile communication, intelligent vehicles and transports systems, and modern media industry. Currently the biggest companies are Volvo Cars, Volvo Technology, Ericsson, IBM, Semcon, and SVT. The main operators of Lindholmen Science Park are Gothenburg Municipality, Chalmers University of Technology, the University of Gothenburg, Volvo Group, Ericsson, Volvo Cars, Business Region Göteborg, TeliaSonera, Saab, and the Swedish Road Administration.

6.2. London – Urban Logistics Solutions

General description

There are a number of well-known successful urban logistics interventions in Britain and most obviously in London as the capital city of UK with long history of transportation development to sustain population and economic growth. By the mid-2020s London's population will grow to approximately 9.5 million and over 5 million jobs (Wainwright 2015). For London, the importance of urban economy and urban lifestyle have attracted attention of a number of city stakeholders (i.e. government at all level, business and industry, citizen, and academia) to understand urban freight transport better than it used to be. This is simply due to the fact that with the population and economic growth, the land use would certainly not grown but has to be shared among people, businesses and beyond, so thus regulated to be in optimal and efficient operation condition. Land use planning is indeed needed to take account of the location of urban logistics activities.

Recent development of the urban freight transport initiatives demonstrates increasing efforts of embedding sustainability context to improving economic, social and environmental impact of urban freight activities. The last national funded research in the UK that looked at the sustainability strategies for city logistics concluded three most prominent initiatives that are being commonly used UK (notably centred around London experience as the main economic capital of Europe) and beyond (source: Allen & Browne 2010):

- Urban Consolidation Centres;
- Joint working between the public and private sectors; and
- Environmental Zones.

In London, the three initiatives above are being successfully implemented. Next, the section focusses on the recent development of urban freight management in London that has been subsequently implemented and included in London Freight Plan (Transport for London 2007). Within the Plan document, three initiatives were promoted:

- Fleet Operator Recognition Scheme (FORS);
- Delivery and Servicing Plans; and
- Construction Logistics Plans.

Fleet Operator Recognition Scheme (FORS)

FORS is a membership scheme that is free of charge to any company operating vans or lorries in London; it provides operators with practical advice and guidance to help reduce fuel consumption, CO2 emissions, vehicle collisions and penalty charges. FORS aims to

improve driver behaviour, vehicle and fleet management and safety and efficiency in transport operations. The programme is delivered through company training, workshops and electronic guides and tools.

Delivery and Servicing Plans (DSP)

DSPs were intended to provide a framework to better manage all types of freight vehicle movement to and from individual buildings. In recent time, this definition has broadened into a large organisation with multi-site buildings, as individual buildings operation management is not necessarily typical of a large organisation policy. The DSP strategy is centred on the receiver within the supply chain, as opposed to traditional urban freight intervention strategies that have focused on the transport operator. It is a management and organisation of multiple operations of last mile deliveries that can be optimised by efficient freight planning in an organisation. Despite its novelty, DSP application is still at the trial level with limited known of its use, especially with regards to real business conditions.

Construction Logistics and Cyclist Safety (CLOCS)

The 2007 TfL freight report introduced the successful use of consolidation centre for construction to serve four major construction sites in the City of London between 2005 And 2007 to reduce the number of deliveries going directly to the construction sites and thereby reducing traffic congestion and vehicle emissions. Consolidating goods at the London Construction Consolidation Centre eliminated the use of Heavy Goods Vehicle (HGV) or articulated goods vehicles for site delivery and significantly reduced the use of vans as well documented in City Logistics handbook for Authorities.

In recent times, issues have arisen from the increasing accident rate for cyclists in London from HGVs have been highlighted. The construction logistics industry responded with the formation of Construction Logistics and Cyclist Safety (CLOCS) (www.clocs.org.uk). CLOCS can be seen as a standard for construction logistics developed by industry to guide work related road risk in contracts, and providing toolkit to promote safety for HGV.

Ideally, each of the above solution should be given detail description and credit for supporting city logistics solutions in London. But, due to size limitation in this particular section, we would report particularly on Fleet Operator Recognition Scheme (FORS). This is also applies to the following section 5.4 and 5.5 respectively. FORS users are Freight Transport Operators (mainly in London).

6.3. Paris – Urban logistics Solutions

General Description

The City of Paris covers an area of 105 km² and has a population of 2.2 million inhabitants. It is part of the Ile-de-France region which covers 12,000 km², and has 11.8 million inhabitants. Paris has a strong reputation for its innovative solutions concerning urban freight transport and logistics. Three such solutions are covered in this section:

- Logistics in the Paris land use master plan

- Distripolis: urban consolidation centres and battery-electric vehicles for last-mile deliveries
- The Monoprix intermodal rail project

Logistics in the Paris land use master plan

Paris has a history of including freight transport and logistics in master planning. One example of such inclusion is the Plan Local d'Urbanisme (PLU) (Land Use Master Plan of the City of Paris) made in 2006. Amongst other measures, the PLU identified specific spaces to be reserved for logistics areas accessible by rail or waterways, creating land-use areas called UGSU areas (zone Urbaine de Grands Services Urbains (Urban Zones for Large Urban Services).

Distripolis

The Distripolis concept combines urban consolidation centres and battery-electric vehicles for last-mile deliveries. To the two regular links in the supply chain – grouped shipments to warehouses and deliveries by truck or light vehicle to towns – Distripolis adds a third link: logistics bases located in cities, from which vehicles adapted to final-kilometre logistics make deliveries.

Geodis' Distripolis urban logistics programme is made up of:

- Grouped shipments to a platform in the city (Bercy platform in Paris);
- "BLUE" Environmental Urban Bases, located in the city close to the main retail districts (eight in Paris), that are supplied several times a day by Euro 5-compliant trucks and, in the long-term, Euro 6-compliant or hybrid trucks with a gross vehicle weight of more than 12t;
- Deliveries from the BLUE bases for parcels and pallets weighing less than 200 kg by ecological vehicles adapted to final-kilometre deliveries, namely electric light vehicles and power-assisted tricycles;
- Deliveries from the platform for goods of over 200 kg by Euro 5-compliant vehicles and, in the long-term, Euro 6-compliant or hybrid vehicles.

Distripolis uses the equipment and systems that are best suited to optimising energy consumption, limiting pollution and reducing disturbances. For the final kilometre, and from the BLUE bases, Distripolis uses clean and quiet vehicles and equipment: "Electron" electric light commercial vehicles with a load volume of 20 cubic metres, power-assisted tricycles, and electric pallet trucks boasting silent operation.

Monoprix Rail Project

The Monoprix project provides an example of best practice concerning the use of intermodal solutions for urban logistics involving rail. Since 2007 Monoprix, a major French retailer, has reduced its reliance on lorry deliveries and has been dispatching goods to its stores in Paris using trains and Liquefied Natural Gas (LNG) vehicles for last-mile deliveries. This sustainable multimodal solution – which involved renovating a platform at a city centre train station – has resulted in significant reductions in CO2 and NOx emissions, reduced the need for warehouse space and generated a positive public 'green' image for the retailer. The increased knowledge and experience in the field of

multimodal transport and logistics, meanwhile, could also be a competitive advantage for Monoprix in the event of France's controversial eco-taxes being introduced.

The high demand for freight in the Paris area poses a big challenge and it is crucial to ensure an efficient and sustainable distribution of goods. Even though the city is at the centre of the radial structure of the French railway network, the share of rail freight transport is very low: in the Île de France region, the share of road transport is as high as 90 per cent and almost 100 per cent in the last mile. The increasing traffic congestion and the negative impacts caused by road transport have mobilised authorities to define measures for sustainable logistics. In 2002 a team composed of relevant stakeholders developed an urban logistics and sustainable mobility programme. In 2006, 47 partners including logistics companies, railway and waterborne transport operators, suppliers and retailers drew up a charter of best practice on transport and distribution of goods in Paris to enhance the sustainability of transport and distribution activities.

6.4. Shanghai – Urban Logistics Solutions

General Description

Shanghai is located by the Yangtze River, close to the East China Sea extending 120 km from north to south and 100 km east to west, the city covers an area of over 6,340 square kilometres, about 0.06% of the national territory. Except for a few hills lying in the southwest corner, most parts of Shanghai are flat and belong to the alluvial plain of the Yangtze River Delta. As the centre of finance and trade, Shanghai registers the highest GDP in the China.

Shanghai has 17 districts and 1 county. The downtown area is consisted of District 1-9 in the following map, while the rest are suburbs. However, the downtown area has become too crowded for the rapid growing population. The population of the city is 25 million registered as living in shanghai. In the core centre of Shanghai, there are three expressway circles: Inner Ring road, Central Ring and Outer Ring road. Ring roads are closed expressways (rural highway) basically with no traffic signals and no non-motor vehicles and pedestrians are allowed. The speed can be up to 80km/h-100km/h but the ring roads are frequently very congested.

The Shanghai government is increasing the number of regulatory measures to handle the increasing congestion, environmental pollution and safety issues through limiting the number of trucks into restricted city regions. The Shanghai government has been studying European cities and one measure is to increase the usage of vans the city replacing the larger trucks. Shanghai shows the best performance in China where the distribution is driven by high customer demands on fast deliveries.

There are four main types of delivery operations in Shanghai; Express delivery, regular logistics delivery, special delivery and self-own delivery.

Express delivery refers to quick delivery of small freights (one package less than 50kg), e.g. garments, documents, snacks, items for daily use, small quantity of IT products, etc. Express delivery is usually fast. The rapid growth of E-commerce in China is a strong support to the express delivery industry. According to statistics from the State Post

Bureau, the express delivery volume totalled 540 million pieces during the 6-days Shopping Carnival of e commerce in 2014 (Nov 11-16). In 2014, the total express volume in China reached 13.95 billion pieces, exceeding the USA and becoming the world highest. In Shanghai, 1.28 billion freights were delivered through express companies in 2014. That is each Shanghai resident sent/received 51 pieces on average. The volume increased by 35.1% over last year. The annual revenue of the industry totalled 36.13 billion RMB, up 40.3% over last year.

Regular logistics delivery; according to (incomplete) statistics from the local authorities, there are about 2,000 regular logistics delivery companies operating in Shanghai. The small scale ones only have 1-3 trucks, while large ones own about 40. No authority today keeps the statistics of regular logistics delivery volume, due to the large quantity and variety of cargos. However, according to the estimation of industry experts, the top 5 companies take up 5%~10% of the market. Large logistics companies have their own warehouse and delivery networks. Meanwhile, small ones usually do not have them, and their transportation routes are determined according to customers' needs. In addition, large logistic companies may outsource part of their transportation routes to small companies.

Special logistics delivery companies refer to those which transport special cargos or have specific transport flow. The transportation follows a very sophisticated flow which is beyond handling by normal logistic companies. Such companies have very complicated management systems. They only account for a small proportion in the transportation industry.

Self-owned delivery; In order to avoid the high cost of outsourcing the delivery, small and medium businesses, such as restaurants, hotels and IT stores, usually choose to establish their own fleet of a few vans for delivery and procurement, due to diversified cargo categories, small cargo amount, random destinations and fixed delivery time. Only when their business grows to a certain scale, would they consider outsourcing their delivery.

The Freight Market Solution

The main purpose of the freight market is to link the owner-operator with the transport buyer through a transport agent, often using a cover logistics company. The Freight Market is usually a very large physical distribution centre for trucks. In Shanghai there are two main freight markets Huahuan and Hongbao. In the core of the Freight Market are the booths for the agents and the information screens displaying available shipment details. The freight markets also provide additional services - basic warehouse services, vehicle repair, spare parts restaurants, shops, hotel services, parking facilities and more to support the drivers and small fleet operators.

The key users and stakeholders at the freight market are the; Independent/Employed Drivers, Transport Agents, Logistics Companies, Freight Market and the Authorities.

Driver/Owner operator; can be either independent or employed. The difference is that the independent driver often operates under a cover logistics company and is self-employed. The way of doing business is usually based on a cash payment upon delivery, or when

returning with a signed receipt. Drivers usually run fixed routes hence the need for finding shipment suited for the vehicle.

Transport agent; acts as the intermediate between transport buyers and the drivers and owner operators. The agent posts transport jobs on large screens, charge a fee for exchange of information, bargains and sets up the contract. The relationship between the driver/owner operator and the transport agent is built on trust and experience.

Logistics Companies; is often small or middle-sized and runs fixed lines and have usually offices in the freight markets in the cities where they operate. The company may hire warehouse capacity in the Freight market.

Freight market owner; owns and operates the freight market providing booth for agents, information screens, terminals and other services such as restaurants, printers, computer rooms, showers, warehouses, hotel rooms and apartments. The users at the freight market needs to pay a fee for using the facilities at the freight market.

The authorities; acts in the background provide the for the publicly owned freight market. In this case there is a private freight market operator.

6.5. Singapore – Urban Logistics Solutions

General Description

The World Bank ranked Singapore as the No 1 Logistic Hub in Asia in the 2014 Logistics Performance Index. Singapore as small city-state has generally urbanises at a faster rate (as is common in fast growing cities in Asia) across limited space. While for passenger with its optimum efficiency a transport system can deliver, the issue is beyond the speed; for freight the issue is about optimising land use. Logistics in Singapore can be considered a fragmented market with relatively unregulated industry. Several factors, however, influence the change including: population (demand) density and intensity, higher demands and expectation as e-commerce gains traction, environmental solutions as sustainability ranks higher in public and corporate consciousness, productivity as costs escalate and service levels become more acute, and leveraging analytics as ‘big data’ proliferates. Collaborative urban logistics concept with synchronizing the last mile was proposed to address these challenges.

Vehicle Quota System (VQS)

Despite no significant measures adopted for city logistics in Singapore, reducing reliance on private transport is one of the measures used to control road use in the latest Singapore Land Master Plan. Singapore is maintaining a sustainable growth rate of its vehicle population by the vehicle quota system (VQS) policy since 1990. The VQS works by determining a suitable number of new vehicles allowed for registration annually and subsequently letting the market forces determine the price of ownership via bidding Certificate of Entitlement (COE); and this COE will last for 10 years.

Using VQS, the vehicle growth rate has been kept in tandem with rate of road development; where between 1990 and 2006, the rate was about 1.0% p.a. but rate of 0.5% is projected for the next 15 years. To monitor the operation of the traffic to a level that is efficient and optimal, electronic pricing system (ERP) has been used that capable

to collect charges at operating speed. Additionally, there are a number of smart control systems that manage traffic flow efficiently with 24h monitoring of traffic flow on expressways, major arterials and intersections. It should be noted that Singapore's ERP does not aim at limiting traffic like Road Congestion Charge in London, but rather to optimise speeds in order to maximise traffic flow at congested times.

Retail Precinct Management (RPM)

RPM aims to encourage different stakeholders to collaborate in addressing the issues of traffic congestion that challenges the development of a new growth area, which is the largest regional center development in Singapore. The solution offered is a combination of city logistics measures including consolidation deliveries, optimisation of route, utilising loading docks, providing a dynamic visualization and analytics to help tracking and monitoring the deliveries and traffic flow in the area.

Users and stakeholders

Since the solutions given above via RPM are rather at a pilot level, only a number of stakeholders can be identified who would contribute to the functioning of city logistics solutions:

- Authorities: as enablers are expected to promote policy to reduce city congestion and pollution through city toll and delivery restriction,
- Business owners: as customers are expected to reduce cost with increasing flexibility, speed and service level; and
- Logistics service providers: as partners are expected to optimise collaborative logistics services via adoption innovative solutions to further productivity.

6.6. Utrecht – Urban Logistics solutions

General Description

Utrecht is the Netherlands' fourth largest city and has a population of approximately 330K inhabitants. As TURBLOG (2011) explains, until around the year 2000 there was relatively little coherence in the policy measures of Utrecht in the area of urban freight logistics, with measures being implemented on a singular ad hoc basis (as, arguably, they are implemented in most other cities). However, since 2003 Utrecht has structured its approach to urban logistics in terms of 'policy packaging', by thinking through how the various solutions at its disposal interact with each other and how their introduction can be scheduled for optimum synchronised effect. This section concentrates upon the milieuzone (low emission zone), originally implemented in 2007 and two innovative vehicle delivery solutions. The first of these is the Beer Boat, which was originally implemented in 1996 but has had various adaptations since then, such as the replacement of the original boat by a zero-emission electric boat in 2010. The second is the Cargohopper, introduced in 2009. References giving further information about these solutions are provided at relevant points below, whilst an overview of Utrecht´s approach to urban logistics is given by Browne et al (2012).

Environmental zone (LEZ)

In July 2007 Utrecht introduced an environmental zone (LEZ) in the inner-city of Utrecht, for the area shown in Figure 19. The objective of the environmental zone was to ban lorries that cause heavy pollution from the city centre. Currently, trucks and lorries with a weight greater than 3.5T need to have a Euro 4 engine (or higher) in order to enter the LEZ. Further information about the evolution of the LEZ can be found in SUGAR (2011) and TURBLOG (2011)[9].

Innovative delivery vehicles: Beer Boat and Cargohopper

The City of Utrecht has implemented two highly innovative methods for sustainable delivery vehicles, the Beer Boat and the Cargohopper. Information about these two projects, from ELTIS (2015) is given in Box 3. Further information is available from TURBLOG (2011), Hoetges et al (2012), BESTFACT (2013a and 2013b), CIVITAS MIMOSA (2012) and CIVITAS (2015).

6.7. Summary

Table 7: Urban Logistics Solutions Benchmarked in Viajeo+

City	Solutions	Key Success Factors, Enablers and Barriers
Gothenburg	• Stadsleveransen • Climate smart city distribution KNEG • Micro terminal	• ***Key success factors***: local collaboration between the users/customers and transport providers; joint projects with public funding; and international research and innovation collaboration • ***Key Enablers***: neutral solution, business operated by a joint organisation, owned by the merchants and the real estate owners; political support; initial funding from development projects, real estate owners and other companies; subcontracting deals with transport companies; and advertising on the vehicles • ***Key Barriers***: lack of financial resources after an initial pilot phase
London	• Fleet operator recognition scheme • Delivery and servicing plans • Construction logistics plans	• ***Key success factors***: use of the planning system; strong policy basis; standards; enforcement; retiming deliveries; consolidation; and engagement programme • ***Key Enablers***: Government/Authority of the City; private sector innovation and involvement; Freight Quality Partnership; financial support from the local and central government and positive attitude of businesses in response to the implementation of the scheme by the authority • ***Key Barriers***: incentives/subsidies from the central

[9] http://urbanaccessregulations.eu/countries-mainmenu-147/netherlands-mainmenu-88/utrecht

		government; financial burden for small operators
Paris	• Land use master plan	• ***Key benefits***: provides the basis for a large range of further environmentally sustainable urban logistics solutions • ***Key Enablers***: strong and long-term political commitment; and logistic sites in dense urban areas • ***Key Barriers***: electoral change affecting the willingness of politicians to promote urban logistics land uses; different time scales for planning by public and private sectors
	• Distripolis	• ***Key benefits***: in 2014-2015, CO2 savings were 1,742 t/year; NOx (2.6 t/year); CO (1.9 t/year) • ***Key Enablers***: reduced risk of complaints by residents living locally • ***Key Barriers***: lack of progress in developing environmental regulations concerning urban freight; high long run costs; and lack of technical efficiency of electric vehicles
	• Monoprix rail project	• ***Key benefits***: reductions of 410,000 t/year CO2; 25 t/year NOx • ***Key Enablers***: local, regional and national administrations • ***Key Barriers***: difficulty in finding a good rail freight operator; noise and traffic generated by rail freight facilities
Shanghai	• The Freight Market	• ***Key success factors***: many agents and freight services are consolidated in one physical location • ***Key Enablers***: driver/owner operator; transport agent; logistics companies; freight market owner; private freight market operator • ***Key Barriers***: journey time and cost resulting from travelling to the location; fees for using the freight market services and the costs for using the transport agents as the middle-man
Singapore	• Vehicle Quota System • Retail precinct management	• ***Key success factors***: robust market with very little intervention needed to adjust to an expected situation • ***Key Enablers***: optimum operation of road system to support traffic flow with much regulation controlling private vehicle; efficient government and governance due to the compact size of the country

		• ***Key Barriers***: awkward response from the freight and logistics industry towards a new approach for city logistics treatment
Utrecht	• Environmental zone	• ***Key benefits***: 0.2-2.6 mg/m^3 reduction of PM10 in the city centre; and 0.1-1.1 mg/m^3 reduction of PM10 elsewhere • ***Key Enablers***: smooth and gradual introduction of the LEZ; and penalty for non-compliance with the admission criteria • ***Key Barriers***: high vehicle adaptation costs; and initial problem due to freight being switched to smaller trucks for entry to the LEZ
	• Beer Boat and Cargohopper	• ***Key benefits***: beer boat (reductions of 38 tonnes of CO2, 31 kg of NOx; and 6 kg of PM10 emissions); Cargohopper (Removal of 122,000 delivery van kilometers from the inner-city streets per year, savings of up to 24,000 liters of diesel fuel per year, and reduction of CO2 up to 34 tonnes per year); • ***Key Enablers***: agreement on a long-term goal, followed by a process of working backwards to a plan of operation and attempts to bridge the gaps between different stakeholders • ***Key Barriers***: high original investment; possibility of companies refusing to share deliveries with competitors; technical limitations (only for Cargohopper in terms of cargo, maximum speed and maximum range) and only suitable for short distance, low speed operations

7. References

- http://viajeoplus.eu/Documents/viajeo-plus-best-solution-method/VIAJEOPLUS_D2.1_BestSolutionMethod.pdf
- http://viajeoplus.eu/Documents/viajeo-plus-best-solution-method/D3-1-Effective-mobility-Managment-best-practice-report_final_v7.pdf
- http://viajeoplus.eu/Documents/viajeo-plus-best-solution-method/VIAJEOPLUS_D4.1_BestPracticeEV.pdf
- http://viajeoplus.eu/Documents/viajeo-plus-best-solution-method/Vaiejo-Plus_D5-1_final.pdf
- http://viajeoplus.eu/Documents/viajeo-plus-best-solution-method/D6.1-v3.pdf
- http://viajeoplus.eu/Documents/viajeo-plus-best-solution-method/D7-1_Best-solution-report-on-Global-Innovative-logistics-solution_v5-1.pdf

- Allen, J. & Browne, M., 2010. Sustainability strategies in city logistics. In A. McKinnon et al., eds. Green Logistics - Improving the environmental sustainability of logistics. London Philadephia New Delhi: CILT (UK). Kogan Page, pp. 282–305.
- Barter, P.A., 2013. Singapore's Mobility Model: Time for an Update? In Institue for Mobility Research (ifmo), ed. Megacity Mobility Culture. Berlin Heidelberg: Springer-Verlag, pp. 225–242. Available at: http://link.springer.com/10.1007/978-3-642-34735-1.
- BESTFACT, 2013a. Zero-Emission Beer Boat in Utrecht. http://www.bestfact.net/wp-content/uploads/2013/08/CL1_13_QuickInfo_ZeroEmissionBoat-26July2013.pdf
- BESTFACT, 2013b. Electric freight vehicle with trailers: Cargohopper in Utrecht http://www.bestfact.net/wp-content/uploads/2013/08/CL1_12_QuickInfo_Cargohopper-26July2013.pdf
- BESTFACT, 2013. Distripolis: Urban Consolidation Centres and battery-electric vehicles for last-mile deliveries. Available at http://www.bestfact.net/wp-content/uploads/2013/08/CL1_2_QuickInfo_Distripolis-26July2013.pdf
- Browne, M. et al., 2012. Reducing Social and Environmental Impacts of Urban Freight Transport: A Review of Some Major Cities. Procedia - Social and Behavioral Sciences, 39, pp.19–33. Available at: http://www.sciencedirect.com/science/article/pii/S1877042812005551 [Accessed January 16, 2015].
- Browne M., Allen J., Nemotob T., Patierc D., Visser J., 2012. Reducing social and environmental impacts of urban freight transport: A review of some major cities. Procedia - Social and Behavioral Sciences 39, 19 – 33
- Connor, K.O., 2013. High Density Approaches to Accomodating Logistics Activity in Cities : A Case Study of Singapore. In J. Cheung & H. Song, eds. Logistics: Perspectives, Approaches and Challenges. Hauppauge, NY: Nova Science Publishers, pp. 111–125.
- CIVITAS MIMOSA, 2012. Innovative cities: Before and after CIVITAS. Available at: http://www.civitas.eu/sites/default/files/civitasmimosacitybrochure_0.pdf

- CIVITAS, 2015. City distribution by boat. http://www.civitas.eu/content/city-distribution-boat
- Dablanc, L., 2013. Commercial Goods Transport, Paris, France. Case study prepared for Global Report on Human Settlements 2013. Available at http://www.unhabitat.org/grhs/2013
- Diziain, D., Ripert, C. & Dablanc, L., 2012. How can we bring logistics back into cities? The case of Paris metropolitan area. Procedia - Social and Behavioral Sciences 39, 267 – 281
- Diziain, A., Taniguchi, E. & Dablanc, L., 2014. Urban Logistics by Rail and Waterways in France and Japan. Procedia - Social and Behavioral Sciences 125, 159 – 170
- Viajeo Plus D7.1 Best solutions on innovative logistics
- Page 48 of 50 Version 5
- ELTIS, 2015. Utrecht's sustainable freight transport (The Netherlands). Available at http://www.eltis.org/discover/case-studies/utrechts-sustainable-freight-transport-netherlands
- ELTIS, 2015a. Distripolis: a new city logistics solution in Paris (France). Available at: http://www.eltis.org/discover/case-studies/distripolis-new-city-logistics-solution-paris-france
- ELTIS, 2015b. Sustainable deliveries of goods in Paris (France). Available at http://www.eltis.org/discover/case-studies/sustainable-deliveries-goods-paris-france
- GEODIS, 2011. Distripolis - Geodis Invents the Urban Logistics Of The Future. Available at http://www.geodis.com/file/dossierpresse/pj/b1/e9/08/a5/dp_distripolis_en5382574943892199980.pdf
- Haque, M.M., Chin, H.C. & Debnath, A.K., 2013. Sustainable, safe, smart—three key elements of Singapore's evolving transport policies. Transport Policy, 27(March), pp.20–31. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0967070X1200193X.
- Hoetjes, G., Degenkamp, M., de Jong, J. & Hogenberg, J., 2012. Measure Evaluation Results UTR 7.2 City Distribution by boat. Report from the CIVITAS MIMOSA project. Available at: http://www.civitas.eu/sites/default/files/documents/Measure_Evaluation_Results_7_2_Distribution_by_boat.pdf
- Land Transport Authority, 2013. Land Transport Master Plan 2013, Singapore. Available at: http://www.ura.gov.sg/uol/master-plan/View-Master-Plan/master-plan-2014/master-plan/Regional-highlights/central-area/central-area.
- Lau, H.C., 2014. Collaborative Urban Logistics – Challenges , Current Practices and Future Research Last Mile Urban Logistics. In Logistics and Supply Chain Symposium Urban Logistics: E-Commerce & Sustainability. Singapore: Singapore Management University. Available at: http://sis.smu.edu.sg/sites/default/files/sis/conference/lscs-urbanlog-ecom-sustain/speaker_slides/Collaborative_Urban_Logistics_-_Challenges_Current_Practices_and_Future_Research.pdf.

- Lau, H.C., 2013. Coordination of Last-Mile Delivery in Urban Cities. In Global Challenges in Smart Logistics - Innovation driving supply chain control. Utrecht: NL Agency Ministry of Economic Affairs. Available at: http://www.rvo.nl/sites/default/files/2013/11/Smart_Logistics_Lau.pdf.
- Leonardi, J. et al., 2014. Increase urban freight efficiency with delivery and servicing plan. Research in Transportation Business & Management, 12, pp.73–79. Available at: http://dx.doi.org/10.1016/j.rtbm.2014.10.001.
- Singapore Economic Development Board, 2015. Logistics and supply chain management. Future Ready Singapore. Available at:
- Viajeo Plus D7.1 Best solutions on innovative logistics
- Page 49 of 50 Version 5
- https://www.edb.gov.sg/content/edb/en/industries/industries/logistics-and-supply-chain-management.html [Accessed October 6, 2015].
- Souza, R. de et al., 2013. Collaborative Urban Logistics - Synchronizing the Last Mile A Singapore Research Perspective. In E. Taniguchi & R. G. Thompson, eds. The 8th International Conference on City Logistics. Bali, Indonesia 17-19 June: ELSEVIER Procedia - Social and behavioural Science, pp. 422–431.
- De Souza, R. et al., 2015. Retail Precinct Management: a Case of Commercial Decentralization in Singapore. In E. Taniguchi & R. G. Thompson, eds. International Conference for City Logistics. Tenerife: Institute for City Logistics, pp. 908–921.
- SUGAR, 2011. SUGAR Sustainable Urban Goods Logistics Achieved by Regional and Local Policies L. Dablanc, ed., Bologna: European Regional Development Fund.
- SUGAR, 2011. City Logistics Best Practices: a Handbook for Authorities. Available at http://www.sugarlogistics.eu/pliki/handbook.pdf
- Transport for London, 2007. Transport for London London Freight Plan sustainable freight distribution : a plan for London Foreword by Mayor. Transport. Available at: http://www.tfl.gov.uk/microsites/freight/documents/London-Freight-Plan.pdf.
- TURBLOG, 2011. Transferability of urban logistics concepts and practices from a world wide perspective - Deliverable 3.1 - Urban logistics practices – Paris Case study. Available at http://www.inovamais.pt/turblog/dissemination/TURBLOG_D3.1ParisFV.pdf
- TURBLOG, 2011. Transferability of urban logistics concepts and practices from a world wide perspective - Deliverable 3.2 - Urban logistics practices – Case Study of the city of Utrecht. Available: http://www.inovamais.pt/turblog/dissemination/TURBLOG_D3.2UtrechtFV.pdf
- TURBLOG, 2010. Transferability of urban logistics concepts and practices from a world wide perspective - Deliverable 1.2 - Regional Report "Brazil"
- Wainwright, I., 2015. Sustainable delivery and servicing - Lessons from London. In UK Network Management Board. London: Transport for London. Available at: http://www.ukroadsliaisongroup.org/download.cfm/docid/31DA53DC-664B-4164-87603AFECDFAE6C7.
- Zunder, T.H., Aditjandra, P.T. & Carnaby, B., 2014. Developing a Local Research Strategy for City Logistics on an Academic Campus. International Journal of Urban Sciences, 18(2), pp.262–277.