VIAJEO PLUS

D5.1 Best Solution report on Global Innovative Public Transport

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Executive Summary

The overall objective of *WP5 - Innovative Public Transport Solutions* is 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 was based on a common methodology applied to WPs 3 to 7 and took advantage of the outcomes of the Viajeo Plus workshops, named "City Showcase", organized within the project lifetime in Europe (Gothenburg), Latin America (São Paulo and Rio de Janeiro), China (Chengdu) and Singapore to showcase deployed systems, services or measures which are comparatively new in the domain, have produced significant benefits to cities and have a high transferability potential.

The selection led to the identification of 5 "best solutions" which are not intended to give a comprehensive overview of the most innovative Public Transport trends worldwide but to present selected successful experiences in the field, namely:

- Redesigning the bus network in Barcelona;
- Shifting commuters travel patterns in Singapore;
- Implementing BRT systems in Brazilian cities hosting large events;
- Developing a network of underground interchanges in Madrid;
- Integrating mobile ticketing systems in a multichannel and interoperable technological platform.

Overall the 5 best solutions are dealing with measures or policies which have been proven to advance both the level of service and the quality of service of PT systems. Therefore 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.

1. Introduction

The goal of Viajeo Plus is to benchmark outstanding solutions for innovative and green urban mobility in Europe, Latin America, China and Singapore and subsequently facilitate the uptake of these solutions across different cities in the project's target regions, and Mediterranean Partner Countries (MPCs).

To meet the Viajeo Plus vision, successful experiences of implementing innovative urban mobility solutions have been identified and analysed capitalizing on the knowledge of the project partners as well as thanks to experts, external to the project consortium, selected to support this task.

The selection of solutions was also based on the outcomes of 4 Viajeo Plus city showcases organized within the project lifetime in Europe (Gothenburg), Latin America (São Paulo and Rio de Janeiro), China (Chengdu) and Singapore. The events aimed at facilitating experience sharing and cross learning between cities worldwide, as a two-way approach introducing innovative urban mobility solutions already tested in European cities to Latin American and Asian cities and vice versa. They successfully gathered and engaged city representatives, policy makers, technology providers and researchers to present their latest achievements on:

- effective mobility management
- clean vehicle solutions
- innovative public transport solutions
- enabling infrastructure
- sustainable city logistics.

Deliverable 5.1 reports about the worldwide best practices identified in the field of Public Transport (PT). Overall, according to the project methodology, a best practice must show a significant level of innovation and/or deliver a proven increase in effectiveness of the PT system. To guide the best practices selection, specific criteria has been agreed between the project partners (see Annex 1) and applied to the selection process according to their degree of relevancy for the specific Viajeo Plus topics.

2. Innovation in Public Transport: background

Towns and cities worldwide are facing growing mobility challenges due to a constant increase of passengers' flows in densely populated urban areas. Urbanisation has grown continuously over the past decades in industrialized countries, counting – for instance - for 74% of the European population residing in urban areas in 2011. This trend is expected to continue in the years to come, reaching a peak of around 82% of urban dwellers in 2050[2]. Urban sprawl, transfer of activities to the outskirts and new mobility habits have resulted in chronic congestion throughout cities, with the many adverse consequences that this entails in terms of air pollution, raise of accidents rates and accessibility problems.

Car dependency, especially in terms of high motorization rates, space consumption and unsuitability to accommodate passenger flows in a sustainable way are behind this (Corazza et al., 2015). The challenge is to create a transport system which combines the individual's desire of mobility and the economic requirement for the movement of people, with environmental needs and health concerns.

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.

De-motorisation in industrialised countries has been already observed, since the recent economic developments started orienting the mobility demand towards transit. In the EU Member States, for instance, the expenditure on the purchase of vehicles among the private households decreased by around 11 % from 2008 to 2012 (in 2014 the registration of new passenger cars was 12,541,543 units) but those on operation of transport equipment (i.e. to buy fuel) and services (i.e. to buy transit tickets) increased respectively by 7.11% and 9.19% (Table 1).

	year				
type of expenditure (billion Euros)	2008	2009	2010	2011	2012
Purchase of vehicles	279	272	260	260	249
Operation of transport equipment	492	453	477	515	527
Transport services	174	165	168	176	190

Table 1 - EU Member States household expenditure on transport-related items

[2] United Nations, World Urbanization Prospects: the 2011 Revision.

The UITP report Public Transport Trends 2015 highlights that young generations are less likely to purchase their own vehicles as they no longer reflect their identity, tastes and income level. This is a great opportunity for public transport but also a challenge to provide an offer that is attractive enough to catch this group of users.

Nevertheless, public transport systems are very often still perceived as a less attractive option in comparison with private modes, because of their low performance mainly in terms of regularity, speed, comfort and design. Undoubtedly, public transport must make significant qualitative improvement in order to become more attractive. Customers expect the same kind of lifestyle services and connectivity from PT vehicles and terminals as they already have in their own living space. Such services build on basic requirements which include comfort, security, cleanliness as well as operational excellence, which calls for enhanced frequency, punctuality and reliability of the services thanks to optimised network design and service performances. Likewise, smart ticketing and integrated travel information contribute to making PT user-friendly while facilitating accessibility for all citizens.

There is no innovation without a long-term research vision with the ambition to reshape PT systems worldwide. The European Union has been supporting Research & Innovation for years, as part of its growth and industrial strategy. EU policy in this respect is based, among others, on coordination of multiple actors in large international cooperation projects such as Viajeo Plus.

Over the last years, several activities have been undertaken between EU and International Cooperation Partner Countries (ICPCs) aiming at fostering greater links between science, research and innovation, as well as businesses, research centres and networks. The increase over the last decade in Latin American and Chinese participation in EU Framework Programme (FP) projects facilitates this relationship between the EU and Emerging Countries with regard to R&D collaboration on different themes. Among them, great emphasis is placed on promoting studies and implementation of solutions to meet more sustainable requirements in local transport systems where PT has a major role to play.

2.1 Viajeo Plus best solutions on Public Transport

The selection process briefly described in section 1 (for a comprehensive report on the methodology, please see D5.3 - Innovative public transport solutions for City Mobility Week preliminary set-up) led to the identification of 5 “best solutions” which are not intended to give a comprehensive overview of the most innovative Public Transport trends worldwide but to present selected successful experiences in the field. It is also worth mentioning that four out

of five solutions have been presented and discussed within the Viajeo Plus City Showcases, allowing project partners and international public transport stakeholders to learn about their implementation process and results achieved.

The 5 best solutions are described in detailed in the following sessions. Overall they are all dealing with increasing both the level of service and the quality of service of PT systems.
According to the definition provided by the COST Action TU 603[3], the level of service "*measures the quantity of the service as it is planned (frequency, capacity, operating span, etc.). High level of Service needs to offer a high quality*", but this does not mean level of service being equal to quality of service, since the later implies the service fulfilment and it is used to describe and qualify the differences between the scheduled service and the service as it is perceived by the client: service quality describes the factors that influence passengers' perception of their journeys.

In other words, the quality of service involves the passenger's point of view, whilst the concept of level of service refers to the quantity of services offered, such as, typically, frequency, vehicle capacity, vehicle commercial speed, but also service span, comfort, safety, accessibility, connection to the network and other modes/services (CERTU, 2005).

Therefore the selected solutions 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.

[3] COST Action TU 603 *Buses with a High Level of Service.*

3. Barcelona new bus network (Spain)

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).

Coherently with the above mentioned criticalities, the following keywords have been identified to inspire the design of the new bus network:

- **Faster**, thanks to dedicated measures such as designated bus lanes, priority at traffic lights and double stops;

- **Easier** to use, as new bus lines follow straighter, more direct routes, designed to increase the efficiency of the layout, to make travel smoother for users.
- **Great links**, as the network covers the city completely, from the Llobregat to the Besòs and from the sea to Collserola and it provides better links with other bus routes and other modes of public transport (metro, FGC, Tram, etc.).
- **More frequent**, buses run more often and services have been extended, which means shorter waiting times at stops.
- **Gradual introduction** of new lines in stages until all 28 lines planned for the new network are operational.
- **Interchange hubs**: the points where vertical, horizontal and diagonal bus routes intersect, in both directions, are called interchange hubs. Here changing buses is quick and easy.

As a result, the newly designed bus network is organised in 28 vertical, horizontal and diagonal lines (17 vertical, 8 horizontal and 3 diagonal lines) as shown in Figure 1. These lines are complemented, except in those cases where routes would be duplicated, with existing local and feeder routes as well as interurban routes.

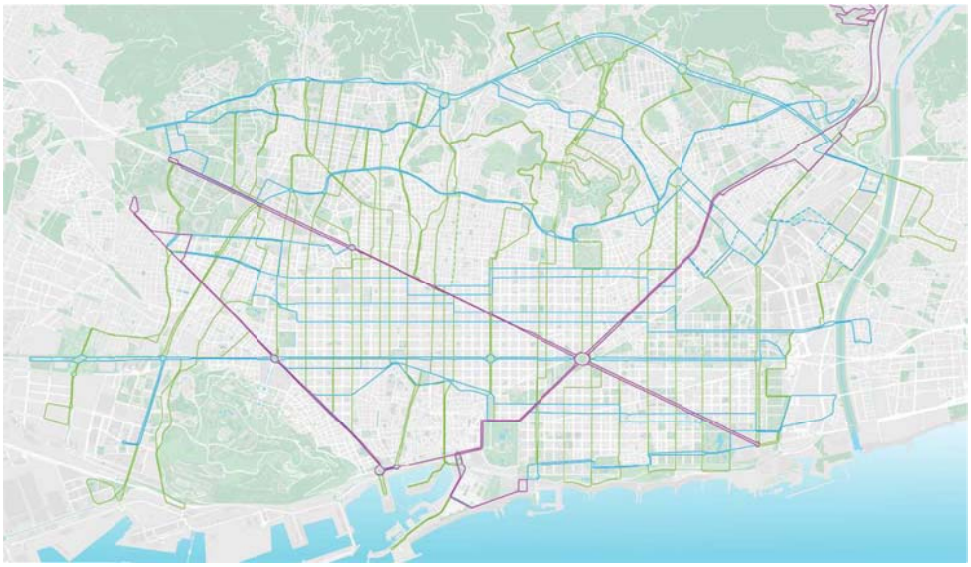

Figure 1 - The 17 vertical + 8 horizontal +3 diagonal routes layout

The orthogonal and diagonal routes grid network is a hybrid model based on:

- The orthogonal route model
- The “RetBus” model

The main features of both models are summarised in Table 2.

Orthogonal route model	"RetBus" model
• isotropic route model (same features all around). • shape-demand model. It defines one corridor next to the other without taking into account the demand, which is expected to be reorganized and to be readapted to the new routes. • 4-minute headway on every corridor. • Average distance between stops: 400 m. • Priority measures: more bus lane stretches. • Instant implementation: from one day to the next.	• 12 high-level routes that follow a hybrid hub (grid) & spokes model. • serve-demand model • Different headways are set: 3-minute in the grid zone and 6-minute out of this zone (the grid zone is the reticular part of the network) • Different average between stops: 430 m in the city centre and 650 m in the outskirts. • Diverse priority measures on each corridor: signal priority, new bus lane stretches, etc. • Gradual implementation.

Table 2 – Main features of the two routes models

The project was initiated in 2009 and the new network was introduced in October 2012 with the launch of the first 5 routes (first phase, see Figure 2). The first five lines (two horizontal, two vertical and one diagonal) accounted for a total length of 88.8 kilometres with 245 bus stops and transported about 70,000 passengers each day. In 2013 further 5 routes were introduced. The implementation continued during 2014 with actions being carried out in four lines, among which three were newly created. Three new lines will start running on 2016, totalising 16 new lines in operation out of the 28 planned.

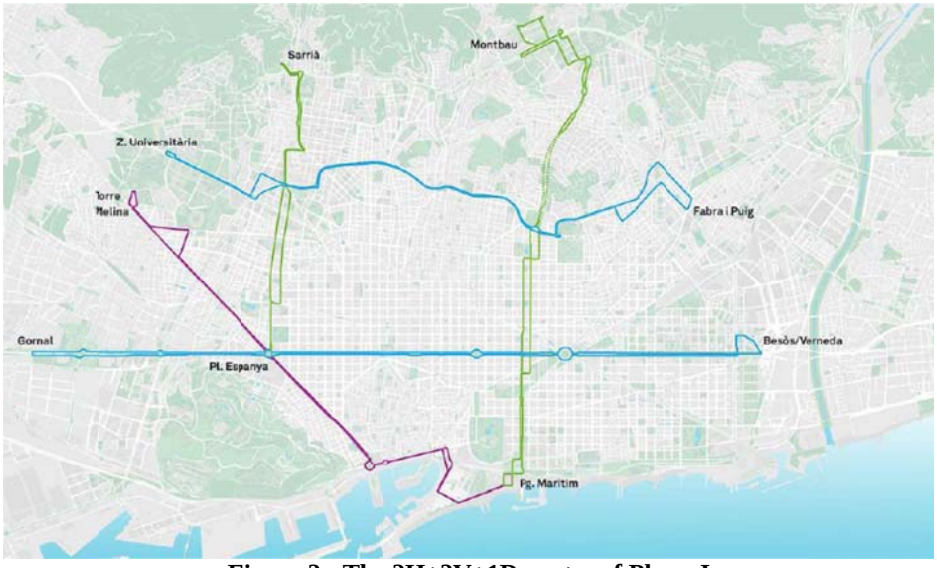

Figure 2 - The 2H+2V+1D routes of Phase I

The project has been financed by public resources, and the total estimated budget is about 8 Million Euro.

The key success factors

An evaluation of the project has been carried out and the results show that there have been a good demand response, a positive appraisal about infrastructures implemented (e.g. bus lane and signal priority), and the improvement of regularity of the service has been highly appreciated. Overall, the demand registered during the first 6 months of operation is about 12.3 million passengers, a higher figure if compared with the previous average number or validations per km of line. The customer satisfaction surveys performed after the implementation of phase1, phase 2 and phase 3 show an a high acceptance of the new bus network which is rated on average 7 (7 out of 10), with a peak of 8,2 for some specific lines.

The key success factor can be certainly identified in the improved level of service offered on the orthogonal and diagonal routes, as shown by the following features:

- Maximum connectivity (from one end to the other of the city, with no antennas).
- High & very high frequency routes (4 – 8 min).
- Only one route per corridor.
- Average distance between stops: 400 m.
- 90% of journeys can be made with 0-1 transfers.

If we look at the improvements achieved on the whole network, TMB estimates that 95% of the citizens can today travel to any part of Barcelona by a single transfer and almost half of them can reach any destination in the city in less than 40 minutes.

One of the main project's objectives was to deploy a bus network easy to understand, remember and read on a map for both frequent and non-frequent users. As a results, the following nomenclature system has been designed (Figure 3):

- The vertical lines (or sea-mountain routes) are named with a V plus an odd number;
- The horizontal routes (or parallel-to-the-sea routes) are named with a H plus an even number;
- The 3 Diagonal routes are named D20, D30 or D40.

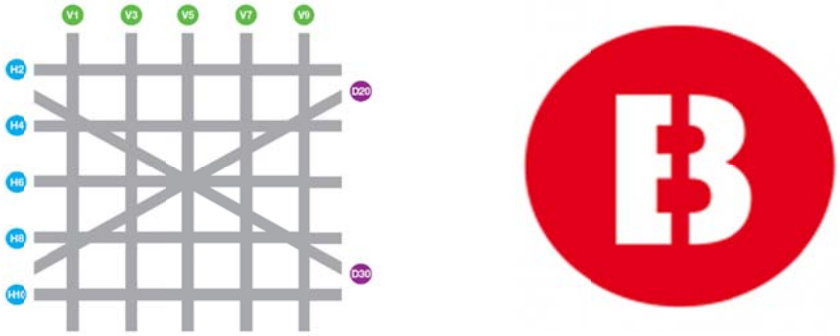

Figure 3 - The nomenclature system (left); the logo of the new routes (right)

Moreover, the colours, letter and number combinations of each line, vehicle design, exchange hubs, stop signage have been designed so that users can quickly become familiar with the new bus network.

Key Enablers

The redesign of the network has been implemented within a more comprehensive project that differs from a "standard" project since it implies quite radical changes of several features of a bus system, in order to increase its effectiveness but also make it more sustainable and more attractive for passengers.

In this process, a key feature relates to the **bus fleet**, which includes standard, articulated and bi-articulated buses, affecting capacity and cost per space-km. Regarding the emission standards of the engines, the fleet is composed mainly of environmentally friendly vehicles (CNG and hybrids) and diesel buses compliant with Euro V emission standards.

The buses running on the new orthogonal and diagonal routes are also highly recognisable. As a matter of fact, the improved systems has been integrated in the city context also by improving the image of buses by new branding of the vehicles themselves as well as bus stations and several features along the lines (Figure 4).

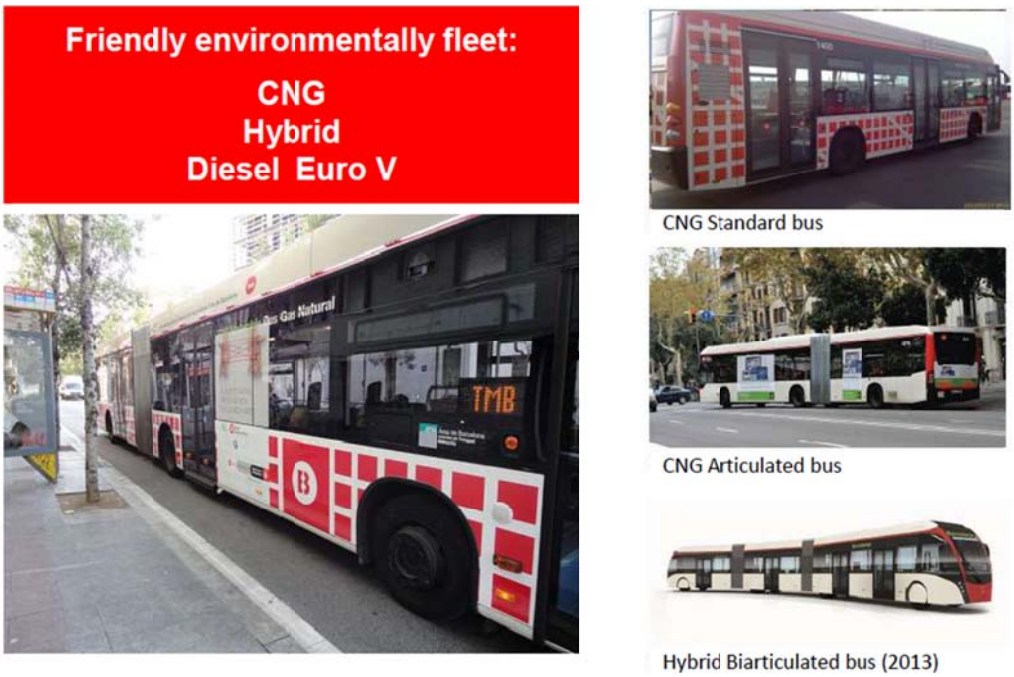

Figure 4 - The rolling stock

To enhance the users' perception of comfort and quality of the system, about 400 bus stops have been renewed with new urban furniture (e.g. smart shelters, enhanced poles for information) and equipped with touch screens where users can interact and get all kind of information, and ticketing machines. Users are always well informed thanks to real-time passenger information systems, including:

- Stops with dynamic information displays;
- Dynamic information inside the bus;
- New format signage and information on lines.

The provision of priority for buses is very important to positively discriminate in favour of buses; even more if the routes run in the city centre. At least the 25% of the length of the routes are provided with dedicated lanes (both, single and double lanes), as well as double bus stops allowing passengers getting in/out of 2 buses at the same time. Moreover, the level of accessibility to the vehicles for users with special needs is very high, due to the availability of low floor, ramps for boarding and acoustics signalling inside the bus.

Finally, the implementation of dedicated interchange areas, where vertical, horizontal and diagonal bus routes intersect, allows maximizing the effectiveness of the new bus network. Some of these interchange areas are particularly important since they are located at strategic points in the city and connect the bus network with other PT modes (metro, tram, suburban rail). These areas have been specifically designed to make the interchange between bus lines or modes of transport as quick and easy as possible.

Key Barriers

No specific elements which represented a barrier to the re-design of the Barcelona bus network have been identified by the author through desk research on this project. However, the following elements can be highlighted as recurrent barriers to the implementation of solutions and policies aimed at improving the level of service of Public Transport by prioritise the bus systems perspective in the urban scenario:

- Lack of funding. The economic crisis has resulted in a reduction in funding of the public systems - public transport among them- where a significant reduction in the subsidies perceived has taken place.
- Lack of cooperation between jurisdictions or stakeholders can be a problem, especially in large metropolitan areas, both in agreeing on level of service standards and in implementing improvement measures.

- Struggle for priority measures. Every PT authority or operator is confronted with the difficulty to implement priority measures (dedicated lanes, priority at traffic lights), so there is a need for commonly supported (political) vision on the importance of PT and courage to make it concrete.

Looking into the future

At present 13 routes with high level of service (HLS) out of 28 have been implemented, 2 completely new conventional routes created and 15 restructured, while 16 conventional routes have been cancelled. In 2016 three new lines will enter in service making 16 HLS lines fully operational.

As already stressed the introduction of the new lines is gradual and there is no deadline for completion of the phase 4 which envisages the implementation of 3 additional lines: 1 horizontal line and two vertical.

4. Travel Smart programme (Singapore)

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 (Chris Hanley 2012). 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

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.

Organisations	A	B	C
Measures implemented	Management of flexi-work arrangements decentralized Addition of shower facilities & lockers Pre-peak activities (e.g. Tai Chi, running club, breakfast sessions)	Promote Activity-Based Work Strategy Encourage mobile work practices amongst staff Change management initiatives	Launched FlexTime (7:30am - 9:30am) scheme Revised Work From Home Scheme (adhoc basis)

Table 3 – Measures implemented during the pilot

The qualitative assessment of the initiative has been carried out also through a staff survey. As an example, the experience of two employees are reported below:

- "LTA's Travel Smart and my company's FlexTime scheme complement very well in enabling me to make "decongesting trips" instead of "peak trips" to work. Now, I get on the first train that pulls into the station and start work earlier in the 7 o'clock hour in a better state of mind. This saves me considerable waiting time without having to give fully packed trains a miss before finally getting on one. Getting a seat and being rewarded for using INSINC are bonuses!" – Director, audit firm
- "Travel Smart Programme has made a difference to my lifestyle. Other than cost savings on the one way MRT ride to work, I am able to spend more time with my 2 daughters in the morning when I join them and my husband in the car ride to their school, before I board the MRT train. In order to promote the Travel Smart Programme, my firm provides free early breakfast to staff who arrives before 8 a.m. I love this programme not only for the benefits of free transport and breakfast but also how it allows me some early morning bonding time with my family." - Legal SecretaryCommuncation campaign.

The key success factors

The pilot's positive results motivated LTA to move forward and launch a more comprehensive scheme which takes into consideration both organisations and individual commuters through a

set of dedicated initiatives (Table 4). The development of initiatives able to meet the needs of different target groups can be considered as a key factor for the successful acceptance of the programme.

Initiatives addressed to commuters	Initiatives addressed to organisation
Travel Smart Rewards (TSR) Launched as a pilot in January 2012 Enhancements in July 2014 **Free Pre-Peak Travel** Initially started in June 2013 Recently extended to 30 June 2016	**Travel Smart Network** First launched in July 2014 Enhancements to the scheme in November 2014

Table 4 – Overview of Travel Smart initiatives

Travel Smart Rewards scheme allows commuters earning 1 point for every 1 km travelled on the train from Monday to Friday and extra points for morning off-peak trips (6.15-7.15am/8.45-9.45am). Points accumulated can be used to win cash rewards (monthly lucky draw of $1,500). Moreover, corporate commuters, upon companies' enrolment in Travel Smart Network, benefit of sign-up bonus of 1,000 points and 2 additional points per km travelled on the MRT/ LRT network.

Free Pre-Peak Travel was started as a trial on June 2013. The initiative allow to travel for free on the MRT network if the commuter exits the final MRT station before 7.45am and to benefit a $0,50 discount on the train fare when the final station is reached between 7.45 and 8.00 am. The initiative is valid on 16 MRT stations located within downtown.

Regarding the initiatives specifically designed for oganisations, since July 2014 organisations which have joined the Travel Smart Network are able to tap on three new initiatives:

- Corporate-Tier Travel Smart Rewards for which employees of Travel Smart Network organisations can enroll and enjoy an attractive sign-up points bonus;
- Travel Smart Consultancy Vouchers of up to $30,000 to engage approved consultants to conduct employees travel pattern analysis and develop travel demand management action plans tailored to the needs of their own employees. The goal for the organisations is to understand employees' concerns and opportunities regarding more flexible travel and work arrangements, potential productivity gains, willingness to improve their overall transport efficiency.
- Travel Smart Grant of up to $160,000 annually for three years to co-fund the cost of measures to support the adoption of flexi-travel arrangements by their employees. The measures can be oriented to the development of transport infrastructures or systems to

support more sustainable travel patterns such as installing bicycle parking facilities and implementing bus shuttle service registration systems, or be more focused on the operational level, e.g. appointment of a Travel Smart coordinator, organization of Travel Smart activities (breakfast, yoga, gym, pilates) or shuttle bus services.

Key Enablers

It is well-known that Travel Demand Management is not a stand-alone concept. Initiatives are successful when they are embedded in a wider transport approach of a government, authority or service provider and are dynamically applied to maximize the potential of new or existing infrastructures. Singapore Travel Smart Programme is an example in this respect, since the scheme was intended to supplement the Land Transport Authority efforts to increase the capacity of the PT system from the supply side with, among the others, more railways infrastructures and improved signalling system to increase frequency of train arrivals, new Integrated Transport Hubs to be added the seven already in operation, the Bus Service Enhancement Programme.

Awareness is key to the success of any TDM programme. A recognised branding strategy has been developed supported by wide marketing campaigns and activities aimed at promoting the porgramme as a whole, for istance through the appointment of a Travel Smart Day, or initiative addressed to target audience such as Travel Smart Rewards and Free Pre-Peak Travel scheme (Figure 5).

Figure 5 – Examples of marketing campaigns to promote Travel Smart

Key Barriers

No specific elements which represented a barrier to the implementation of the Travel Smart Programme have been identified by the author through desk research on this project. However, the following elements can be highlighted as recurrent barriers to the implementation of TDM solutions:

- A lack of awareness of Travel Demand Management; an extensive stakeholder engagement programme to inform can greatly facilitate the success of the initiative.
- The need to quantify the potential benefits; an impacts assessment undertaken to show the role that TDM can play and the potential benefits is key to convince organisations and commutes to join the programme.
- A lack of TDM experience; TDM initiatives are not as expensive as infrastructure projects, but they can be very labour intensive. They require ongoing input to upskill new individuals and organisations.

Looking into the future

The Travel Smart Programme so far has achieved its main objective to shift commuting patterns and foster a flexi-work mindset. It is estimated that the different off-peak travel initiatives implemented have managed to keep 7 to 8 per cent of commuters off the trains during the morning peak period that is about 10,000 people or six to eight MRT trains. The Travel Smart Network has been joined by more than 60 companies, with over 160,000 employees.

The programme, started as a pilot in 2012, is now recognized as a key tool for supporting a wide range of transport-related environmental, economic and social goals.

5. Bus Rapid Transit systems for large events (Brazil)

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 (see Table 5, source: STADIUM Project).

Event	City	Daily Attendance
Summer Olympic Games 2012	London (UK)	Athletes and officials: 18,000 Workforce: 200.000 Media: 28.000 Olympic Family: 6.000 Technical officials: 5.000 Marketing partners: 25.000 Spectators: 500.000
Summer Olympic Games 2008	Beijing (China)	Athletes: 10.950 Workforce: 100.000 Media: 24.699 Spectators: 425.000
Summer Olympic Games 2004	Athens (Greece)	Athletes and officials: 19.000 Workforce: 110.000 Media: 21.600 Olympic Family: 5.500 Sponsor: 31.000 Spectators: 410.000

Table 5 – Olympic games daily attendance

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.

The key success factors

The implementation of BRT systems in Brazilian cities is undoubtedly one of the most important steps for the urban passenger transportation to be really efficient and in line with the expectations of the population. Originally designed, tested, and operated in the city of Curitiba, BRT systems have become international benchmarks of high performance, quality and low cost mass transportation. Today, major cities in the world use the BRT concept as the backbone for sustainable urban development policies.

In 2010, the Brazilian federal government announced urban mobility projects in the 12 host cities of the 2014 FIFA World Cup. These projects totalled over USD 3.1 billion of investment. Nine of the 12 cities have managed to implement 43 projects that were expected to be operational before the end of the World Cup. The latest reports indicate that 247 km of infrastructure assets will be created, although official sources cannot estimate the number of passengers that will be transported on a daily basis at this stage.

In this context, Rio de Janeiro is going through major structural changes in its public transportation systems, in order to equip the city for major events that have already taken place (i.e. World Cup 2014) and are still to come, especially the Rio Olympic and Paralympic Games in 2016. Among those changes, the implementation of the BRT transport system, consisting of 4 large capacity bus corridors, interconnecting several neighbourhoods in the city and enabling effective integration with various modes of transport in the metropolitan region (Figure 6).

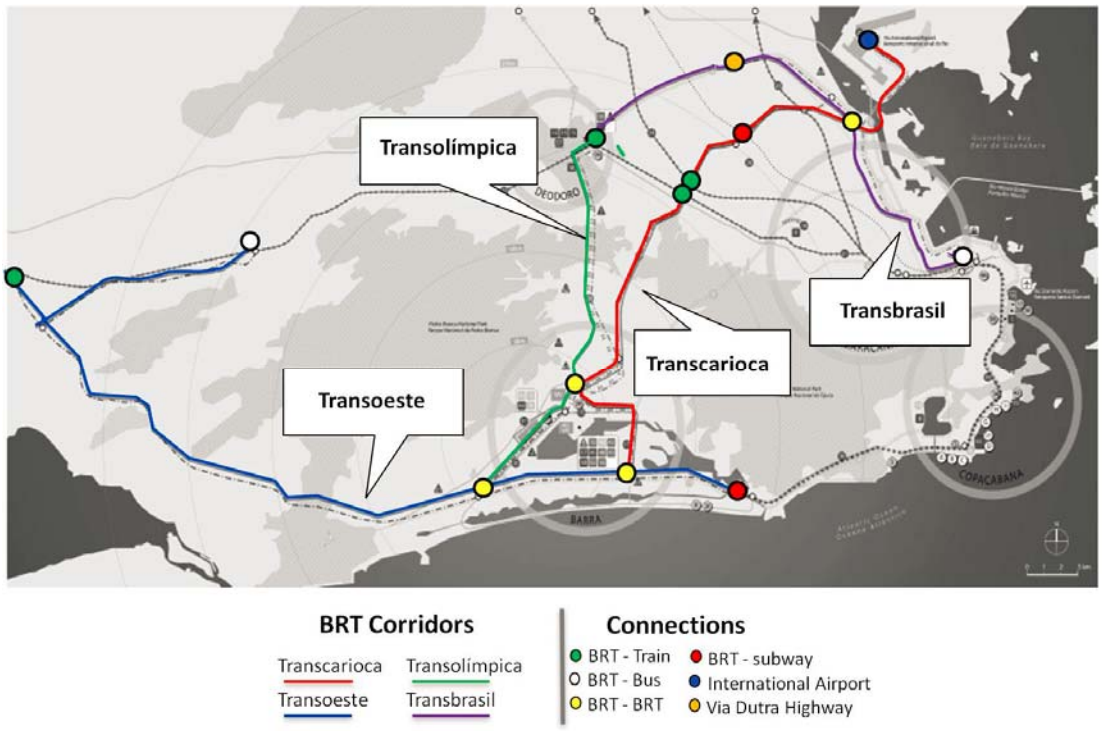

Figure 6 – BRT corridors planned in Rio de Janeiro (source: Secretary of Transportation, Rio de Janeiro, 2013)

The first corridor to be deployed was TransOeste which opened in 2012 and represented a real transformation in the west zone of the metropolitan area. If before the traffic jams were frequent, especially in the Serra do Catonho region, and passengers took about two and a half hours from Santa Cruz and Campo Grande to Barra da Tijuca, with the corridor, this time decreased by 40%. Today 230,000 passengers travel along the 52km of TransOeste, aboard articulated buses equipped with air conditioning and riding on exclusive lanes. By 2016, the last stretch of TransOeste, which connects the Alvorada Terminal to the Metro's Line 4, will open, ensuring also a fast and efficient connection between the South Zone and the West Zone of the

city. Service previously provided by 11 regular bus routes on and adjacent to the TransOeste corridor has been replaced by 11 feeder lines from March 2013 and the average weekday bus ridership on these lines is approximately 41,000 (2013). As BRT service expands, other regular bus lines will be altered and formed into feeder bus lines.

The second BRT corridor (TransCarioca) since June 2013 connects Ilha do Governador to Barra da Tijuca, in over 39 kilometers, serving several populous neighbourhoods of the north side of Rio and reducing by 60% the travel time between the terminal stations. Currently, it connects with Transoeste at the Alvorada Terminal, which was fully refurbished to serve with more comfort passengers from all regions of the city. In the future, it will connect with the Transolímpica at the Olympic Center Terminal in Curicica.

All lines are connected and monitored by one of the most modern Operational Control Centres in Brazil, which is responsible for controlling travel timetables at the terminals, overseeing the operation of the lines, among other operational inspection activities. At the terminals electronic information services assist users in identifying lines, schedules, destinations and other operational information.

Being one of the decision makers' priorities the promotion of non-motorized modes, the construction of bike paths along the corridor is planned. The integration between BRT and bicycle mode occurs through the construction of bike racks on all integration terminals. For pedestrians, the BRT implementation project envisages also the treatment of the sidewalks along the corridors.

Another relevant examples of BRT developed in view of large events which took advantage of the World Cup-related investments is MOVE in Belo Horizonte. The city, one of the host cities for Brazil's 2014 World Cup, on March 2014 launched its first bus rapid transit system designed to improve journey times for fans and residents across the city. Thanks to the system, getting to the stadiums Mineirão takes approximately 20 minutes, whereas by car takes approximately 1 hour and 30 minutes.

The new corridor runs along Avenida Cristiano Machado and follows best practices in BRT design, including center-aligned stations, off-board fare collection, and integrated intermodal connections.

MOVE was developed with support from EMBARQ Brazil and it has already proved its benefits by moving people three times faster than commuting by car during rush hour. When fully operational, the system will transport more than 700,000 passengers each day. The new high quality system is also improving surrounding areas of its corridors and is helping to reshape the downgraded downtown area to a more people oriented environment.

Key Enablers

Overall in Latin America, it is estimated that buses have lost around 30% of passengers since a 1995 peak. One of the main reasons is the significant decrease of the commercial speed due to congestion. In Sao Paulo and Rio de Janeiro , for instance, commuter trips are 30% longer than in smaller cities because of the heavy congestion. Recently the percentage of street surface dedicated to buses has been increased in some big cities but this is still at starting phase.

In this context, BRTs meet the users' needs thank to physically segregated lanes and traffic signal management that can significantly raise commercial speed and reduce overall travel times by holding green signals for BRT buses approaching an intersection. Finally, high-frequency bus service (sometimes more than 60 buses per hour) minimizes passenger waiting time.

The perception of buses is positively changed in Brazil thanks to BRT systems. BRT combines exclusive and segregated busways, smart stations and intelligent transportation system elements into an integrated transit system with a strong brand that evokes a unique identity (Hidalgo and Carrigan 2010). As a result, high-quality bus rapid transit systems affect the quality of life, productivity, health, and safety of people living in Brazilian cities.

It is common for urban transport decision makers to compare the costs and benefits of alternative transit modes before opting to implement any given solution. According to ITDP (2008), a BRT system costs 4 to 20 times less than light rail vehicles systems and between 10 to 100 times less than a subway system. A comparison of mass rapid transit systems according to capital cost and capacity is shown in Figure 7. They can also be implemented in a much lower timescale. This is mainly attributed to the relatively simple right of way improvements needed for BRT – no tracks must be laid – as well as the less expensive bus fleet.

Finally BRT systems are characterized by good flexibility in terms of capacity and they are more adaptable to the future growth and development of the cities. They are used not only to meet the existing demand, but also to drive urban growth to areas of interest for the municipality. In Curitiba, for instance, where BRT system do exist, it was allowed to construct

high-rise buildings and this seems to be the case also for the new neighbourhood developed in view of the Olympic games 2016 in Rio de Janeiro.

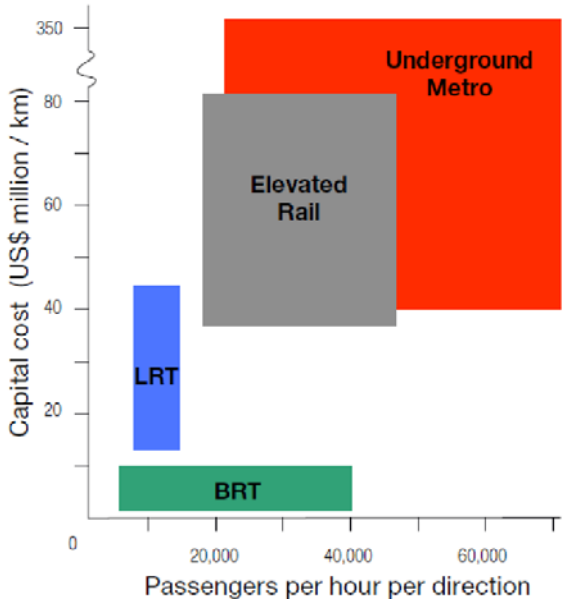

Figure 7 - Passenger capacity and capital cost for mass transit options, Source: (Wright & Hook, 2007)

Key Barriers

It is well know that main barriers for the design and implementation of BRT system are related to institutional, financial, legal and political sectors. The scientific literature report the following as the main issue to be overtake: (i) lack of political will, (ii) governance,(iii) opposition from key stakeholders (existing public transport operators, motorists, etc.), (iv) institutional biases, (v) inadequate technical capacity, (vi) insufficient funding and financing, (vii) geographical / physical limitations, (viii) rushed inauguration.

The lesson learnt from the experience in Rio de Janeiro, thanks to analyses on the level of service registered on the corridors already in operation, allows identifying some barriers which prevent a correct operation of the system, namely:

- Low passengers' comfort due to overcrowding. The results of a survey conducted on the TransOeste corridor shows that 45% of passengers recommend increasing the bus fleet and/or improving bus frequency because of the overcrowding. Different measures or policies can be implemented to address peaking problems beyond improving the capacity, such as implementing variable pricing schemes to shift travels to off-peak hours or enhance the transit-oriented development.

- Lack of Integration with soft modes. The same survey showed that only 0.5 percent of the TranOeste passengers use bicycles to reach the BRT stations. Considering that the corridor serves an area with a proven high volume of cyclists, it can be argued that the system has missed the opportunity to make TransOeste accessible for cyclists. Secure bicycle parking, bicycle lanes and bicycle-sharing system are essential in this respect.
- Lack of integration with the traditional bus services, mainly affected by very low efficiency (e.g. commercial speed, comfort, accessibility). The BRT is only one part of the complex transport network, and the integration with the other collective transport modes is recommended to bring more benefits in the long-term.

Looking into the future

BRT systems have been widely developed in Brazil in recent years and this trend seems to be confirmed for the coming future. TransOeste has drastically improved mobility, emissions and comfort within its corridor and represents a successful precedent to carry forward as BRT expands both within the corridor and across Rio, where 2 new completely systems will be built in the following years and extension or improvements are planned on the existing ones (TransOeste and TransCarioca) also in view of the Olympic Games. These corridors will encircling the entire city and officials expect that they will accommodate demand for approximately 1,700,000 daily trips through 160 km of BRT.

The MOVE system in Belo Horizonte will eventually be composed of three BRT corridors – Antônio Carlos, Cristiano Machado, and Hipercentro – which will connect the city's center to its major districts. The system will benefit of a total of 23 kilometers of dedicated bus lanes and will serve approximately 700,000 people each day.

The leading experiences of Rio de Janeiro and Belo Horizonte will stretch beyond the boundary of the World Cup and the Olympic games. Brazil is moving forward on its National Policy on Urban Mobility. This legislation, established in 2012, required cities with more than 20,000 residents and those with significant tourism and trade industries to incorporate urban mobility planning in their greater development plans in order to receive federal development funding. Given that approximately 3,065 cities across the country are affected by the law, this change is a major milestone for sustainable urban mobility in Brazil to reduce inequality, promote access to services, improve mobility and promote sustainable development.

6. Madrid Public Transport Interchanges Plan (Spain)

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 km2. 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 (except 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 (Figure 8). 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.

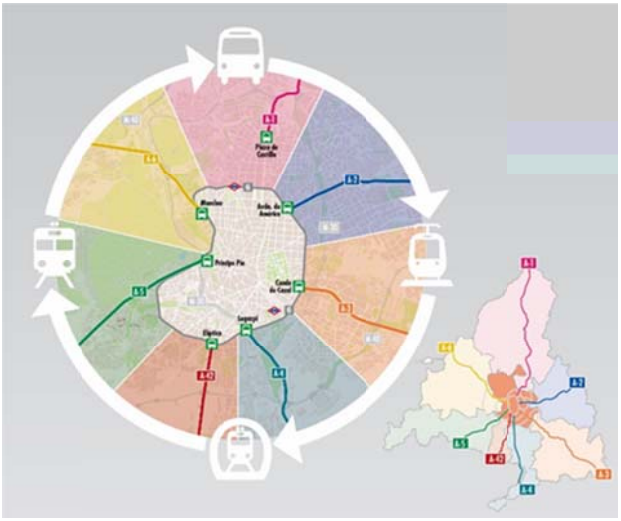

Figure 8 -Madrid Interchange Plan (source CRTM)

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 passengers flows accessing the city from all its main entries.

Key success factors

The primary factors of success and innovation are gathered in the following requirements:

- Location and urban integration

The location of an interchange must pursue the connection of the feeder modes (generally buses and private vehicles) with the transport system's structuring modes (metro, light rail and commuter rail). It must be integrated functionally and aesthetically with the urban environment. From a functional point of view, the interchange station must resolve the

connection between the street network around the interchange and other transport services nearby and facilitate access to the interchange, especially for pedestrians.

- Integration of different modes and mobility demands

It must offer different types of mobility solutions in an integrated manner, not only through the various modes of public transport but also through complementary modes or mobility services (including pedestrians, bikes, park&ride, kiss&ride, car sharing, etc.), trying to adapt to users demand and promoting a more sustainable transport.

- Reduce transfer time

Minimising the transfer time between modes, which can be considered practically equivalent to minimising the distance and time the passengers must cover when changing from one mode of transport to another.

- Information and signalling

Accessible and easy-to-understand information is required. Information and signalling systems must ensure that the public transport user perceives his trip as a "unit", to which end it is necessary to reduce the sense of "trip fragmentation" caused by transfers.

- Quality of waiting areas and environment

One of the main factors of success of an interchange from the user's point of view is based on his perception of a single space whose functionality is easy to understand and whose environmental characteristics make for a pleasant stay: design of diaphanous spaces, visual connections that allow the whole interchange to be perceived, natural light, etc. Environmental quality is achieved through ventilation (pollutant gases must be extracted near their source), temperature and noise control (with conditioned waiting areas).

- Accessibility

Likewise, the elements necessary for the accessibility of all groups of users (people with reduced mobility, occasional users, etc.) must be considered when designing the infrastructure, integrating them from the very beginning of the design process. Such aspects include the design of the building, furniture, signalling, evacuation, specific measures for visually impaired, etc.

- Additional services

The subjectively perceived waiting time can also be reduced if the wait or transit in the interchange is made more pleasant. Thus, libraries or book-lending service, cafeterias, shopping and/or leisure area, baggage store, etc. can promote the use of the interchange not only as a part of the transport network, but also as a place of interest in the city. They also can give an added value to the use of the interchange, since continued use reinforces the feeling of security and can contribute to a reduction of time loss feeling.

- Operating needs

The transport service provider and its operation needs must be considered when designing a good interchange. In this respect it is necessary to try to reduce the operating costs of the modes of transport that operate in it. For example, tunnels entering in the interchange to avoid congested areas in the surroundings reduce significantly the journey time, causing a benefit for travellers and operators.

- Interchange management and operation

The management of the interchange, a task performed by the different authorities involved, is a crucial aspect for its day-to-day operation, including the need to create the figure of interchange manager, with responsibilities vis-à-vis the operators and users, and with the powers to impose penalties if necessary. The possibility of obtaining direct income through management of the interchange makes it possible to consider the economic profitability of the investment rather than just the social profitability, and to consider using the administrative concession system for its construction and operation.

- Safety and security

Safety and security must be considered when meeting other requirements, for instance in information and signalling, accessibility, interchange management and operation, etc. Safety must be developed and improved from the design point of view, in order to facilitate the rapid evacuation and clearance of these buildings, as well as the rapid evacuation of the fumes caused by a fire.

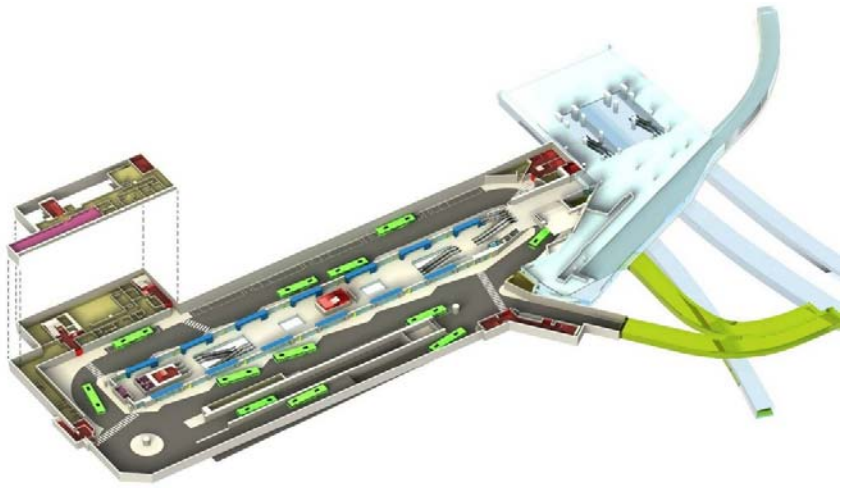

Figure 9 – Principe Pio interchange layout (source CRTM)

Key Enablers

Cooperation between all relevant stakeholders (including city council, several public administrations, public transport authority and transport operators) was key to the success of the project.

From a financial point of view, the project was funded through a 30-year concession to cover the construction and operation of the infrastructures, where private companies recover their investment by collecting a fare from each bus passenger getting on or off at the interchange. Transport interchanges are profitable infrastructures when created at important nodes of a public transport network, as is the case of Avenida de América, where the highest volume of passenger boardings and alightings of the entire Madrid Metro underground system is recorded. Furthermore, complementary revenues can be obtained when parking facilities for local residents and short-term parking for general public are incorporating in the scheme, in addition to shopping premises and other profitable activities such as advertising, vendor machines, antenna services for mobile telephone coverage, etc.

As a result, financing some of these interchange infrastructures through a public concession to a private group becomes a feasible approach, in which the concessionaire is responsible for the complete capital costs, management and operation of the transport interchange and its complementary facilities for a period of time.

From an operational point of view, substantial journey time savings and financial savings for transport operators, are achieved when interchanges are designed with several hundred metres of underground tunnels in urban areas with high levels of congestion. In the Moncloa interchange, for instance, the buses can access the underground bus station through a 4 km exclusive bus lane.

Key Barriers

One of the main difficulties to build the transport interchanges was to perform an infrastructure of these features in an already consolidated city plan, both in the entries of the Madrid city as well as its integration in an urban framework.

The need to sign numerous contracts and agreements with various authorities and privates was another added difficulty to make this project happen. In one side, the soil owners (e.g. the case of Príncipe Pío-Adif, the Urban Consortium for the enlargement of the Moncloa interchange, sometimes the Municipality) and, in the other side, the transportation managers (CRTM), or the planning permission issued by the Municipaity, etc.

Another eventual barrier was the viability of funding. The execution of an Interchange Station is something costly, as well as the maintenance of its facilities and the option of administrative concessions was the most feasible solution for the Interchanges Plan. In some cases, it was

impossible to fit them within a workable and sustainable economic model, therefore they have not been built yet (e.g. Conde de Casal Interchange Station).

Finally, an interchange hub is a very new type of infrastructure in terms of rules or legislation. Normally, they are underground infrastructures but with a different use from the more common structures like parking. The city of Madrid experienced a lack of dedicated regulations to apply and therefore the option was to resort to performance solutions, for instance for the protection in case of fire.

Looking into the future

The interchanges built so far have achieved their main objectives, including reduced journey times and improved quality of service. Two further main interchanges are planned to be built (Conde Casal and Legazpi), together with additional smaller intermodality areas located within the urban area of Madrid in strategic points where the mobility demand is very high, because of mainly mixed land use and high population density.

In the future, similar complementary interchanges will be built also in the metropolitan area, with the following functionalities:

- To be points of confluence of radial bus lines from areas of minor density and accessibility, towards high capacity radial transport modes of connection with Madrid;
- To be transfer points for transverse displacements that avoid the step along the central city;
- To favour intermodality not only among public transport modes, but also with private modes.

7. myCicero: Integrated mobile ticketing system (Italy)

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.

[4] Piano Generale Traffico Urbano 2014

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 intermodality between public and private modes depends also on the availability of exchange parkings 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, Cotral[5] and Trenitalia[6], 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 (Figure 10). The new service allows the purchase of "dematerialized" bus and metro tickets via smartphones.

Figure 10 – BIPiù service

[5] Largest Public Transport operator for regional transport (extra-urban)
[6] National railway company

Atac makes available the new BiPiù service through myCicero®, a free application available in the App Store and Google Play. myCicero integrates in the same App all the information on local mobility, schedules and route calculation, purchasing tickets for bus and metro, and on-street parking payment.

myCicero from 2015 provides in Rome a new service for contact-less & Mobile Ticketing responding, on one hand, to the needs of new customer segments through the dematerialization of the media and, on the other, the needs of virtualization of sales network through new distribution channels capable of ensuring time coverage of 24 hours a day and a specific offer, compared to changing customer needs. Basically, once the user is registered to myCicero service, s/he can buy a ticket via the App and get on the smartphone the equivalent of a paper ticket (Figure 11). The validation of the ticket will then happen nearing the smartphone to the QR-Code[7] present on buses or the Metro gate, and by tapping a button on the App. With the new ticketing system (although the classic paper ticket still remains) also the control methods become technological: controllers are provided with a handheld device with a dedicated application to check if the ticket is actually validated.

The mobile ticketing includes also seasonal tickets. The service is available on all of the surface transport: ATAC bus, tram and trolley bus, Cotral, Trenitalia railways. In the metro the service is available on lines A, B, B1, railway Roma-Lido and the Flaminio station Rome-Viterbo railway. Soon the service will also be active on the Roma-Viterbo railway and the metro line C.

Figure 11 – Rome Metro and access to gates

In addition, through myCicero the capital is among the first cities in Italy to have solved the conflict between virtual tickets and physical gates in the Metro stations (Figure 12).
When users access the Metro, a QRcode is generated by myCicero App to approach the optical reader on the turnstiles. QRcode is not the only technology available; it is the first case in Italy

[7] https://en.wikipedia.org/wiki/QR_code

where NFC[8] technology is applied in the world of urban mobility, in the specific case for the opening of the Metro gates. When users enter the gate through QRcode or NFC, the ticket will be valid for one ride, even on multiple lines. The same modality also applies to seasonal tickets.

Figure 12 – Access to Metro gates through NFC technology

myCicero application also allows the electronic payment of on-street and in-door parking. Through the app, therefore, the travellers can park, pay for the parking, take the bus, buy and validate a ticket in a seamless way without the need of any cash.

The ticket purchase can be done through different payment channels: by credit card (Visa and Mastercard), Paypal, cash at SisalPay shop, Bemoov. To enable interoperability of services along the country, myCicero® provides e-Wallet as an additional payment channel that can be used either to buy tickets, abonnements or pay for parking, not only in Rome, but in all cities participating in the myCicero ecosystem (i.e. Milan, Bologna, Ancona, Trento, Palermo).

Key success factors

myCicero and its application to the several services offered by ATAC is based on a **user-centric approach**. myCicero© is a 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. It is a personal assistant, a profiled reference based on specific users' needs in terms of mobility, transport and parking, purchase and fidelity policies, public services, hospitality culture entertainment. Actual services, available through myCicero platform (App for smartphone, Web Portal, Totem) are:

- Multimodal transport planning solutions for travelers and infomobility service: the system detects the best solutions to travel within Italy and Europe (combining together

[8] Near Field Communication: https://en.wikipedia.org/wiki/Near_field_communication

multiple rides by different operators); checks timetable, number of connections, time needed to reach the stops, anticipation and delays.

- Ticket purchase: the system searches for offers and proceeds with the ticket purchase and season ticket renewal directly through smartphone/web portal.
- Smart parking: the system allows the user to look for the on-street and in-door parking space, identifying the position and displaying the parking areas around him/her. By selecting one of them, the user can set the duration of parking time, but also extend or interrupt the parking. The parking duration is calculated on the actual parking time and the user pays through e-wallet.
- Information on events and points of interest: the system shows the most interesting events, itineraries and points of public interest within the covered territories, and allows the user to consult all transport mode available to reach them (public transport, organized tour, shuttle bus service, taxi, private vehicle).
- Bike and car sharing: the system will allow the user to view the availability of the vehicles in real time and their locations, with respect to the user's position or within a specific area, if covered by the service. Through smartphone/web portal, the user could also book a vehicle, among those available, and pay for the use by e-wallet.
- Municipal services: the system offers online payment of public services (such as local police services, economic activities, sports, cultural heritage, socio-educational activities, urban planning, taxes), managed by Italian municipalities.

MyCicero is rapidly growing on the Italian territory (Table 6). Some of the most important served municipalities are: Rome, Milan, Bologna, Ancona, Trento, Palermo. The updated list can be found on https://www.mycicero.it/eng/.

Local Public Transport	**More than 2200 Cities**
National Lines	More than 90 areas served
International Lines	France, Germany, Belgium, Switzerland, Hungary, Balcans, Slovenia, Luxemburg, Nederlands
Parking	More than 30 cities
registered users	More than 200.000

Table 6 - Figures about myCicero (December 2015)

Key Enablers

Mobile payment is a key enabler for integrated payment systems. The purchase of tickets for public transport, parking, tourist packages and other services linked to transportation are the most widespread solutions of Mobile Payment in Europe. In many cases the amount is deducted from the phone credit, however today the Mobile Wallet represents a valid option that can

offer a better and more efficient user experience. The high frequency of the usage, the reduced amount of every purchase, the advantage for the user of buying tickets wherever and whenever, are only a few cornerstones supporting that statement.
Today the legislation is heading to an homogenization of cost models linked to the different payment methods and the Mobile Wallet are becoming more and more ordinary tools. In this context, myCicero provides a single App able to manage several payment methods and different types of dematerialised tickets in order to offer advantages in terms of *User Experience*.

The service is not limited to the payment only but can also give to the user information related to tickets, lines, timetables, taxis, limited traffic areas, flexible transport, ride-sharing, car-sharing, bike-sharing according to the user's position and destination. It can communicate delays and other information as well, consistently with the consumer's *Customer Journey*, more and more "Digital" and "Mobile".

Another key enabler is the **single sign on** feature offered by myCicero service. End-users can experience the same Identity, the same user interface and, most of all, the payment methods in all cities where the service is available: VISA, Mastercard, PayPal, BeMoov, MyBank, PagOnline.

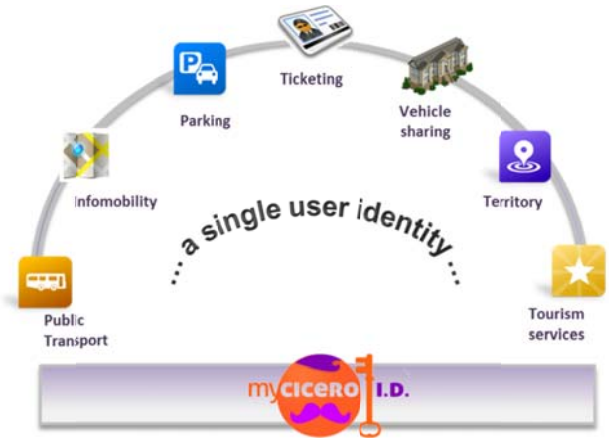

Figure 13 – myCicero features

In addition, the befits are not only reserved for the end user, but also the entire chain could benefit from the most efficient and effective processes (i.e. Automatic monitoring of lines, issuing of dematerialized tickets).

Last but not least, a crucial enabler is the willingness and commitment of city authorities and transport operators like ATAC and Rome to implement and promote integrated and mobile ticketing systems.

Key Barriers

Introducing innovation in ticketing systems to integrate multiple transport modes is not an easy task. Technology has been demonstrated to be ready, however several barriers can be identified for the adoption of new integrated services like the BIPiù service in Rome:

- **Technical barrier**: lack of standardisation and interoperability among transportation-related services supplied by different providers is still a barrier for the actual integration.
- **Stakeholders collaboration**: in order to integrated transport modes and provide the end-users with a seamless travel user experience, both in terms of information received and ticketing, it is essential that all the stakeholders involved look towards the same direction. Lack of collaboration among policy makers, public transport operators, service providers, technology providers, category associations is a huge barrier for the penetration of such innovative systems.
- **Usability**: the world of applications for end-users is a minefield. Easiness to use and intuitive interfaces are mandatory for user acceptance of Apps dealing with mobile ticketing.
- **Security**: Security with mobile payments is also a key concern for users
- **Consumer mindset**: The biggest obstacle to widespread mobile payment usage lies in the consumer's mindset. People do not intend to take up mobile payment options because they are already familiar with cash and card. The familiarity with cash and card makes consumer believe they are more convenient even if they have to fish around for change when paying with cash or enter PIN numbers and sign during card purchases.

Looking into the future

Social and economic trends indicates change of behaviours and attitudes of consumers, among them:

- Young people are less attracted by owning a car;
- Rise of sharing and collaborative economy;
- Bike-sharing has taken off across the world and car-sharing is growing fast;
- The example of Uber is significant and changes the expectation of the customers;

- On-demand and personalised services are emerging as well as high penetration of smartphones and internet connectivity.

2015 has seen the raise of a novel concept in the transportation sector: Mobility as a Service.
Mobility-as-a-Service (MaaS) is a paradigm shift in personal transportation in which travelers use services for transportation, rather than owning a car. This shift is enforced by several new mobility service providers such as ride-sharing and vehicle-sharing services as well as on-demand services.
The emerging paradigm can meet the new customer expectations, namely:

- Shift from vehicle ownership to vehicle usage by replacing purchase of means of mobility (Car, Bike, Bus ticket, etc..) with purchase of mobility services.
- The provision of transport as a flexible, personalised on-demand service that integrates all types of mobility opportunities and presents them to the user in a completely integrated manner to enable them to get from A to B as easily as possible.
- Offer a service contract to a customer that satisfy his/her transport requirements - service agreements between MaaS Operators and customers with packages for urban commuters, businesses, families, tourists, etc.

The new model involves various stakeholders: public transport, local authorities, mobility service operators, connectivity providers, citizens and technology companies all working as part of an ecosystem that enables mobility services.

The mobile ticketing integration of mobility services in Rome is today already a reality through myCicero and has a high potential for driving the introduction in Rome of the Mobility as a Service paradigm. Additional services, such as car-sharing, bike-sharing, taxi, ride-sharing, demand responsive transport would be integrated in myCicero providing the consumers with dedicated mobility packages.

8. Annex 1 - Criteria of Selection of Best Practice

No.	Criteria	Definition
01	Innovation Degree	Solution is comparatively new and has not experienced broad diffusion in practice
02	Policy Relevance	Solution addresses a range of key policy objectives (e.g. economic efficiency; modal shift; social inclusion; environmental sustainability; increased accessibility etc.)
03	Civic delivery team	Resource capability to successfully deliver the solution
04	Maturity	Solution is ready for implementation, having passed pilot or experimental stages and can build on working examples in one or more cities
05	Global Potential	Solution could become implemented broadly across countries/cultures/regions
06	Localised applicability	Solution addresses a very particular issue with a limited take-up potential
07	Complementarity	Represents a promising complement for other (innovative) solutions
08	Expected Impacts	Previous implementation of solution has had social, economic and environmental impacts
09	Measurability	Progress of solution implementation can be measured sufficiently
10	Public Acceptance	Solution is likely to have a wide public acceptance
11	Expandability/ Scalability	Solution can be up-scaled to accommodate different contexts and situations