	World Road Association (PIARC) Cycle 2012-15 Technical Committee 2.2 Improved Mobility in Urban Areas

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KEY ISSUES FOR IMPROVING MOBILITY STRATEGIES IN LARGE URBAN AREAS

4th of November 2015 (pm)

TECHNICAL REPORT

CONTENTS

EXECUTIVE SUMMARY

During the period 2012 – 2015, Technical Committee TC 2.2 collected and evaluated case studies on urban mobility from numerous large and medium-sized cities from all over the world. Three issues were evaluated in these case studies:

- A comparison of strategies for sustainable urban mobility, at a mobility plan level.
- The design of transport infrastructure for multimodality in urban areas.
- The promotion of walking and cycling.

In regard to the first issue, the objective was to find out how policies regarding transportation strategies, methods, and operations are decided and implemented by the authorities in an effort to solve current transportation challenges such as traffic congestion, ever changing population demographics, and environmental impacts. In order to benchmark system performance, mobility data at a metropolitan level was collected and analysed.

In regard to the second issue, the objective was to investigate the sustainability and efficiency of the increasing trend to dedicate travel lanes on existing road networks for use by buses, (bus rapid transit (BRT) systems) or carpooling (high occupancy vehicle (HOV)/high occupancy toll (HOT) systems)) to increase person throughput. The aim was to highlight and better understand the different practices observed among countries. We had also the objective to investigate the increasing motorcycle or scooter evolution, including its advantages and its drawbacks with regard to safety and road management. Since we could not collect enough material on this particular sub-topic, we introduced this issue at the Seoul conference.

In regard to the third issue, the objective was to investigate the evolution of the active modes (walking and cycling), and to identify and benchmark the different mobility plans for walking and cycling that are being implemented in several cities.

In summary, the main trends observed were as follows:

- Despite the large number of tools and policies to influence the modal share and the provision of transport facilities to the citizens, it will not be easy to solve congestion issues in the near future in all urban environments, even with a strong willingness of the numerous partners. Nevertheless, a progressive evolution toward improved mobility has been observed.
- Policies that encourage Transit Oriented Development (TOD) have improved intermodality and reduced the demand for private motor vehicle traffic.
- Improving mobility in a more sustainable way requires the efficient use of available road space. The change in focus from moving cars to moving people requires deliberate decisions to prioritise road space for the movement of BRT, HOV and pedestrians and cyclists.
- In addition to the existing rail mode, bus systems can play an efficient role towards a better modal shift into public transport.
- A great improvement of BRT implementation has been observed, at different scales, with different solutions and with a new trend to utilize BRT on motorways. BRT is implemented with significant differences among countries,

due to numerous factors, such as the existing efficient rail market, the geographical context, and economic trends.

- The HOV concept is well developed in many large North America cities. Many HOV facilities are now being transformed into combined HOV/HOT lanes, providing access to other vehicles upon payment of a toll. Free flow in these lanes is guaranteed by applying a variable toll to vehicles with less than three occupants. The tolls vary based on lane usage to provide continuous free flow conditions on the HOV/HOT lanes, even during peak traffic conditions. This operating system offers guaranteed flow for high added-value trips (buses, emergency services, car-pooling, etc.), freedom of choice for motorists with time demands, as well as an additional resource for public finances.
- Active modes of transportation, such as bicycling and walking, are now becoming more recognised as an indispensable part of the mobility plans of cities.

In addition to this report, the reader will find the report called **"Summery of HOV, HOT, BRT case studies collected"**.

COMMITTEE MEMBERS WHO CONTRIBUTED TO THE REPORT

Harlan MILLER, USA,
Dilip MUNDKUR, USA
Ana Maria LEYTON, Canada
Robert FREEMANTLE, Australia
Gabor SCHUCHMANN, Hongrie
Urs GLOOR, Switzerland
Horacio MALDONADO, Chile
Juan COFRE, Chile
Keechoo CHOI, South Korea
Thomas MACOUN, Austria
Lluís ALEGRE I VALLS Spain
Marc GARCIA, Spain
Louis PROCHORE NOUBISSIE, Cameroun
Akira ENDO, Japan
Takashi YAJIMA, Japan
Toshiro KONO, Japan
Takeshi HONDA, Japan.
André BROTO, France
François RAMBAUD, France
Oscar FARINA, Argentine
Ricardo Eugenio ARREDONDO ORTIZ, Mexique
Valentin ANTON, Roumanie
Jean Claude MOUREAU, Belgique
Natalia TANAN, Indonesia

1. THE DEMAND

The efficiency of the transportation systems in large urban areas affects the daily lives of millions of inhabitants as well as the economic dynamism, liveability and the environmental quality of urban centres.

Understanding people's transport needs and their behaviour

As cities grow and the demand for travel grows it is important that transport systems are developed and managed to best meet the needs of users in a sustainable way. This requires a good understanding of users transport needs including demand for travel, origin and destination, recent trends and future travel demand forecasts. It also requires clearly defined objectives that the transport system is seeking to achieve.

The table below illustrates urban sprawl in the US: the national trend on the location of US population has been dramatic, with people moving out of the central cities and out of rural and small urban areas into the suburbs of larger cities.

Location	Percentage of population in 1950	Percentage of population in 2010
Central City	33 %	24%
Suburbs	29 %	61%
Non-metropolitan Areas	38 %	15%

*Location of Population in the US 1950 to 2010**

With the movement of population to the suburbs, the average trip length has significantly increased, while travel time has remained fairly stable as shown in the table below.

Year	1983	2009
Average Trip Length (km)	14.2	19.7
Average Travel Time (min)	22.0	25.4

*National Average Work Trip Length and Travel Time in the US (1983 vs. 2009)**

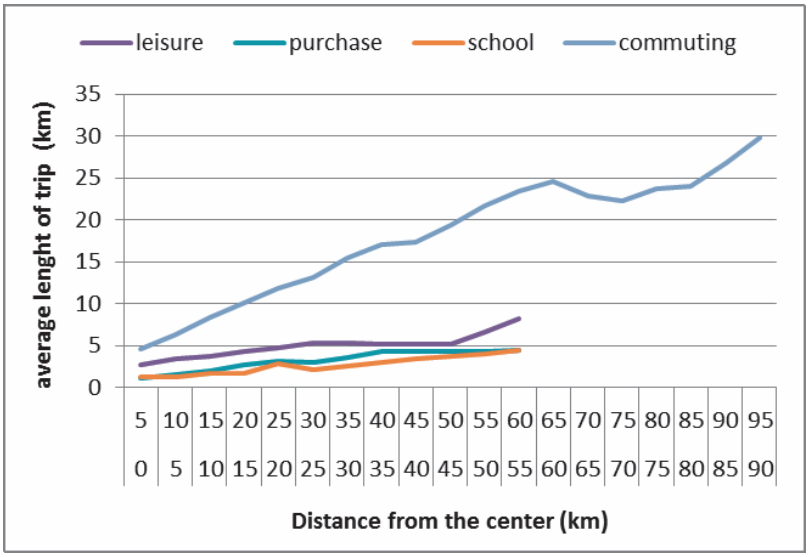
Most large urban areas in the world are facing the same effects of urban sprawl.

Transportation trends are directly influenced by the urban structure and land use patterns. Trip length depends on the density of destinations and planners tried to minimize that increasing trip length, by providing jobs and facilities (schools, shops, etc.) in sufficient number, and well spread over the urban area.

An analysis of trips length[1] as a function of the purpose of the trip and as a function of the distance of home from the city centre shows that the strategy of providing a good

[1] From the article published in "Routes-Roads 2015 - N°365" - Mobility issues in large urban areas: Paris metropolitan area - by André Broto, deputy general director, Cofiroute, France, and Julien Villalongue, Concession contract manager, Vinci-Autoroutes, France.

distribution of the facilities works for all purposes, except for commuting trips: people who leave at 30 km from Paris have to travel on average 15 km instead of 5 km for people living in Paris.



The figure gives the trip length in the metropolitan area of Paris as a function of the distance between home and the city centre.

We have therefore to organize transportation facilities taking into account two types of needs: short trips which need the promotion of walking and cycling, and longer trips, mainly in the suburbs, which need an adequate organization of transport modes as well as intermodal facilities.

Also, a better understanding of the interdependencies between land use decisions and transportation is required if we are to fully understand transportation trends and improve the overall sustainability and efficiency of the transportation system. Monitoring of progress toward achieving sustainable transportation such as the Urban Transportation Indicators surveys conducted by the Transportation Association of Canada[2], can provide valuable information in this regard.

Recommendations concerning the transportation demand:

- Comprehensive transportation demand data is needed to understand commuting patterns and trends. Such data should capture the geographical characteristics and structure of a given urban area (including population and employment data, densities, mix of uses, etc.) and detailed commuting information (number of trips, purpose (school, work, etc.), distance travelled and duration, as well as choice of transportation mode).

- Monitoring of trends is required to determine if changes in infrastructure have altered travel behaviour, in favour of more sustainable transportation modes (public transportation, carpooling, walking and biking).

[2] Transportation Association of Canada http://tac-atc.ca/sites/tac-atc.ca/files/site/doc/resources/report-uti-survey4.pdf

2. COMPARISON OF STRATEGIES FOR SUSTAINABLE URBAN MOBILITY

Comparing strategies of metropolitan areas (MAs) for realizing sustainable mobility is a challenging task requiring consideration of wide ranging factors. Firstly, we need to understand the diverse settings where MAs are placed. Those diversities include population, area, density, terrain, economy, social structure, public administration structure etc. These are considered as given conditions for planning sustainable mobility strategies. Secondly, we also need to understand and establish evaluation criteria for comparing performance of strategies in terms of sustainable mobility. MAs have prepared their strategies aiming at achieving higher performance under their given conditions or constraints. Therefore, the strategies themselves are also quite diverse.

In order to investigate this challenging task, we adopted two approaches: one to collect baseline data on background and mobility performance of MAs; and the other to collect good cases of strategies for sustainable mobility. In both approaches, we had in mind as sustainability concept the social, economic and environmental dimensions.

To find and explain some strategies for sustainable mobility we launched a survey for collecting new case studies and updating existing ones.

During this collection and concurrent analysis, some items appeared important for stakeholders, such as the recurrent problem of urban space reallocation, the field of application of the TOD concept, the field of application of HOV lanes. Hence some key points were collected and described in the latter part of this chapter regarding these three items.

2.1. Some findings from the surveys

A survey was conducted to compare urban transport service levels in 8 metropolitan areas (Tokyo, Vienna, Santiago, Melbourne, Seoul, Paris, Barcelona, Nagoya); a similar survey had been done in the past PIARC cycle concerning population employment and modal split (Mexico, Madrid, Helsinki).

Modal Split

We evaluated the modal split taking into account only motorized trips for 11 MAs stated above. Modal split is considered as an important indicator of social, economic and environmental sustainability. As a social indicator, it represents mobility for so-called transportation poor with no private car available. As an economic indicator it represents the efficiency of land use for transportation purpose. As an environmental indicator, it represents less environmental impacts in terms of local environment and global warming[3].

[3] Nota : it is difficult to take into account non-motorized trips because the comparisons are affected by the type of data done in each country.

Métropolitan areas	General data			Modal split in number (motorized modes only)		
	Population	Employment	area	public transport	Car	Motorcycle
Metropolitan areas with about 50% of public transport among motorized modes						
Tokyo	37 267 582	19 042 085	16 344	51%	46%	3%
Seoul	25 258 057	12 527 000	11 818	51%	42%	6%
Mexico	19 239 910	13 336 917	7 858	67%	33%	
Santiago	7 007 620	3 362 340	15 391	60%	40%	
Madrid	5 804 829	2 763 068	8 029	46%	54%	
Metropolitan areas with about 30% to 40% of public transport among motorized modes						
Paris	11 659 260	5 612 336	12 012	34%	63%	2%
Barcelona	5 052 000	1 394 422	3 340	38%	55%	7%
Vienna	2 631 830	1 198 535	8 943	39%	61%	0%
Metropolitan areas with less than 30% of public transport among motorized modes						
Nagoya	9 831 194	4 957 090	6 590	16%	83%	1%
Melbourne	3 940 808	1 744 260	8 831	9%	91%	0%

We can summarize that table as follows:

- Group 1 : very good modal split with about 50 percent or more of public transport;
- Group 2 : good modal split with between 30 and 40 percent of public transport;
- Group 3 : less than 20 percent of public transport.

It is interesting to analyse the survey taking into account the different types of public transport (rail based vs. road based) as presented in the table below. We observe two groups of metropolitan areas:

- Metropolitan areas with a system of public transport mainly based on rail networks;
- Metropolitan areas with a system of public transport with a significant use of buses.

Métropolitan areas	General data			Modal split in number : detail for public transport			
	Population	Employment	area	Rail	Bus	Total	Ratio rail / ratio bus
Metropolitan areas with a system of public transport mainly based on rail networks							
Tokyo	37 267 582	19 042 085	16 344	47%	4%	51%	11,44
Paris	11 659 260	5 612 336	12 012	25%	9%	34%	2,65
Nagoya	9 831 194	4 957 090	6 590	14%	2%	16%	8,83
Melbourne	3 940 808	1 744 260	8 831	7%	2%	9%	3,11
Vienna	2 631 830	1 198 535	8 943	32%	7%	39%	4,80
Metropolitan areas with a system of public transport with a significant use of buses							
Seoul	25 258 057	12 527 000	11 818	18%	33%	51%	0,54
Mexico	19 239 910	13 336 917	7 858	9%	58%	67%	0,16
Santiago	7 007 620	3 362 340	15 391	no figures but mainly bus		60%	?
Madrid	5 804 829	2 763 068	8 029	27%	19%	46%	1,42
Barcelona	5 052 000	1 394 422	3 340	15%	23%	38%	0,65

The main findings are the following:

- Most of the metropolitan areas in Group 1 (4 onto 5) have a system of public transport with a significant use of buses.

- Most of the metropolitan areas in Groups 2 and 3 have a system of public transport mainly based on rail.
- Tokyo is a very special case with a very good modal split mainly based on rail systems.

Travel speed

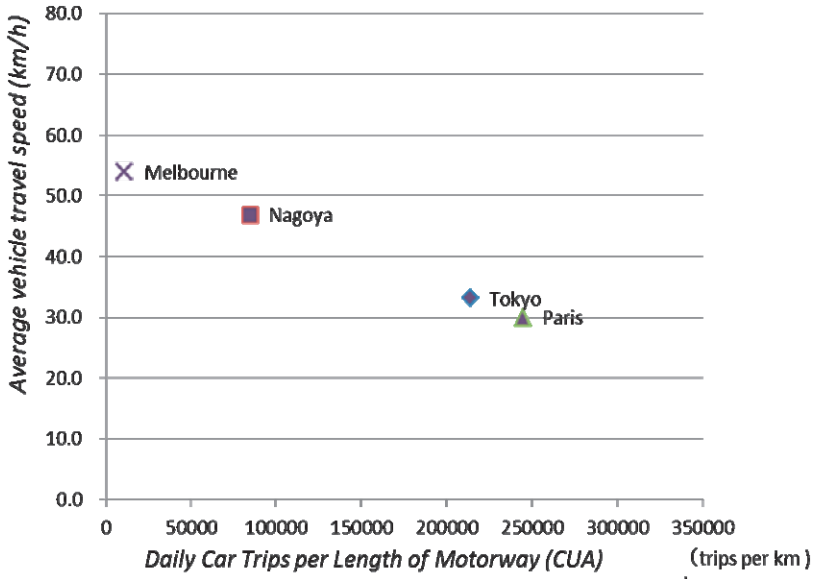
Another main output from the survey is travel speed. It is considered as an indicator of economic and environmental sustainability. As a former one it represents efficiency of time and as the latter less emission of pollutant per distance travelled.
Comparison was made for 8 MAs surveyed in this cycle. Analyses revealed that there are not large differences among MAs for travel speed during off-peak hours, in the suburban areas or on arterial roads other than motorways. A significant differences are detected for those on motorways in the central urban areas during peak hours.
An analysis was made to find out factors affecting travel speed. Although the sample size is small, it is suggested that the ratio of motorway length and number of vehicle trips affects travel speed.

(km/h)

Metro-politan areas	Motorway						Arterial Road					
	Central Urban			Suburban			Central Urban			Suburban		
	Twelve-hour daytime average	Peak hour average	Daytime off-peak average	Twelve-hour daytime average	Peak hour average	Daytime off-peak average	Twelve-hour daytime average	Peak hour average	Daytime off-peak average	Twelve-hour daytime average	Peak hour average	Daytime off-peak average
Tokyo	41.2	33.1	48.5	68.6	60.9	74.9	16.9	16.4	17.1	29.0	27.4	30.2
Vienna	55.0			100.0			35.0			60.0		
Santiago	85.1	82.2	86.1	–	–	–	–	20,30 – 20,00	–	–	18,1 – 17,0	–
Melbourne	63.0	54.0	74.0	76.0	68.0	84.0	28.0	25.0	32.0	39.0	36.0	43.0
Seoul	42.9	36.7	51.3	73.8	71.3	79.6	20.5	20.9	21.3	38.6	37.4	41.5
Paris	38.0	30.0	49.0	68.0	60.0	78.0	–	–	–	–	–	–
Barcelona	54.7	–	–	–	68.1	96.1	22.5	–	–	–	47.4	53.5
Nagoya	57.2	46.9	63.0	71.5	65.5	75.2	22.3	17.0	21.7	30.0	26.8	31.8

Average travel speed in metropolitan areas

In recent years (2010-2011)



Case Studies

Among case studies collected, four cases are presented here to illustrate the wide variety of strategies involved in this issue: Tokyo as a case of good coordination between land and rail developments; Madrid of coordination between road and rail networks; Switzerland (Berne) of coordination between different levels of the public sector; and US of illustration of overall national trend of modal share.

Tokyo: a case of coordination between land planning and development of rail transit network

In Tokyo[4], the pattern of land use densities follows the pattern of main mass transit networks, and thus, multi-modal urban mobility has been realized at a substantial degree. This is due to the medium-term strategy of coordinated planning and financing between rail transit network development and suburban development. The strategy has long been employed by private rail companies and by public sectors in the Japanese large metropolitan areas including Tokyo.

Throughout the 20th century, the period of lasting urbanization for Japan, one of the policy issues was to provide affordable housing and housing sites to inflowing population in the large metropolitan regions, under soaring land prices. In order to develop suburbs at a large scale, the extension or improvement of existing urban rail network (basically formed up by 1920's) was considered to be an effective urban transport policy.

The key concepts of the coordination strategy are twofold. One is the implementation of suburban development under private rail companies' initiative, supported by central and local governments. The other is re-investment of the gained development benefits to further rail-extension and suburban development by private rail companies. The strategy has been an effective urban transport policy as well as a sustainable business model over years.

Madrid: a case of optimization / coordination between main road networks and rail networks

According to the European Metropolitan Transport Authorities (EMTA) 2008 barometer, the metropolitan area of Madrid had the best modal split (motorized modes) among about 20 European great cities. The transport authority of the area (CRTM) won several awards (Intermodes Award 2010, ITF-UITP Award 2010 for the best innovation in public transport, International Osmose Award 2011: efficient planning and use of infrastructure and interchanges).

We can summarize the case study as follow:

- A huge development of suburban bus lines on motorways: every year about 180 million trips are done by buses on the eight main radial corridors.
- Very efficient interchanges: there are five interchanges (metro station + suburban bus station + urban bus station) connected to motorways through tunnels; every day about 250,000 passengers are changing from bus to metro.

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[4] From the article published PIARC's "Routes/Road" No.365 "The Medium-term Strategy to realize Multi-modal Mobility in Tokyo Metropolitan Region", by Takashi Yajima.

- The suburban bus lines are dedicated mainly to commuters and student's needs, the average trip length is 17.5 km :

Metropolitan area of Madrid	Number of trips	Pass*km	Lenght per trip	Type of trip addressed
2006 data	million / year	million / year	km / trip	
suburban bus	230	4032	**17,5**	Long distance
Rail	204	3966	**19,4**	
Metro + Tramway	660	4616	**7,0**	Medium
urban bus	529	1987	**3,8**	Short
Total	1623	14601	**9,0**	

This is a very important point: motorways can play an important role in providing a good service for commuters who are leaving in the suburbs and periurban areas.

Generally speaking, there are no dedicated lanes except in the most important corridor (Motorway A6) where there is a dedicated reversible lane on the last 16 km:

a. A "only bus lane" on 3.8 km with 8,000 passengers per peak hour,
b. A "HOV + bus" section of two reversible lanes with 5,500 passengers per lane and per peak hour.

Switzerland: a case of coordination between different levels of the public sector

In Switzerland[5], there is an interesting approach to urban and transport planning. The Urban Area Project in Switzerland is a good example of a coordinated planning:

- between the different levels of the public sector (government, cantons, agglomerations and municipalities)
- of urban development and transport,
- of sustainable development.

The factor of access is a coherent derived unit of measurement. On the national level the Spatial Concept for Switzerland is a good framework for the cantonal, regional and communal planning. Regarding the urban area, the Federal Government has contributed to the sustainable development of towns and agglomerations since 2001 with its Agglomeration Policy. To date, this policy has concentrated heavily on coordinating settlement growth and transportation, as well as on improving cooperation at the institutional level within the agglomerations themselves and between the different levels of the public sector.

Goals and conditions:

- improve the quality of the transport system,
- encourage urban development in the centres,
- increase road safety,
- reduce pollution and resource consumption.

[5] From the article published in PIARC's "Routes/Road" No.365 , by Urs GLOOR : Le concept de transport régional et de design urbain de l'agglomération de Berne (2012) - déclenché par le Projet de territoire Suisse et le Projet d'agglomération.

There is a kind of competition between urban areas in Switzerland as the subsidies are higher if the effects are large and positive, if the costs are small, if the planning status shows that the measure can be implemented in time, and if the results of the monitoring are positive.

The Regional Transport and Urban Design Concept of Greater Berne (2012) is an example of an Urban Area Project in Switzerland:

> Berne, capital of Switzerland, is a city with about 138,000 residents and about 150,000 jobs. In the whole area of the region, there are in total 380,000 inhabitants and 240,000 jobs.

Strategy/Vision: concentrate urban development in the city centres with good public transport as much as possible; protect the landscape; regarding the traffic, shift to public transport and non-motorized transport, make the traffic more compatible.

Examples:

- Prioritization of public transport over motorized private transport
- Traffic management for steering and dosage (overload protection) of the motorized private transport and preference of public transport
- High compatibility of the roads through city districts and villages
- Mobility management and parking policy across community
- Appreciation of tangential connections for pedestrian and bicycle traffic
- Good secure supply of B+R (Bike and Ride) lots, even for city commuters from train stations to jobs

The measures were assessed in terms of cost-effectiveness.

Participation of the people and politicians was requested at public enquiry events and discussions were very important. Everybody could comment on the new concept. The concept was subsequently adjusted according to the comments and opinions. Finally, the concept was endorsed by the conference of the mayors of the communities of Greater Berne.

There are several ongoing measures with positive effects. For example, the development areas for workplaces and for transport-intensive projects in the whole agglomeration are mainly situated at railway stations. Also, some trends are positive for the sustainable development. In Berne, more than 50 percent of the households don't own a motorcar, and this percentage is increasing. With the construction of two new tramlines (instead of two existing bus lines) to the western part of the city of Berne, the modal split between the western part and the city centre/eastern part of the city could be changed from 54 percent motorized private transport / 46 percent public transport (2007, two bus lines) to 44 percent motorised public transport. / 56 percent public transport (2013, two tramlines).

National trends in the US encourage expanded HOV/HOT use, light and commuter rail, and BRT.

In the United States, nationally, as shown in the table below, the percentage of all commute trips that are drive alone single occupant vehicle trips continues a long trend of increasing while the overall percentage of carpooling trips is declining. Those trends are a consequence of the expansion of commuting areas.

MODE	Percentage of Trips in YEAR - 1980	Percentage of Trips in YEAR - 2010
Drive Alone	64.4%	76.6%
Car Pool	19.7%	9.7%
Public Transportation	6.2%	4.9%
Bicycle	0.5%	0.5%
Telework	2.3%	4.3%
Walk	5.8%	2.8%

*Commute Trip Mode Share in the US 1980 to 2010**

**Source – Commuting in America 2013, The National Report on Commuting Patterns and Trends, AASHTO, January 2015.*

Public transportation use has very recently begun reversing a decade's long decline and has increased in the past ten years as a percentage of all commute trips. Bicycle trips, although still a small percentage of all commute trips, has remained constant, walking trips have declined, and telework has increased significantly.

These changes in commuting patterns and the resulting changes on the demand for transportation services explains, in part, the recent trends toward the planning and implementation of networks of HOV/HOT facilities, light and commuter rail, and BRT in the larger metropolitan areas in the US.

These systems improve the connection of the expanding population in suburban areas to employment in the central city and surrounding suburbs along major corridors while reducing the needs for single occupancy vehicle highway expansion where land is scarce and environmental impacts can be significant.

Findings concerning the strategies:

- The question of “the efficiency of the transportation system in large urban areas” is a very difficult question. We could focus for example on the economic aspects, the social efficiency aspects (are the transportation benefits shared equitably through the community?) or the environmental aspects, depending on the priorities.
- There is not a single solution, and the planner has to try to find the best path, to go from an existing mix of “urban structure + transport system”, to a better one taking into account the city's policies, culture, history and constraints.

Recommendations concerning the strategies:

- Generally speaking, all members of TC2.2 pointed out the need to provide, at least at local level and for all municipalities, mobility policies taking into account cycling and walking.
- According to the context, a bus network dedicated to long distance trips (commuter’s needs) can play a high strategic role in the suburbs and periurban areas, using the structuring road network. Dedicated lanes could be necessary in some sections.
- Such a bus network should be designed in relation with the mass rapid transit network with adequate intermodal interchanges.
- The purpose of both actions is the "use of different modes on their own and in combination" with the aim of achieving the "optimal and sustainable utilisation of resources”, defined as co-modality.
- Facilities such as HOV and HOT lanes can also play a strategic role to support carpooling.

2.2. Road space reallocation

Road space reallocation issue

Large cities are always faced with mobility issues, congestion and their increasing environmental impacts such as pollution and greenhouse gas emissions. Since the option of building new infrastructure is no longer easily affordable or sustainable, public policies have tended instead to redistribute road space to benefit those modes deemed preferable to the single-passenger automobile. This wide evolution has required creativity, strong decision-maker involvement and considerable outreach to all actors.

Such sustainable modes are highly numerous, such as BRT, multi-occupancy vehicles, car sharing systems, clean vehicles, and active modes, whose mobility markets are actually much differentiated and mostly complementary.

One of the big challenges we face is to manage the competing demand for limited road space in a growing city, while ensuring the city is economically vibrant and a place where people want to live.

As roads become more congested, we need to make decisions on how we will use this finite public resource. Traditionally, most road space has been devoted to general traffic lanes and for on-street car parking[6]. Roads have also generally been managed to provide a balance between competing uses. It is increasingly apparent that the limited road space can no longer equally provide for all road users, at all times and in all locations.

Road space reallocation has been described as shifting road space currently devoted to automobile traffic or parking to serve other modes, such as sidewalks, bike lanes, High Occupancy Vehicle (HOV) and bus lanes or rail lines[7]. It represents an important change to the traditional approach to managing roads. It is increasingly being used as a response to traffic congestion and its consequences for economic competitiveness and city liveability.

Example of road space reallocation showing a dedicated bus and taxi lane in Melbourne, Australia.

Policy Objectives

Policy objectives should be established to guide decisions on road space reallocation. Desirably, these should be developed and agreed with stakeholders and be transparent to all citizens. This is particularly important as reallocating road space results in 'winners' and 'losers'.

Whilst all cities are different and many have differing objectives, best practice suggests adopting policy objectives that seek to improve the sustainability of our transport systems. These include:

- Optimising the movement of people and goods.
- Increasing the proportion of trips undertaken by public transport, walking and cycling.
- Reducing the demand for travel.
- Making the transport system safe and encouraging healthier transport choices.
- Improving the environmental performance of vehicles.
- Providing for social inclusion.

Road space reallocation is an approach that enables a number of these objectives to be realised. It is not new. Bus lanes, car-pooling lanes and clearways have been

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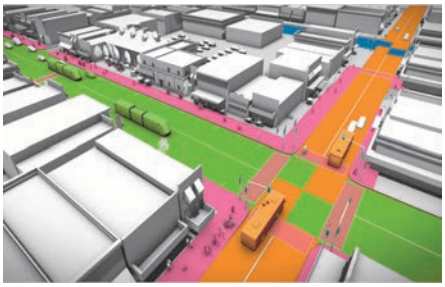
[6] On-Line TDM Encyclopedia, Victoria Transport Policy Institute
[7] On-Line TDM Encyclopedia, Victoria Transport Policy Institute

used for many years to manage traffic flow. However, with growing congestion and increasing competition for limited road space, prioritising the use of this road space by mode, by time and by location provides a strategic logic for road managers and land use planners.

A Network Approach

A best practice example of managing competing road space demands is the 'SmartRoads' approach by VicRoads in Australia[8]. SmartRoads focusses on a road-use hierarchy that allocates priority road use by transport mode, place and time of day. It is a network-wide approach that reflects that a change in priority use of one road will have impacts on other roads that also need to be managed.

SmartRoads



VicRoads has worked in partnership with a broad range of relevant stakeholders in developing SmartRoads. Network Operating Plans have been developed for each of the 31 local government areas across Melbourne. These plans are being used to inform all decisions regarding the operation of the road network, from major infrastructure projects to minor works, as well as land use development with implications on the road network.

Implementation

Road space reallocation is particularly appropriate on congested roads. Unfortunately, these are the most difficult to change. Giving priority to one mode over another results in an increase in delay and congestion for the 'loser'. A network approach is generally required to reasonably manage the redistribution of traffic that is likely to occur, at least in the short term. Where road space is prioritised to favour public transport, over time, a mode shift should be expected as private motorists realise the mobility benefits offered by this alternative.

Road space reallocation should also be considered in areas currently not experiencing congestion but where future growth is forecasted. It is easier to introduce say a bus lane or a cycle lane where traffic flow is relatively low than when the road is heavily congested. Securing the footprint early provides the ability to build a more sustainable transport system in the future. Where bus frequency or other priority use is low, it may be appropriate to allow other vehicles such as taxis and cars with multiple passengers to use a bus lane until bus frequency grows with demand.

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8 www.vicroads.gov.au

Community and stakeholder engagement and support is critical to the successful implementation of any scheme to reallocate road space. This should not be underestimated.

Implementation should also include a range of supporting tools and actions to enhance a road space reallocation project. Travel time information systems help people make travel choices between modes; traffic signal priority reduces delay and improves reliability for priority modes, and safety and comfort are important in attracting and retaining passengers. Attention should also be given to mitigating the impacts for 'losers' in such a project. This may include actions such as the provision of replacement parking in an off-street location where on-road parking in a shopping environment has been removed.

The Challenge

As cities grow and the demand for travel grows, attention needs to be focussed on the attributes of travel if we are to manage this growth sustainably. Changing to travel modes that move more people, changing the time at which people and freight move to avoid congested travel periods, reducing the length of trips through improving access locally to goods and services and changing the direction of travel to utilise spare capacity in transport systems in the counter peak direction will help improve the sustainability of our transport systems. These require an integrated approach to transport and land use planning. Some actions can be implemented in the short term. Many will take longer and may need city reshaping planning and investments to realise.

Reallocating road space, is a short term action. In congested cities, it is also hard to implement. It will require a change in the culture of thinking by transport and land use planners if it is to be implemented on a wider city-scale. Importantly, it is one element that can help move us towards a more sustainable transport system.

Any projects of re-sharing this limited public space have often encountered opposition, highlighting the need for more and better studies. Such studies should be managed at a large scale if possible, to not only reflect the local concerns but also the more global interests.

On another hand, setting up such studies is never easy, as compromises are always required and need to be discussed. How can we improve the efficiency and reliability in favour of road-based public transport without decreasing the space dedicated to the car? How can we achieve a high compatibility of the roads through city districts, with safer crossings and turning lanes for pedestrian and bicycle traffic?

Case study from Japan (A policy change toward road space reallocation - Dr. Takashi YAJIMA)

The following case study from Japan is illustrative of the policy changes occurring in a number of countries to more sustainably manage existing road space.

<u>Introduction</u>

The National Council on Social Infrastructure Development reviewed and evaluated the performance of national road development policy over the past 60 years, and proposed tentatively various policy changes to the Minister of Land, Infrastructure and Transport in June 2012. Among others, a policy change toward “road space reallocation” is clearly stated.

In a few years to come, the proposals would be finalized and necessary legislative and/or administrative measures will be worked out toward implementation of the proposed policy change.

Policy Review

- Past policy focused mainly on increasing vehicle traffic, and less emphasis has been paid to the other road users, such as pedestrians, bicycles, and road-based public transport.
- Past legislative and administrative measures were designed mainly for “road construction and improvement” for expanding vehicle traffic capacity, and less consideration has been paid for how to better utilize existing road space.
- Whilst the national trunk road network has more or less being completed, congestion and related problems still remain significant in large urban areas.
- Throughout the whole process of planning and implementing road development and use of road space, road administrators tend to stand by themselves and coordination with the other stake-holders, including road-side dwellers, NPOs, and operators of the other transport modes, has been limited and poor.

Proposals for policy change

Among a wide-spectrum of proposals for policy change by the Council, noteworthy is firstly "road space reallocation", and then "coordination and assistance for road-based public transportation".

1. road space reallocation
    - Toward road space allocation, main road users should be identified for each urban road from the point of “urban road hierarchy”.
    - For major urban roads, where traffic function is a major concern, existing space for vehicle traffic can be reallocated to pedestrians, bicycles etc., by partial distribution and dispersal of existing vehicle traffic to by-pass and other detour routes.
    - For minor urban roads, particularly in residential areas, priority should be given to pedestrians and bicycles and “humane priority zone” should be created in cooperation with area traffic control. Consideration should also be paid to the other “slow-moving traffic”.
    - Partnership among road administrators, local governments, local traffic police and citizens concerned should be worked out on “better and wise use of road space” in a particular urban area.

2. Coordination and assistance for public transport
    - Smoother access to transport nodes in urban areas should be developed and improved.
    - Rail station front space for inter-modal connection i.e. “station frontage plazas”, are to be developed and improved for seamless modal change. Attention should be paid also to smooth pedestrian traffic flow, both horizontal and vertical, in and around transport nodes.

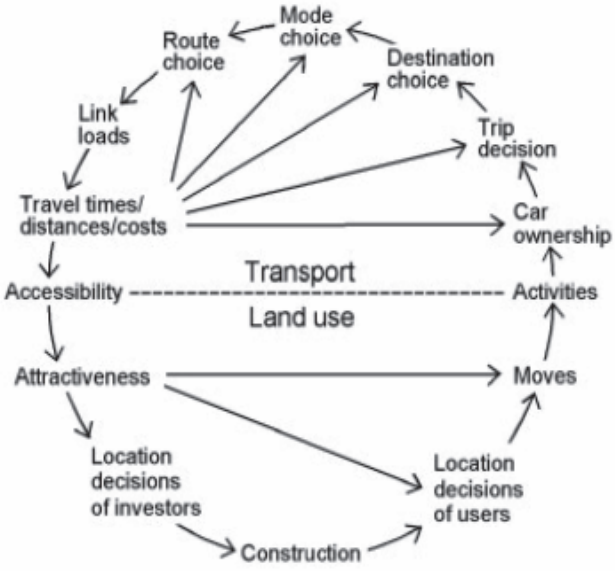
- Assistance for bus transport should be promoted by provision of exclusive bus lanes and reversible lanes by reallocation of carriageway space in existing urban roads.
- Possibility of introducing LRT and BRT should be pursued and expanded through reallocation and redesigning of existing road space.

2.3. Transit Oriented Development, as a strategy for urban development and intermodality

Many cities and local governments have considered sustainable development and urban sustainability against the growing consumption of fossil fuels in the transport sector. Here, Transit-Oriented Development (TOD) is the fast growing trend being considered as the way to realize *new urbanism*[9] throughout the world. To make a city sustainable, people's travel demands must be fulfilled by transportation modes with smaller energy consumption and lower CO2 emission such as transit, walking, and biking. Therefore, TOD can be one of the solutions to general urban traffic congestion in the short term and a one to serious and growing problems in the long run caused by climate change by global warming. The idea of TOD is to promote walkable communities connected to public transportation system that greatly reduce the need for driving and the consumption of fossil fuels (Zhang, 2006; Kang, 2012).

Linkage between Land Use and Transportation

In talking about TOD, the land-use and transportation is not far away from it and TOD also falls in the realm of the interaction between the two with the medium of accessibility. Wegener and Furst (1999) provided the 'Land Use Transport Feedback Cycle' to explain the accessibility – land use – activities – transport system relationship. This feedback cycle indicates that a key problem in the transport planning logic and idea of integrated transport often fails to consider land use impacts with ignoring the wider impacts of transport in the urban environment (Mepham, 2013). As shown, the accessibility and activities lies between the boundary line of the land use and transportation and two factors plays an important role in achieving good example of TOD.



Land Use Transport Feedback Cycle (Wegener and Furst, 1999)

[9] This is strongly influenced by urban design practices that were prominent until the rise of the automobile and encompasses principles such as traditional neighborhood design (TND) and transit-oriented development (TOD). It is also related to regionalism, environmentalism, and smart growth. (Wikipedia)

Definitions of TOD

There is no unique definition of Transit Oriented Development (TOD). Among the many definitions of TOD, the following three, provided by the Centre for Transit Oriented Development (CTOD), the Institute for Transportation and Development Policy (ITDP), and Wikipedia respectively, are noted below.

> Transit-Oriented Development is typically defined as more compact development within easy walking distance of transit stations that contains a mix of uses such as housing, jobs, shops, restaurants and entertainment. TOD is really about creating walkable, sustainable communities for people of all ages and incomes and providing more transportation and housing choices (Centre of TOD, 2007).
>
> TOD implies high quality, thoughtful planning and design of land use and built forms to support, facilitate and prioritize not only the use of transit, but the most basic modes of transport, walking and cycling (ITDP, 2014).
>
> A transit-oriented development (TOD) is a mixed-use residential and commercial area designed to maximize access to public transport, and often incorporates features to encourage transit ridership. A TOD neighbourhood typically has a centre with a transit station or stop (train station, metro station, tram stop, or bus stop), surrounded by relatively high-density development with progressively lower-density development spreading outward from the centre (Wikipedia).

Although there are many transit station types that can be integrated with TOD neighbourhood, the following three types are the most dominant and provide better potential for enlarging the TOD catchment area: rail stations, bus stations and stations providing bicycle support.

Typologies in TOD

Traditionally, the transit orientation of an area has been measured using the 3 D's of ***density***, ***diversity*** of land uses, and ***design*** or built form. Here, the transit normally refers to rail-based, but these days bus rapid transit also comes into play for TOD and sometimes the tram or light rail transit is also intertwined with TOD and various implementations are available all over the world. In addition, for the purposes of better evaluating urban form and transportation system performance, the 5 P's used for the strategic plan are suggested and those are as follows:

1. ***People****: The number of residents and workers in an area.− This has a direct correlation with reduced vehicle miles travelled.*
2. ***Places****: The number of neighbourhood serving retail and service establishments.− Areas with commercial urban amenities such as restaurants, groceries, and specialty retails not only allow residents to complete daily activities without getting in a car, but they also improve the likelihood of higher density development by increasing residential land values*
3. ***Physical Form****: Average block size.− smaller city blocks promote more "urban" style compact development and walkability.*
4. ***Performance****: The frequency of bus and rail service.− High quality, frequent bus and rail service makes public transportation a more reliable means of getting around and can be correlated to less driving.*
5. 5. ***Pedestrian/Bicycle Connectivity****: Access to sidewalks and low stress bikeways.− Bicycle and pedestrian connectivity encourages many more people to walk or cycle to transit and neighbourhood destinations.*

Moreover, depending on the support and dependency of the transit, the transit communities can be categorized into three types based on this assessment as shown in the following box.

1. Transit Adjacent
Non-transit areas or areas close to quality transit that don't possess the urban character that would best support transit; generally describes low to moderately populated areas within walking distances of higher quality transit stations or corridors that lack a combination of the street connectivity, pedestrian and bicycle facilities, and urban amenities to more fully support the level of transit service.

2. Transit Related
Areas that possess some, but not all, of the components of transit-oriented development; generally describes moderately populated areas served by higher quality transit, a good or improving pedestrian/bicycle network, and some mix of neighbourhood supportive retail and service amenities.

3. Transit-Oriented
Areas that are most likely to support a transit lifestyle; describes more densely populated areas served by high quality rail and/or bus transit, good to excellent pedestrian/bicycle connections, a finer grain of blocks, and a supportive mix of retail and service amenities.

Other breakdown of TOD can be arranged based on transit mode and geographic region such as urban core, urban general, suburban, and rural area.

One typical example of taxonomy is from that of Florida TOD guideline (http://www.dot.state.fl.us/rail/PlanDevel/RSAC/Mtg3files/Delaney%20handout%202.pdf)

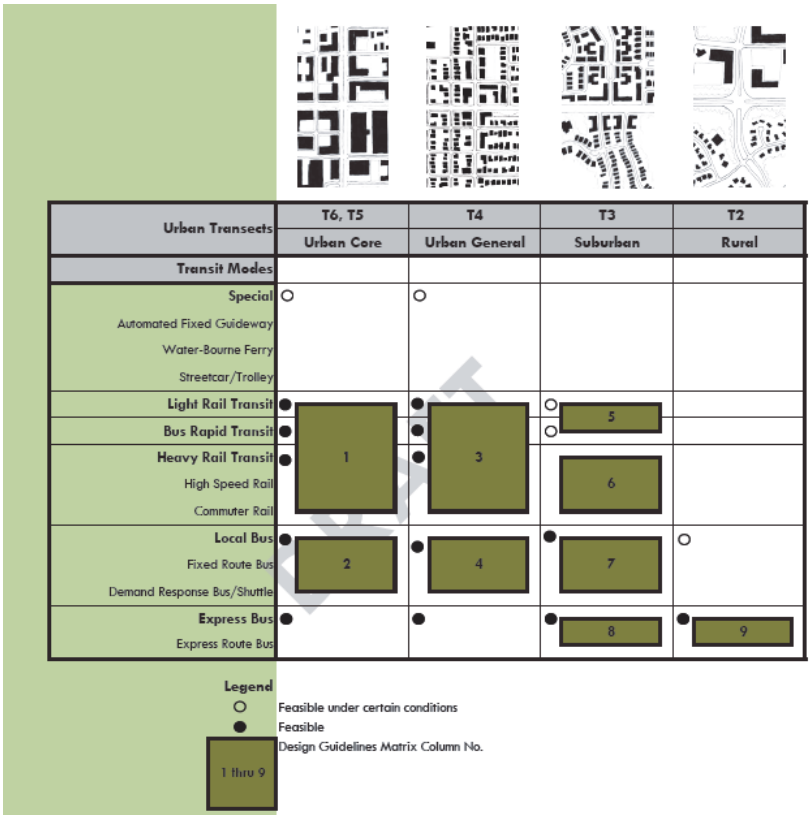


Figure 3 – An Example Typology of TOD (Florida Case - USA) -

The Benefit of TOD

TOD makes it easier for those who live or work in the area around the transit station to get around the region providing a range of benefits including increased transit ridership, reduced regional congestion and pollution, and healthier, more walkable neighbourhoods. It also benefits drivers because it removes trips from the road network. EPA (2013) reported that the mix of commercial and residential uses, enhanced pedestrian realm and streetscapes, and reduced traffic congestion, improved quality of life in transit-oriented neighbourhoods, as well as vitalized the city centre.

In general, by creating "activity nodes" linked by transit, TOD provides important mobility options for the young, the elderly, people who prefer not to drive, and those who don't own cars. TOD can increase transit ridership and by that TOD could improve the efficiency and effectiveness of transit service investments. It is known that TOD increases transit use of transit near stations by 20 to 40 percent and can reduce rates of vehicle miles travelled (VMT). In addition, considering that the housing and transportation costs are ranked as the first and second largest expenses in households, TOD can bolster households' disposable income. TOD reduces air pollution and energy consumption rates by 2.5 to 3.7 tons per year for each household. Other than those, TOD can help conserve resource lands and open space, can play a role in economic development, can decrease infrastructure costs, and can contribute to more affordable housing. Summing up, as identified, the benefits range from individual, community, and to regional level, respectively.

Rail Transit and TOD

Most of TOD distribution is spread across rail transportation in the US and in Europe and Asia. The heavy rail and commuter rail based high-capacity metro and urban light rail offer solutions for improving urban mobility, quality of life and the environment, they played an important role in shaping urban form, promoting higher densities, including mixed and accessible land use. Therefore, many TOD implementations are situated outskirts of central cities in newer and older suburbs.

Japan’s Shinkansen and Korea’s KTX corridor are good examples of TOD implementation on a regional scale which are associated with high speed rail corridors. More specifically, Korea’s Cheonan-Asan and Kimcheon-Kumi stations are good examples in a sense that it mixed new town development with KTX high speed train stations. The major cities along the high speed rail corridor in Korea show the changes of land price with an increase of housing investment. According to the report by KB Kookmin Bank, the housing prices increased by an average of 4 percent throughout the city of Cheonan over the last year. Moreover a development project of large industrial complexes connected with the station is in progress. They are good example of high speed rail based TOD and mixed use development around the station is still going on.

For the commuter rail case, the Tokyu company’s Den-en-toshi Line in Japan is a good example in implementing TOD and the Tama Plaza station on this line is a prime example. Around this station, relatively spacious apartments, the Tokyu Department Store, offices, and some small stores, contributing to the spic-and-span ambiance, are clustering together. Convenient in terms of location, this area is home to many

residents commuting to central Tokyo who wish to be close to the city but without the pollution, crowds and noise. Similar TOD cases are also apparent in the French RER corridor, would-be Korea's new metropolitan railway (GTX or MTX) corridor, and some of US commuter rail corridors such as the Chicago Metra and Philadelphia region SEPTA rail corridor.

BRT and TOD

Bus rapid transit (BRT) systems have gained reputation world-wide as a cost-effective alternative to urban rail investments. Furthermore, BRT is an innovative bus system with sophisticated vehicles and inflexible busways integrated in the cities, they are high capacity and high quality, high speed and high frequency, with a distinctive image and higher levels of comfort (Cervero and Dai, 2014 ; Stojanovski, 2013). BRT has contributed to an urban transport transformation in the last decade. Today, more than 160 cities around the world have implemented 4,200 kilometers of bus rapid transit or high-quality bus corridors which cover nearly 30 million daily passenger trips (BRTdata.org 2013).

Cervero and Dai (2014) noted that well-designed TOD serves as a hub for organizing community development and revitalizing long-distressed urban districts. Also BRT seems particularly suited to the low-to-moderate density, residentially oriented market niche of TOD. According to the report of EMBAQ, BRT encourages increased physical activity, since the spacing of BRT stations tend to require longer walking distances than other motorized modes and its higher operational speeds increases passengers' willingness to walk to stations. Therefore, there are positive effects of BRT on TOD and some successful cases which consider the service of BRT to implement TOD are introduced. The best example of this kind can be found in Curitiba Brazil and some good examples are found in US cases, such as Berkeley CA San Pablo corridor and Transrapid BRT system in Seattle, Washington state. Even though the Bogota's Transmillenio system achieved a great success with BRT, it lack the TOD synergism more or less.

Bicycling and TOD

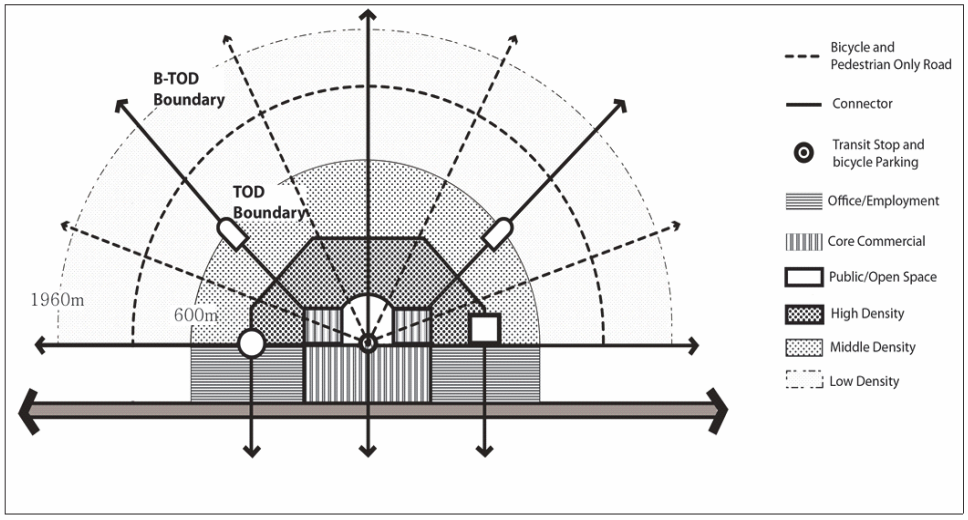
When TOD is considered, typically there is careful consideration and design of rail stations as well as planning for the development of the adjacent land areas. Klenin (2014) noted that a better sense of bicycle use as part of the larger transit system is needed to expand the transit usage. Moreover, he indicated that there has been a move towards seeing bicycling as a more basic form of transportation in cities and bicycles are eco-friendly means of transportation serving diverse travel needs and purposes. Even though the bicycle itself is often sufficient for a complete travel trip, it is more likely to be an access travel mode to a major line-haul mode. In general, the average bicyclist can move three times faster than the average pedestrian (Lee et al., 2014).

The number of people riding bicycles has been increasing, in particular, the trip-chaining pattern of integrating bicycle and public transportation (bicycle+PT)' has grown, especially in Europe, Japan, and Korea. The share of bicycle in access trip to public transport went up to 13 percent of the total subway users in Tokyo (Replogle, 1994). Both in Denmark and Sweden, the use of bicycle and public transportation are 25 and 9 percent of the total trips respectively. Lee et al. (2014) suggests the concept of bicycle-based TOD (B-TOD). The suggested B-TOD is based on a combination of

Bicycling and PT, a new concept to enlarge scope of the station area with a bicycle friendly environment, while adopting the traditional TOD concept within walking range.

As can be seen in the figure below, the spatial range of B-TOD is divided into two sections, where the enlarged part provides a greater catchment area over the traditional scope of TOD. Lee et al. (2014) also estimated access distances of bicycle to station and the key finding was that access distances from the bicycle trip chaining is up to the range from 1.96 km to 2.13 km in case of from home to station and station to workplace.

Bicycle trips in the US, still represent a very small percentage of commute trips (0.5 percent). Efforts are now underway to increase its mode share. Large cities in the US are starting to encourage and support bicycle commute transport, such as by providing regional bike sharing programs, biking facilities and infrastructure such as dedicated bicycle lanes, connected bicycle networks, and secure bicycle parking areas. There are also major efforts in the US to enhance traffic safety for bicycle and pedestrian safety by reducing accidents and fatalities through better facility design, increased traffic enforcement, and education.

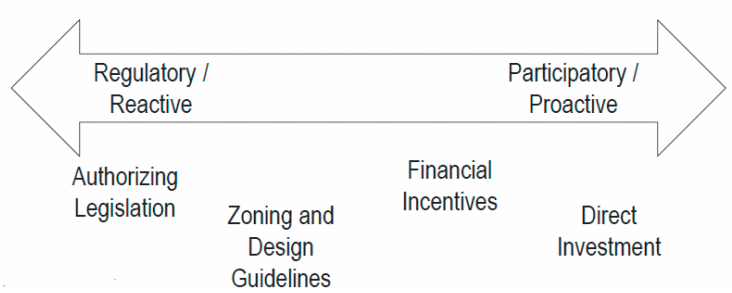


Spatial Context and Configuration of B-TOD (Lee et al., 2014)

Implementation Strategies for TOD

As shown in Figure below in Zimbavwe's presentation in 2011, there are two broad directions for accomplishing TODs-regulatory or reactive and participatory or proactive directions and there are four instruments such as regulations, voluntary instruments, expenditure and financial incentives which are the tools most of the TOD projects around the world once used and are using to make that happen.

Regulations include instruments such as laws, licenses and permits that have a statutory basis. Voluntary instruments include information, technical assistance and community activities, which do not require financial investments. Expenditures include direct investments by governments for provision of infrastructure and amenities. The last category involves providing financial incentives to people through mechanisms such as pricing, taxes and charges, subsidies, rebates, grants and loans, rewards and surety bonds. Although these four policy categories are not mutually exclusive and have some overlaps, they provide a useful basis to analyse the mechanisms to promote TOD (Bajracharya, 2005).

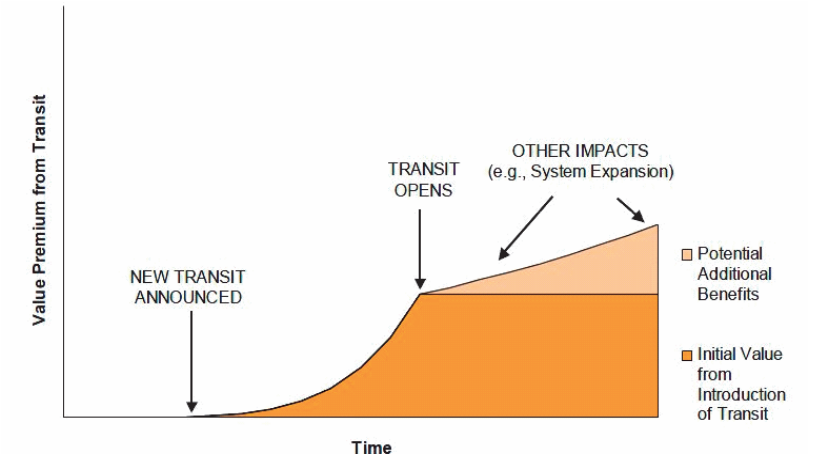


TOD Implementation Strategies and Tools (Zimbavwe, 2011)

Once some of government legislation and/or guidelines are set, to effectively promote TOD projects, there should be a clear consideration of incentives at two levels – one for the local community and another for the developers. To effectively gaining support from the community, incentives comprising of community benefits need to be carefully packaged. The package may include provisions of community facilities, walkable active streets and attractive neighbourhoods. Likewise, developers need to be offered an incentive package focusing on their needs, such as support with respect to land assembly and infrastructure provision, and a simplified and integrated development approval system.

It is widely recognized and accepted that the introduction of transit services, particularly on fixed guideways, will increase the value of land near station locations. Land value premiums in excess of 30 percent near commuter rail transit have been observed (Cevero, 2004). Value capture is defined broadly as a means by which the increment of increased land value resulting from transit investment is "captured" by some means for use by the transit agency as shown in figure below.

Such transit premium, for the purpose of funding TOD, should be captured and according to the CTOD report published in 2008, most of the strategies fall under four broad categories listed below.



Value Curve in Transit Premium (CTOD, 2008)

- ***Special Assessment***: a tax assessed against parcels that have been identified as receiving a direct and unique benefit as a result of a public project. Typical examples of this category involve Metro Red line in LA, Portland street car, and New York Avenue metrorail station in Washington DC.

- ***Tax Increment Financing***: a mechanism that allows the public sector to "capture" growth in property tax (or sometimes sales tax) resulting from new development and increasing property values. This type include Pennsylvania Transit Revitalization Investment Districts and some of Chicago RTA Metra stations.

- ***Joint Development***: generally, cooperation between the public and private sectors to deliver transit-oriented development (TOD), usually involving development on transit agency owned land. This involves San Francisco Bay Area Rapid Transit (BART), Washington Metropolitan Area Transportation Authority (WMATA), and Metropolitan Atlanta Rapid Transit Authority (MARTA) station area developments.

- ***Developer/Impact Fee****:* a fee assessed on new development within a jurisdiction as a means to defray the cost to the jurisdiction of expanding and extending public services to the development. Transit Impact Development Fee (TIDF) in city and county of San Francisco and Transit Oriented Concurrency (TOC) system in Florida cases belong to this category.

This summary of implementation strategies contains most of the US cases due to the availability of references. However, the overall approaches made in other parts of the world are not much different from the US cases and some local context and situations are reflected in arranging the implementation strategies.

2.4. The HOV and HOT evolution

Birth and evolution in USA

A major cornerstone of Transportation System Management (TSM) is the High Occupancy Vehicle (HOV) lane, which was first popularized in the U.S. during World War II as part a national fuel rationing program. HOV lanes are restricted lanes for the use of multi-occupant vehicles and are generally separated from general purpose traffic lanes by markings and identified with the international diamond sign.

HOV lanes on motorways are the most developed in the USA, mostly used by carpoolers. Geographically, these HOV lanes are concentrated in larger urbanized areas in 24 States representing 75 percent of the country's population and include approximately 7,000 km of existing dedicated HOV lanes across the USA:

- 5,500 km HOV for carpooling,
- 400 km for buses,
- 600 km HOT lanes, a newer trend.

California is the state having the most HOV lanes (almost 2,400 km) representing almost 40 percent of the existing HOV lanes in the USA. California also holds the record for the longest HOV lane with close to 110 km on the I-405 freeway. In Canada, HOV lanes have been in operation for close to 20 years, primarily in the three major cities of Toronto, Vancouver and Montreal but also in medium-size cities such as Ottawa, Calgary and Gatineau. Transit buses are often permitted on HOV lanes.

The presence of HOV lanes is an important Transportation Demand Management (TDM) tool for promoting ridesharing and transit, supporting a modal shift away from the single-occupant vehicle, reducing vehicle trips and, in turn, lowering traffic congestion and vehicle emissions. In addition, HOV lanes – by moving high occupancy vehicles – can carry more passengers per hour than general purpose highway lanes, increasing highway capacity.

HOV Lane in Canada (Transport Canada)

Today[10], many HOV facilities do in fact outperform adjacent general purpose highway lanes in terms of person throughput, especially during peak hours of service. By themselves however, the extent to which HOV lanes induce new ridesharing beyond pre-existing levels is debatable and varies from region to region. Trip chaining, particularly family-related trip movements, and other factors (e.g. the scarcity of potential carpool matches) may dis-incentivize new HOV formation regardless of the presence of viable HOV express options. When new carpool formation is low, HOV lanes may appear underutilized and not meeting congestion relief expectations.

The "Empty Lane Syndrome" can put significant pressure to open the HOV lanes to other users. Depending on the facilities, certain vehicles such taxis, motorcycles and green electric vehicles have been permitted to use the HOV lanes, without meeting minimum-capacity requirements. Also, better marketing of the HOV lanes, organised carpooling and incentive programs (preferential parking for carpoolers, etc.) can assist educating the public and encouraging carpooling formations. Such programs are common across the US and Canada such as the DriveLessConnect program in Portland, Ridershare in the US and the SmartCommute in Toronto. Overall, periodic monitoring of the HOV lanes as well as effective enforcement is required to measure its effectiveness and maintain its efficiency.

A shared bus and HOV lane sign

Over the past decade, the commercialization of new technologies has created new opportunities to manage highways using age-old economic principles. The application of these innovative concepts has demonstrated unequivocally that congested highways can be managed more effectively and expand user choices. These

[10] http://ops.fhwa.dot.gov/publications/fhwahop08034/hot1_0.htm#_ftn1

applications come in a variety of names – managed lanes, high occupancy toll (HOT) lanes, Express Lanes, and smart roads.

Together, they represent a growing body of evidence suggesting that efficient and effective management of existing highway assets is both achievable and sustainable.

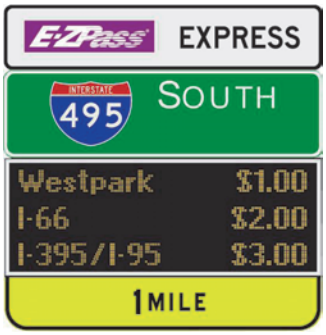
Hence, in the USA, an increasingly popular highway system enhancement opportunity is observed: **the conversion of HOV lanes to HOT lanes**.

The HOT lanes concept is a managed lane that combines HOV with pricing strategies to improve facility operations.

Unlike HOV lanes, HOT lanes allow single occupant vehicles (SOV) to gain access to HOV lanes if they choose to pay the applicable toll, which can sometimes vary depending on traffic conditions. To maintain the "improved facility operations" and the service benefits of a HOV lane, HOT lanes may employ some or all operational strategies.

Although HOT lane operational and policy parameters may vary from facility to facility, they share several common characteristics with respect to system design, physical configuration, operations and technology. The Federal Highway Administration (FHWA) "Guide for HOT Lane Development" identifies several major characteristics of HOT lanes:

- HOT lanes typically are limited-access; normally barrier-separated highway lanes that provide free or reduced cost access to qualifying HOVs, and also provide access to other paying vehicles not meeting passenger occupancy requirements.
- By using price and occupancy restrictions to manage the number of vehicles travelling on them, HOT lanes maintain free flow levels of service even during peak travel periods.
- Most HOT lanes are created within existing general-purpose highway facilities and offer potential users the choice of using general-purpose lanes or paying for premium conditions on the HOT lanes.
- HOT lanes utilize sophisticated electronic toll collection (ETC) and traffic information systems that also make variable, real-time toll pricing of non-HOV vehicles possible. Information on price levels and travel conditions is normally communicated to motorists via variable message signs (VMS), providing potential users with the facts they need in order to decide whether or not to utilize the HOT lanes or the parallel general-purpose lanes that may be congested during peak periods.
- HOT lanes may be created through new capacity construction, conversion of existing lanes, or converting HOV lanes to HOT lanes with additional capacity added. Since both right of way and construction funds are limited, conversion of existing HOV lanes to HOT operation is the most common approach.



The dynamic display that indicates the price you will be in charge, at real time (State Virginia).

About HOT Lane Benefits

The Primary Benefits of HOT Lanes Strategies:

- They provide the driving public with a choice – reliable free flow travel conditions – on corridors where conditions would otherwise be congested.
- They maximize the use of managed lanes – including HOV lanes – without causing traffic service to fall below desired levels.

HOT lanes can also afford a wide range of secondary benefits, including:

- New revenues that can be used to support the construction of the HOT lanes themselves or other initiatives, such as improved transit service or regional transportation initiatives;
- Traffic service improvements on congested parallel highway mainline lanes by drawing vehicles off parallel local streets and improving corridor-wide mobility;
- Performance reliability compared with general purpose lane during peak periods.
- Faster highway trips for express transit services such as regular bus and bus rapid transit (BRT);
- Environmental advantages by providing opportunities to encourage carpooling, improve transit service, moving more people in fewer vehicles at faster speeds, and eliminating the impacts that would have resulted from otherwise building new general purpose lanes;
- Increased efficiency of managed lane facilities making them attractive in regions that might not otherwise consider them; and,
- Improving the utilization of HOV lanes and therefore eliminating potential pressure to convert under performing HOV lanes to general-purpose use.
- In many cases, HOV and HOT lanes are also reversible lanes (directional) so that they accommodate the direction of peak traffic flow during morning and evening commutes.
- HOV/HOT lane facilities are often built through public private partnerships (PPP) whereby a public highway agency owns the facility and whereby the expansion of the facility to include the additional lanes (the HOV/HOT lanes) and the subsequent operation of the facility is conducted under a long-term lease arrangement with a private sector entity who then expands the facility to

add HOT lanes, and maintains and operates the facility in exchange for rights to collect the toll revenue. Through our case studies we learned that HOV/HOT can provide a significant improvement in system reliability and travel time in a travel corridor, particularly for peak period commuter trips in large urbanized areas. We also learned that many of these significant transportation improvements to add HOV/HOT lanes would not have otherwise happened without the involvement of the private sector, given the severe funding limitations most public agencies are under.

- HOV/HOT lanes, once the exception in North America, have become more common, particularly in the last ten years, with many major urbanized areas, such as in the Washington DC case study, planning for and building entire networks of connected HOV/HOT lane facilities on their controlled access freeway systems.
- In order to advance PPPs and HOT lane implementation, there are major institutional and policy issues that must be overcome, such as the implementation of enabling legislation (State laws), obtaining the support of State and local elected officials, and gaining public acceptance for tolling. There are also environmental justice (social) issues that must be overcome regarding potential impacts of HOT lanes to traditionally underserved populations such as low income and disadvantaged populations. HOT lanes also have higher implementation costs due to more complex technology and enforcement requirements.

HOV, HOT evolution in Europe

There are very few HOV facilities for carpooling in Europe. Among the 28 member states, only five states have HOV lanes or HOV projects:

- UK, two projects in Bristol and in Leeds,
- Norway : one project in Trondheim, in 2001,
- Spain : the emblematic project in Madrid, opened in 1997,
- Netherlands : one project in Amsterdam,
- Austria : one project in Linz.

In Europe, we observe actually only one big and emblematic case study "HOV" well-known, implemented into the north-west entrance of Madrid. This managed lane is also dedicated for the buses and motorcycles, providing an efficient reversible "one way" dedicated lane, which is operated as an alternative way, according to the pendulum traffic. This case study is described (see annex of this report).

Generally speaking, public transport is much more developed in Europe and the highways rarely have the extra capacity to truncate one lane for carpooling purposes. Other than the USA and Canada, it appears that the demand for such lanes would be much smaller in Europe and Asia where urban areas are often much denser.

Regarding high occupancy toll lanes (HOT), no example could be observed in Europe, in projects aiming at optimising the capacity of the motorway with free entrance of HOV. Projects observed in Europe that introduce a toll in mobility access are mainly congestion charging (London, Stockholm), designed to decrease car traffic in city centres.

2.5. HOV and HOT case studies collected

The following HOV and HOT case studies were collected and described by the TC 2.2 members :

- “HOT” lane, state Virginia - 2012 - USA
- Houston HOT networks, Texas (2012 / 2013) - USA
- HOV to HOT - MnPass Express Lanes - Minneapolis, Minnesota - USA
- A6 Corridor BUS-HOV System, Madrid - Spain
- Interurban services - HOV, almost like in Madrid, C-31, C-58, Barcelona - Spain

The first observations are as follows:

- Such projects, HOV, HOT are nearly exclusively developed in the USA and Canada: the longest HOV lane,110 km long, is located in California.
- HOV, HOT seem to be much more useful for long trips.
- Very few examples HOV are observed in Europe and in Australia.
- HOT projects appear to be much more efficient (better quality management, level of use, new revenues, etc.)
- HOT projects need sophisticated electronic toll collection and enforcement.
- A greater compliance observed on HOT lanes.
- Busses are generally permitted on the HOV and HOT lanes, free of charge.

The full description of these case studies is available into the separate file called "**Summery of HOV, HOT, BRT case studies collected",** annex of this report.

Short feedbacks from the case studies collected :

Case studies collected	**Benefits / Success factors / strengths**	**Barriers / weaknesses /points to monitor**	**Lessons learnt**
"HOT" lane, state Virginia - 2012 – USA	Added 50% capacity to manage congestion Connects four major commuter routes to create seamless HOV and transit network Three new access points to major retail and employment centres including Tysons Corner and Merrifield		Use as expected Good level of respect, with the enforcement system.
Houston HOT networks, Texas (2012 / 2013) - USA	Increases safety and promotes quick response to accidents and issues in the lanes due to additional camera monitoring Improves air quality by reducing traffic congestion Better utilizes existing HOV Lanes Offers increased enforcement of the HOV Lane system.		
HOV to HOT - MnPass Express Lanes - Minneapolis, Minnesota – USA	This dynamic toll system has proven effective in regulating single-occupancy vehicles demand and maintaining traffic speed over 80 km per hour 98% of the time. Social acceptability On average, MnPass Express Lanes are used 10 times per month by single occupancy vehicle drivers, what accounts for $12.		The good way to manage and to insure the level of service required for this lane.
A6 Corridor BUS-HOV System, Madrid – Spain	The key success elements are four: 1. The Bus-HOV stretch = 12.3 km 2. The only-Bus stretch = 3.8 km 3. The underground interchange point in Moncloa (arrival in Madrid) 4. Good connections with metro lines and urban buses routes	Need of urban space (not always available) to implement such infrastructure Need of coordination of different administrations, also taking into account the needs/worries of citizens Need of important amount of economic resources for such big investment.	Intermodality is a key factor in public transport systems. Interchanges are a key element to favor the use of public transport and the ease of connections among modes (including private vehicles) are decisive for the modal shift.
Interurban services, C-31, C-58, Barcelona – Spain	C-31 : Remarkable travel time savings for bus users plus external cost reductions at an extremely low infrastructure marginal cost needed to introduce the bus dedicated lane. C- 58 : Low use at the beginning, Need to revise the bus VAO infrastructure concept : no more reversible, to accept HOV+2	C-58 - Little use of the bus VAO lane by highly occupied cars - Low modal share of bus in the C-58 corridor (Vallès Occidental	C-31 : Opportunities to obtain substantial socioeconomic and environmental benefits from a low cost investment. C-58 : too little use of the bus VAO lane by highly occupied cars (VAO+3). Low modal share of bus in the C-58 corridor (Vallès Occidental).

Findings:

- HOV lanes can carry more people per hour than general purpose lanes;
- HOV lanes can encourage ride-sharing and transit, which can reduce vehicle trips and congestion;
- Where HOV lanes appear underutilized, there is substantial community pressure to revert these back to general traffic lanes;
- HOT lanes are an emerging form of HOV lanes which improve lane utilization and its management, provide improved travel conditions for those prepared to pay and generate a revenue stream for re-investment.

3. THE BRT TRENDS

3.1. A concept for urban and sub-urban mobility[11]

The bus system represents the most widely used transit mode. Upgraded bus services, primarily those which have partially or fully separated rights-of-way, represent a very cost-effective method to improve the balance between automobile and transit. Many measures for improving bus services have been introduced since 1970. A “new wave” of quality bus systems has emerged all over the world. These are collectively called “Bus Rapid Transit” (BRT), “Bus with High Level of Service” (BHLS) in Europe or other acronyms. Many of its elements are already familiar – priority for buses in traffic, higher quality vehicles, improved comfort at stops, improved information for passengers, integrated ticketing, intelligent transport systems to improve operations management and planning, etc.

BRT was defined in 2002 by Levinson et al. as "a rapid mode of transportation that can combine the quality of rail transit and the flexibility of buses" [12]. As their implementation increased in North and South America, the studies describe a wider spectrum of characteristics to define the BRT systems. They were ranked in 2006 by Gray et al from “BRT-Lite” to “Full-BRT” depending on their components[13].

Full-BRT represents bus systems that can achieve metro-style performances. They necessitate full grade-separated transit ways, off-board fare collection, frequent and rapid services, modern and clean vehicles. Bogotá, Brisbane and Ottawa are the most famous Full-BRT examples.

BRT has to focus on a bus-based “system approach” (road vehicle urban / sub-urban) with characteristics inspired from rail concept, as a line whose target is to structure the urban network. These concepts are explained in fact according to light rail transit

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[11] From the final report of the COST action “BHLS” - 2011

[12] Levinson, H.S., Zimmerman, S., Clinger, J., Rutherford, S.C., (2002) Bus Rapid Transit: An Overview. In Journal of Public Transportation, 5 No2, pp.1-30.

[13] Gray, G., Kelley, N., Larwin, T., (2006) *Bus Rapid Transit, A Handbook for Partners*, Mineta Transportation Institute Report 06-02, San Jose State University, 66p.

(LRT), because they tend to provide to the bus advantages that allow either to move their performances closer to the tramway.

The “system approach” should be defined as a coherent articulation of three fundamental elements, i.e. "infrastructure", "a rolling stock" and "operating conditions" that offers a public transport service regular and suitable in a given urban context. Hence, different mix of components will lead to form different BRT.

The emblem “system” sourced from the EBSF project.

Such a « system » approach leads to highlight the infrastructure as the backbone of the system, giving structure to the capacity and the performance. In fact, this is the visual marker and the manifestation of the system’s permanence or perennity.

The notion of « system » approach is fundamental, as it makes up a method whose objective is to ensure a coherent choice process of all components, according to the project objectives.

3.2. About the fundamental indicators

A BRT / BHLS qualification should improve primarily the indicators that are strategic in the long term for the service offer. Three fundamental indicators can be considered as the most often strategic:

- Punctuality / Regularity,
- Frequency,
- Speed.

To achieve improvements simultaneously on all three of these key performance indicators (KPIs), requires an action on infrastructure that provides a Right of Way (RoW) which is not only dedicated, but is also appropriately designed and equipped. This is the only way to give the bus the advantage of these three strategic characteristics. On the other hand, a high frequency needs a high level of regularity.

The key issues to achieve a full “BHLS” project can be summarised as follows:

- To belong to the structuring network (wide schedule span).
- Integration of a strong intermodality (train, tramway, biking, cars…).
- Mostly stations and not simple bus stops, which can be easily moved.

- Dedicated infrastructure, mostly « central » type B (type A when needed).
- To achieve a rather high distance between stops (for attractive running times).
- To achieve a high reliability (i.e. around 95 percent passengers having a bus on time).
- Not to sell ticket by drivers, mostly off bus ticketing system.
- Integration of dynamic information at all stops (full ITS solution).
- To be able to offer a High passenger capacity.
- A specific brand/image into the whole system (not necessarily with a specific fleet).

The following chapters will show that the concept "BRT" can be developed into very different levels of capacity and quality, due to several factors, like the geographical context, objectives of the master plan, the existing rail market, the economical context... The concept "BRT" is then, more a method or a tool for building an appropriate hierarchy into the existing bus-based network.

A report[14] published by "Across Latitudes and Cultures" explores how to upgrade bus services in US cities that cannot practically implement full bus rapid transit (BRT) corridors due to demographic, land-use, political, and financial constraints. As a summery, this report points out:

> *Guidelines for developing BRT corridors reveal a tension between an emphasis on comprehensive planning on the one hand, and incremental, flexible development on the other. A review of the literature discusses this tension, various BRT elements, and the impact of these elements on performance and ridership. Case studies of incremental BRT projects in four U.S. cities highlight the importance of considering the socio-demographic and institutional contexts surrounding bus priority projects. Longitudinal and cross-sectional sketch models, using corridors as the unit of analysis, offer some insights into the relative impact of BRT features and external factors.*
>
> *While BRT can be a promising mode for a range of contexts,* ***service frequency and reliability improvements*** *are the foundation for successful projects.*

This report shows the importance of reliability in determining ridership. The impact of commercial speed on ridership and productivity is lower than expected. However, speed relative to car travel times is found to be significant; this is likely more relevant for choice riders' perceptions than absolute commercial speeds.

3.3. BRT , a wide range observed in the world

The current trend of BRT projects over the world shows that BRT is really not just experimental but widely used[15]:

- globally, over 150 cities operate BRT systems, covering a length of over 4,000 km;
- on a daily basis, more than 25 million passenger trips take place on BRT;

[14] Across Latitudes and Cultures - Bus Rapid Transit Centre of Excellence - Case Studies and Sketch Modeling of Incremental BRT Upgrades Considering Demographic and Network Effects - Anson Stewart - October, 2013

[15] Reference, Sam Simmerman, former expert in the world bank

- these projects are commonly considered to be public transit development tools, in addition to serving as an alternative to rail modes, like the tramway, in some economical and city context.

The table below shows roughly how important the "heavy" BRT market has increased in each continent. As well known, this market is much more developed in Latin America, the continent where rail systems have not been implemented in a wide scale.

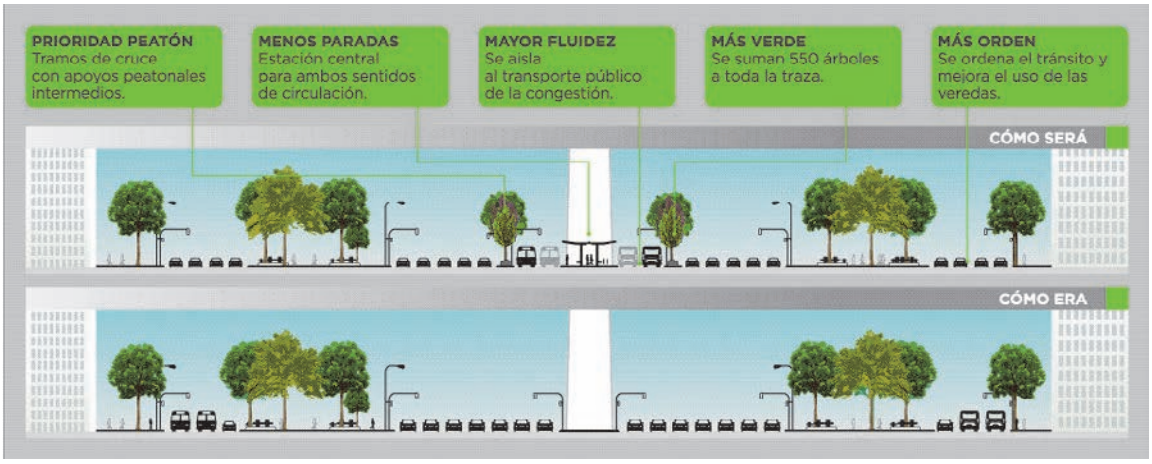
As said by Luis R. Gutierrez[16], "Latin America has emerged as a pioneer in BRT. Currently, it leads the BRT global expansion in terms of number of cities, corridors and passenger demand. It also stands out for its corridors' high average in terms of passengers-day-km. However, not all these achievements count with a solid foundation to ensure sufficient quality and long-term viability". In fact, he points out in some BRT the difficulties to achieve a good level of reliability with so high capacity.

Regions	Number of cities	Length (km)	Passengers / day
Africa	**3**	**62**	**238,000**
Asia	**30**	**1,044**	**6,275,622**
Europe	**43**	**699**	**1,656,966**
Latin America	**53**	**1,347**	**16,326,783**
Northern America	**20**	**592**	**849,285**
Oceania	**7**	**328**	**327,074**

BRT systems in operations throughout the world (*Source of data: brtdata.org, WRI/EMBARQ)*

Curitiba was the first city to implement a BRT system, now adopted as the massive transport worldwide. Known as one of the more sustainable cities of the planet has structured its development since the BRT and its corridors. PHOTO: URBS S.A.

[16] General secretary of SIBRT and Latin America Strategic Director of Embarq - Article 2013 "Quality of Transit and the urban mobility" .



The cross section, before / after of the BRT project "avenida 9 de Julio" in Buenos Aires.

On another hand, the BRT market generally offers flexible systems that are permanently integrated, as high performance system with a quality image and a strong identity. Below, the tables show the different capacity levels achieved, some levels are much higher than a metro capacity, as these systems are implemented into a highway with grade separated crossings.

Illustration 2 presents the various rush-hour capacities of the world's systems with the greatest capacities[17]. These extreme values are only reached on certain sections (i.e. a 2x2 dedicated lane configuration, intersections with elevation differences, a common corridor shared by several lines - often more than ten). Some systems exceed the capacities of a subway and allow serving much more distant areas without interruption. Very few of these systems are located in developed countries. Besides the need for considerable space, this system integration relies on heavy protection at network points with short headways, where transit service interruptions can occur.

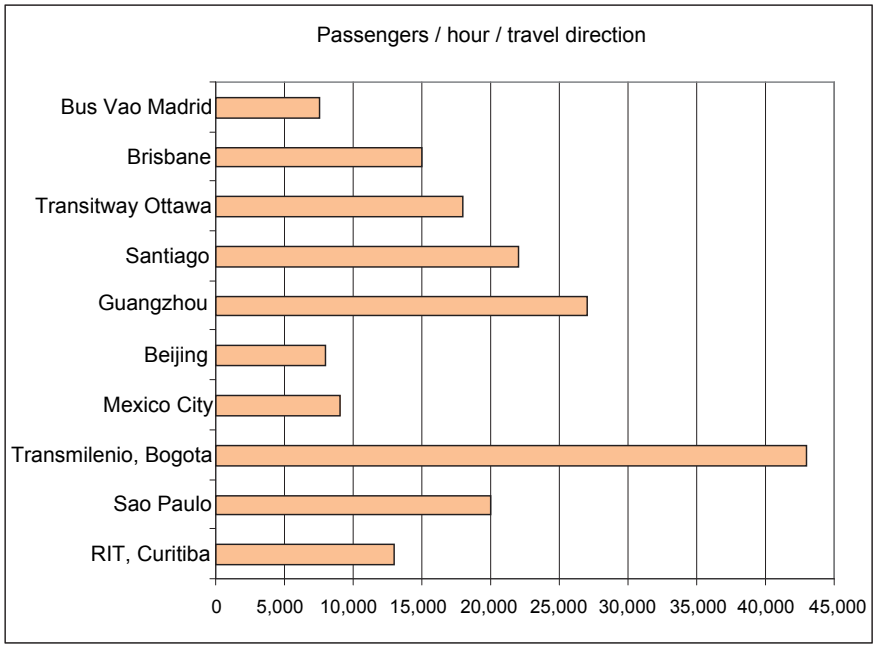


Illustration 2 - Rush-hour capacity of the "Full BRT" service in each direction

[17] *With additional Data to those collected by WRI/EMBARQ, 2009)*

Illustration 3 reveals the capacities available when the design resembles more of an urban tram. In this case, the intersections tend to be level and the infrastructure more readily transparent, thus limiting the urban bottleneck effect. Consequently, headways are set so as to reach a maximum level of regularity, which turns out to be a major objective of such systems. These choices are most often part of a strategy to complement rail modes.

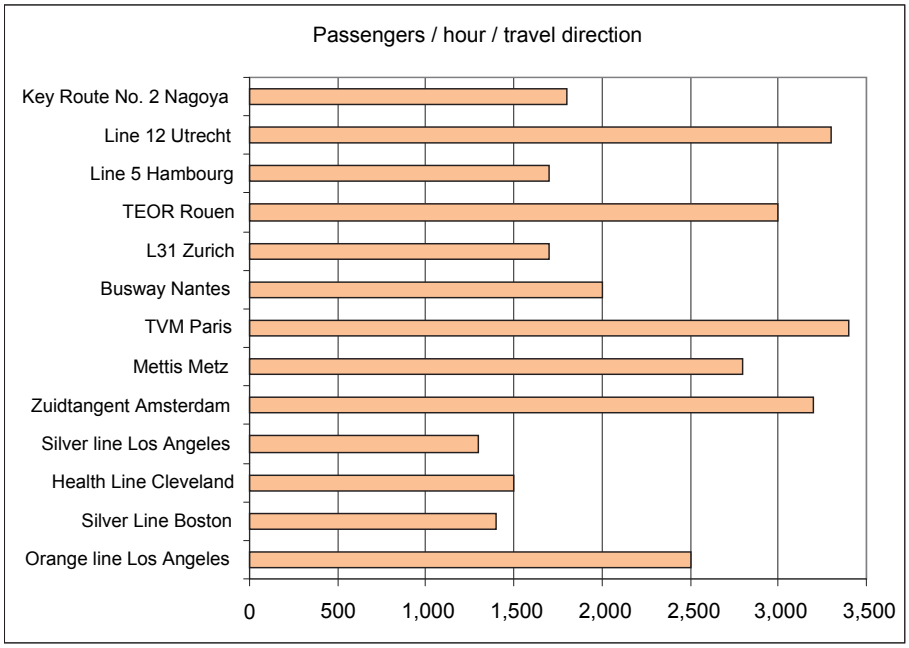


Illustration 3 - Rush-hour capacity in each direction for systems designed like the tram

Illustration 4 - Metz's Mettis service, launched in October 2013 with 27 double-articulated buses
Photo credit: Cerema

By virtue of its capacity to generate very diverse services, the BRT concept is definitely considered to be a valuable tool for the purpose of prioritizing, at different level, the bus and coach network of any metropolitan area, in order to comply with urban planning guidelines.

From this worldly BRT overview, the lesson learnt from case studies are generally as follows:

1. BRT is an attractive, potentially cost-effective rapid transit option
    - Convenient, rapid, reliable service

- Attractive to passengers of all incomes
- Attractive to developers
- Relatively modest costs, easy to build and operate

2. Plan BRT as Part of Integrated Land Use/Transport Strategy
   - Like for other rapid transit modes, BRT doesn't create total demand for housing, commercial space, retail, recreation, etc. but can be tool for re-orienting development in more sustainable patterns
   - Best results when:
     - BRT planning addresses urban integration
     - Other supportive policies are implemented at same time
     - Intermodality with other modes

3. There Is No Single BRT System Prescription for all Situations
4. Communications
   - Work hard to overcome the negative image of bus "systems" and bus mythology and introduce everyone to BRT with *aggressive communication program*
   - Ensure that decision-makers, professionals and the general public know what BRT is and what its potential benefits might be for their city before they make a major investment decision where it might be a choice
5. Integration, institutions Critical
   - *Multi-modal Integration* critical to success : Services, Fares, Facilities, Passenger Information.
   - Integration critical throughout life of project -- planning, design, operations management
   - *Multi-modal Institutions*, related human resources must be created and/or nurtured for BRT to be successful

However, BRT, as a road mode, is actually a very efficient way of contributing to sustainable urban mobility. Since BRT is not the only solution, intermodality with other modes is a key factor, as it is the case with the well-known efficient rail modes exemplified in Japan or Korea. These rail modes, well developed in big and mega cities in Europe or Asia, are efficient modes for sustainable mobility that can offer high capacity, sometimes with high speed, on long distance services.

More and more, developers and public transport experts consider the field of application of these public transport road and rail modes as complementary. These fields of application, regarding the economical criteria, will differ also according to the level of life (or working cost) of the country. The higher the driver costs, the higher capacity of the vehicles will be sought as much as possible.

3.4. Analysis of the BRT market, at country level

When the BRT "market" is discussed, it has to be noted that the BRT is not a packaged single product as it is the case of many of consumer products. Instead, it is a public transport service that calls for a comprehensive set of infrastructure and operations. In this section, several viewpoints needed to think about the BRT market are discussed first, followed by a worldwide overview of the current BRT market. A

typology of the BRT market is discussed next, ending with a comparison of two cities with similar features but different public transportation systems.

Viewpoints associated to the BRT markets

Various components are associated with BRT and the "market" may differ from one to another. Among many, the most basic prerequisite for the BRT market is that a city has to have an appropriate volume of the passenger demand for public transport. This is much associated with the size of the urban area and urban density as well as preferences of the people. Generally speaking, high urban density will result in much higher demand for public transport irrespective of modus. If this basic feature is strategically embedded in urban planning, transit-oriented development (TOD) can encourage the use of public transport rather than private vehicles. It is worth noting that, generally speaking, where the car is a strong status symbol and vast road infrastructure is provided, the need for public transport is often limited to the low-income segment of the population.

Yet the BRT is not an appropriate public transport to provide with a capacity with hundreds of thousands of passengers per hour. Rather, realistically and empirically, BRT is more appropriate as a middle-volume public transport with up to some 20,000 passengers per hour during peak time. To this end, the streetcar – or what is recently called light rail transit (LRT) – is a strong competitor against BRT.

When it comes to the BRT infrastructure, high-density urban areas often have no possibility to accommodate segregated bus lanes. This is often the case in European cities with densely developed historic city centre. Yet, this does not exclude the possibility of BRT in certain places (mixed traffic in the city centre and segregated BRT lanes in the outskirts) as it is often the case for the streetcars in European cities. When the BRT is associated with widening road infrastructure to accommodate segregated bus lanes, the cost advantage of the BRT becomes limited. Below is an overview of the BRT nowadays around the world, subdivided by the region and country. While it may not provide a fully comprehensive overview due to the space limitation, it illustrates where BRTs are currently in use.

Europe

France is at a forefront with the introduction of the BRTs, with relatively small urban areas adopting BRTs as (a part of) their main trunk of the public transport (e.g. Metz, Cannes) and some large agglomerations adopting BRT together with other mode (e.g. Nantes combining it with tramways, Lyon combining it with underground railways and tramways). What tends to be common among these French cities is that they tend to have abandoned existing tramways during the boom of the automobile (e.g. Metz in 1948, Cannes in 1933); in the context of "renaissance" of the public transport after the 1980s, the BRT was selected in some cities. Similar tendency can be seen in Sweden and the Netherlands. The UK has several cities with guideway bus, but they are not necessarily referred to as BRT. Where there is a long tradition of utilizing tramways, including Germany, Switzerland and Austria as well as former communist countries, BRT is practically non-existent.

East Asia

China (PRC) is rapidly expanding its BRT systems, as well as underground railways and other types of urban transport in its large cities. Some unique ones include the elevated tracks (e.g. Xiamen) or the ones making a part of the urban public transport network with other modes of public transport (e.g. Beijing, Guangzhou). It is of note

however that Hong Kong, where its Mass Transit Railway (MTR) network is extensive, does not plan BRT so far.

The countries and regions that have developed public transport systems early, including Japan and Taiwan, do not have much urban BRTs. However, Japan has a long tradition of intercity busways that are similar to today's BRT: these are typically converted from closed regional railway lines. Seoul, South Korea, has exclusive bus lanes in the middle of wide roads that were extensively implemented through the reorganization of the city's entire bus networks in 2004, albeit they are not always referred to as BRTs. It is worth noting that the segregated bus lanes of Seoul is a part of its comprehensive reorganization of the entire bus system towards better usability, integrating 86 private bus companies that were previously operated separately into one system: four bus categories – interurban, urban rapid, feeder, and local services – were introduced, and the fare system is integrated with the underground and suburban railways.

Southeast and South Asia
Cities which developed their public transport systems early such as Singapore do not invest in BRT. In the case of Singapore, the investment is directed to expand the city's Mass Rapid Transit (MRT) system.

Extensive implementation is seen in countries that are under rapid development. Indonesia has built BRT systems in large cities, with TransJakarta at its forefront. Besides its capital Jakarta, other large cities including Yogyakarta (Trans Jogja) are running or planning BRTs. These cities use the BRTs as its main mode of urban public transport. Hanoi, Vietnam, is planning its first BRT. Bangkok has built its first BRT line in the southern part of the city that serves as a feeder to the MRT. Besides these countries, Cebu, Philippines, is planning its first BRT. India has built extensive BRTs in the cities of Ahmedabad, Pune and Kolkata, although larger metropolis such as Delhi and Mumbai tend to choose heavy rail as its main public transport mode. Of note, the system in Lahore, Pakistan, as well as "BRT" in some cities in India, is sometimes referred to as a BRT, but it is reported not to have its own segregated lane.

Oceania
Several cities in Australia have some busway corridors that are sometimes categorized as BRT, including Brisbane, Australia (there often referred to as T-way, an abbreviation of *transitway*).

Middle East and Africa
Tehran and other Iranian cities including Isfahan and Mashad are reported to have extensive BRT systems, but their actual situations are hardly known. In Africa, South African cities build several BRT systems in large metropolis including Johannesburg and Cape Town, right before the FIFA World Cup in 2010. Recently Lagos, Nigeria, introduced a new BRT system into the city, and in Eastern Africa it is reported that Kampala and Dar-es-Salaam, the capitals of Uganda and Tanzania respectively, are planning BRTs.

North America
The United States built several bus-exclusive lanes that are considered to be a forerunner of the BRTs, such as the El Monte Busway in Los Angeles that was built in early 1970s.

Similar to some of the aforementioned Western European countries, many North American cities used to have streetcars as their main mode of public transport: they were rapidly replaced with the bus between the 1940s and 1960s. These kinds of the cities tend to reintroduce improved bus systems that are often branded as BRTs; however, these do not always have full features of the BRT. In the US, approximately 20 cities have reported to operate BRTs today. In Canada, the one in Ottawa is fairly known, and several cities have busways in some sections of the city. In Mexico, several large cities including Mexico City's Metrobus are planned or in operation. Some cities in the US built urban tunnels exclusively used by public buses, such as the underground tunnel in downtown Seattle and the tunnel of Silver Line connecting Boston's downtown and Logan Airport: these are sometimes referred to in the context of the BRT, but not necessarily classified as is it.

Latin America

As seen in the earlier section of this report, the region is at a forefront of the BRT, hosting a number of full BRTs that are well-known, including Bogota's *Transmilenio*, Rio's *TransOeste* and *TransCalioca*, Curitiba's *Rede Integrada de Transporte (RIT)*, Lima's *Metropolitano*, and *Transantiago* in Chile. Many of them have almost full features as the BRT such as fully segregated lane, off-vehicle ticketing, and priority signal. Many cities with similar size in many of the countries in the region including but not limited to Brazil, Ecuador, Venezuela, Columbia, and Argentina are planning or operating BRT systems.

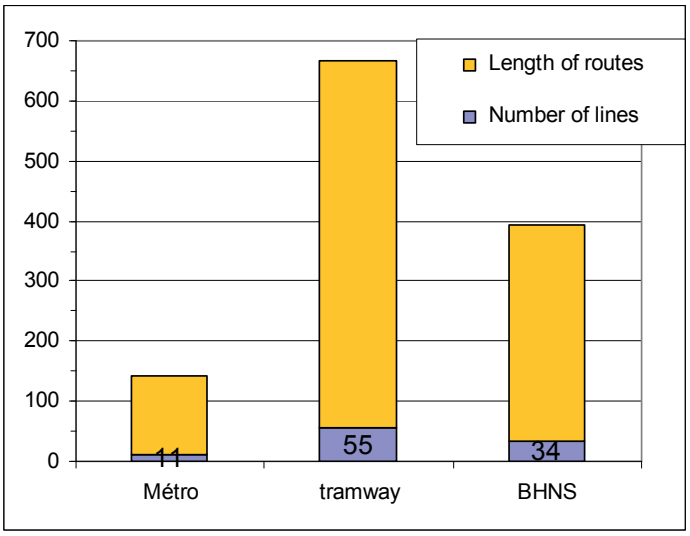
A BRT market typology

As seen around the world, there are three different main "markets" of the BRT systems observed, namely:

- Large metropolis in developing countries, which can introduce BRT as its trunk public transport system;
- Cities both in developing and developed countries with railway-based public transport, which can introduce BRT as a supplementary mid-capacity rapid public transport system; and
- Middle-sized and small cities in developed countries, which can introduce BRT, more as a reintroduction, often with once-abandoned tramways as their forerunners.

The first group, large metropolis in developing countries, includes Jakarta (Indonesia), Bogota (Columbia), Curitiba (Brazil), and Lagos (Nigeria). These cities are/were experiencing rapid urbanization and motorization while the country does not essentially have/had techniques to build urban railway, or can/could not afford the expensive rail-based transport modes. These are supposed to be most prospective market in the future.

The second group, the cities with rail-based public transport mode to use the BRT as a supplementary rapid transport mode, includes cities both large ones such as Lyon (France), Guangzhou (PR China), Rio de Janeiro (Bresil), and Istanbul (Turkey) and small ones such as Nantes (France). Some of the segregated bus lanes can be categorized into this group such as the ones in Seoul (South Korea) and Leeds (UK).
Cities in the third group are mostly in European countries, where tramways were typically abandoned during the rapid motorization typically in the 1960s, and these include many middle-sized and small cities in France.



Number of lines and length of the main public transport routes declared in France (outside Paris region): as many BHNS km as the tram sector are now expected in 2020 (around 800km).

On the other hand, where the BRT market is unlikely to be extensive, are as follows:

- Large metropolis in developed countries with extensive railway-based network; and,
- Middle-sized and small cities that has extensive tramway network.

The former ones, especially those relaying heavy rail, have an option to introduce BRT as a supplementary public transport mode. However, such introduction can be fairly limited to the periphery of the city as the city centre tends to be already densely populated. Financially, these tend to be able to afford more expensive rail-based mode in such periphery area, and thus, when seen as "market", the potential of the BRT is not necessarily large. These include major metropolis with extensive urban railway networks such as London, Hong Kong, Tokyo and Singapore.

The latter one uses tramway as their main public transport mode in the city, and the role of the bus is often limited to feeder these tramway lines or to serve the lines where the demand is too small for tramways. This includes but is not limited to many of the German, Austrian and Swiss mid-sized and small cities such as Freiburg im Breisgau and Dresden (both in Germany), Innsbruck (Austria), and Basel (Switzerland), as well as many cities in former Eastern Bloc countries such as Krakow (Poland), Riga (Latvia), Ostrava (Czech Republic), and Zagreb (Croatia). This is not to say that these cities cannot implement BRT system: the potential is however limited due to the existence of tramway.

These are a mere general tendency and the "market" of the BRT is much dependent on the city's context, timing of the development along with the diffusion of the technology.

A comparison: Vienna vs. Curitiba

Vienna is the capital of Austria and does not have BRT; Curitiba is the capital of the Brazilian province of Parana and is well-known for its BRT network. Many features of these cities today are comparable as seen in the table below. Major differences can be observed in terms of the green area and the private vehicle ownership. Lower percentage of green area in Curitiba implies that the actual population density in the built-up area is much lower than that of Vienna: this indicates that the city is more sparsely developed, and this is reflected in the higher car ownership. It is worth noting

that 690 cars per 1000 inhabitants is much higher than the European average (536 cars per 1000 inhabitants, 2009-2013 average).

	Vienna	Curitiba
Population [people]	1,766,746 (2014)	1,776,761 (2012)
Area [km^2]	415 [km^2]	432 [km^2]
Population density [inh./km^2]	4257 [inh./km^2]	4113 [inh./km^2]
Green Area [km2]	188 km^2 (45%)	114km^2 (26%)
Modal Share [%]	Car: 27%; Motor bike 0%; PT: 39%; Bike: 6%; Foot: 28%	Car: 23%; Motor bike 5%; PT: 45%; Bike: 5%; Foot: 21%
Private cars [cars/1000 inh.]	386	690

Source: Stadt Wien, Statistik Austria, Japanese Consulate Curitiba, ICLEI e.V.

Both cities have gone through different socioeconomic and political changes, as well as different demographic and economic development, and in turn, different development of their transport systems. While it was not possible to conduct a detailed comparison, a short review of the development of their public transport systems highlights what makes a city a "market" for BRT.

Both cities started horse-drawn tramway in the late 19th century: Vienna inaugurated its in 1865, while Curitiba started its in 1887. Vienna's tramway was turned into steam-driven tramway, and both were later electrified (Vienna in 1897, Curitiba in 1911). Since then, the two cities have experienced different development paths. Vienna expanded its tramway during the decades afterwards. In 2013, 29 lines (225 km) of tram service are provided (some lines overlap). Since the 1970s, Vienna started implementing the underground railway, too. On the other side, Curitiba replaced the tramway with the bus during the World War II, as many cities in America did during that era. The last tram line was closed in 1952; Curitiba was one of the first cities to close the entire tram network in Brazil. Since the 1970s, BRT has been built through the city.

Judging from the high level of private vehicle ownership, it is not difficult to guess that Curitiba once oriented its transport policy towards the use of the automobile. It is also easy to guess that Curitiba did not retain the required engineers and industry to support a rail-based public transport system. Contrary to this, Vienna has developed itself as one of the most important centres for tramway production. Common to these two cities is the fact that they now both have transport policies that are clearly oriented towards public transport and deterrent of the automobile.

In light of these, paradoxically, Curitiba's once fairly deteriorated public transport system seems to have helped the development of its BRT system. And, as seen in the previous section, this seems to be common to many of the cities that have implemented BRT. This is in turn a way to find potential for the BRT – cities with once deteriorated public transport are where the BRT can find its "market".

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3.5. BRT on urban motorways : a new market opportunity in all over the world

Major metropolitan areas have developed a vast network of thoroughfares, in search of adding not only capacity but also speed in connecting its primary urban centres. Both the single-passenger car and urban sprawl have often led to a chronic saturation of these corridors. Now, as soon as the public transit networks are enough developed in urban centres, authorities are focusing on extending high-quality service to the area's outskirts via urban motorways.
The technical choices will be various depending on the specific objectives and context: permanent vs. temporary dedicated lane, centre vs. side lane vs. in some instances required use of the emergency shoulder space of the motorway.
Alternative solutions to the single-occupant vehicle are no longer limited to urban settings as developments now extend further into suburban zones, thus offering the significant benefit of vastly improved intermodal connections with the urban network. Advances and innovative solutions are also readily available.
We observe efficient solutions in the USA, Europe (Netherlands, Spain, France), and Australia. In some cases, particularly in North America, implementation of BRT in a corridor can be an economical precursor to the future implementation of light rail transit (LRT) as growth and development in a corridor expands and becomes denser and travel demand increases. This is particularly the case of Ottawa, Canada, where construction of LRT is currently underway.

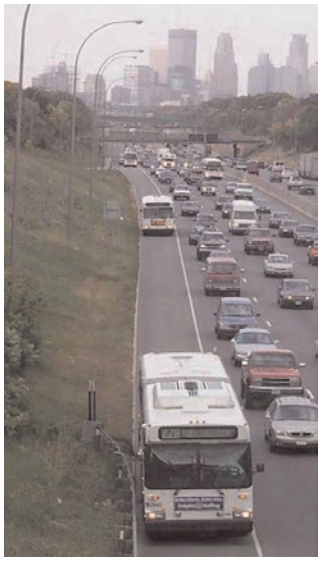
Evolution in USA

BRT on motorways are mostly implemented on HOV or HOT corridors, so that taxis and carpooling are authorised on the dedicated lane.

The case in Minneapolis is emblematic for a rather high capacity of buses.

The Twin Cities have a history of strong transit priority programs. In 1991, bus-only-shoulders were tested for freeway express buses. Buses are allowed to use the shoulders only when mainline traffic speed drops below a threshold of 56 kph. Douma et al. (2008) describes the design and operation of these lanes and summarizes the ridership and cost benefits as follows:

> *"Shorter, more predictable travel times and fewer missed transfer connections have increased ridership.*
> *Operational costs have decreased because more reliable travel times result in less driver overtime.*
> *Although the traffic speed as well as the speed of buses may be minimal when corridors are heavily congested, passengers' perception of time saved is considerable...Metro Transit determined respondents overestimated the actual amount of time saved by two to three times (Douma et al., 2008)."*



Minneapolis - Saint Paul, Minnesota, USA
Bus Only Shoulder operations (Douma et al., 2008)

Evolution in France[18]

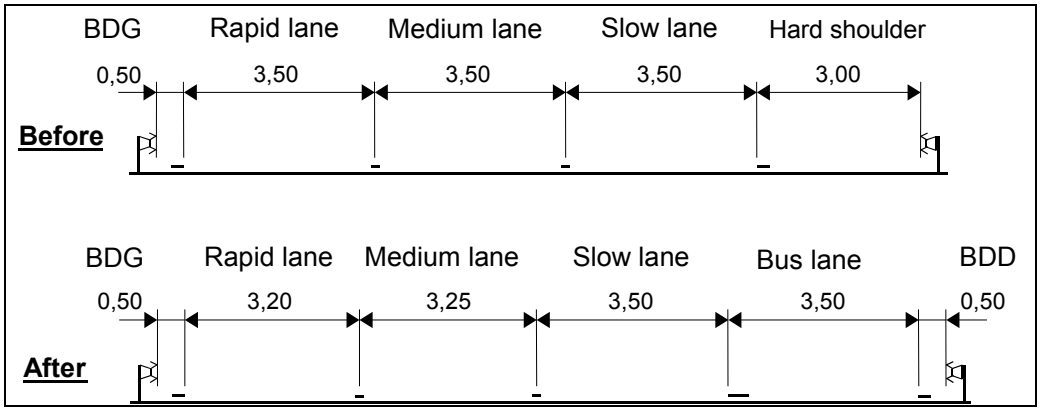
Subsequent to the Grenoble experiment (on the A48 motorway), many projects are presently underway, in Marseille (A7), Strasbourg (A351), Montpellier (A9), and especially in the Paris Region (where 11 corridors are currently under study). The technical choices have been quite various, according to the specific objectives and context. Two of these will be presented below.

Reserved lane at the northern entrance to Grenoble (A48) - since 2007

It was decided to allocate the emergency shoulder space over a 4.2 km distance to nine motor coach lines. This reserved lane, fitted with dynamic signals and DAI-equipped[19] cameras, is activated by the control room operator solely during rush hour whenever traffic speed dips below 50 km/h. The level of traffic congestion remains regular during the 2 to 3-hours morning commute. The overall motorway speed was limited at 90 km/h.

This reserved lane retains its emergency shoulder function under all circumstances, with the frequency of shelters being raised to one every 500 meters. Headways have now reached 25 buses an hour while assuring complete satisfaction. Thanks to this increased regularity, public transit ridership has more than doubled in the past three years, with 46 percent of all users switching from the private automobile.

Feedback so far has been very positive; it would be preferable however to loosen certain operating rules. The specific entrance approach may be decided more freely by the driver, and the 4 km length may be handled in two separate sections given that the downstream section sometimes clears before the upstream section.



A48 motorway in Grenoble, redistribution of the slightly raised cross-section

Reserved lane at the northern entrance to Marseille (A7 motorway) - since 2013

This motorway section, delineating the entrance to Marseille, ends at a traffic light intersection that serves to limit capacity. This section is regularly congested, both

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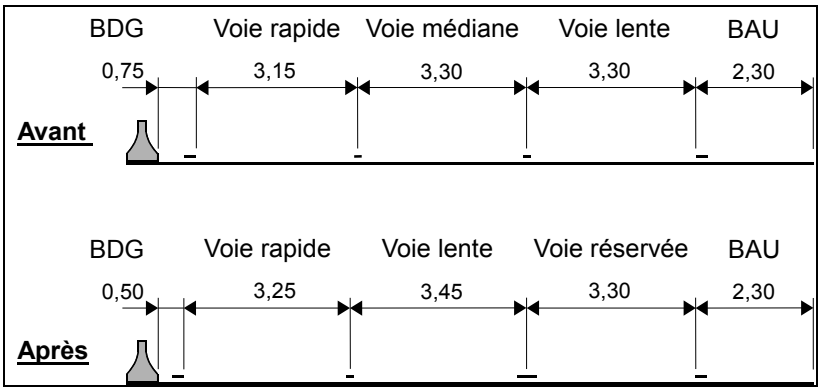
[18] An article has been published on this subject in "Routes-Roads 2015 - N°365" - Bus Rapid Transit (BRT) : a concept also popular on urban motorway - by François Rambaud (CEREMA).

[19] DAI means : Automatic Incident Detection

morning (for approximately three hours) and afternoon (approximately one hour). Travel time upstream of the improvement is variable, i.e. from 60 to more than 300 s with a maximum at 900 s.

Over the last 2-km stretch, it was decided to reserve the slow lane for motor coaches (50 during the rush hour) and taxis (10 to 20 at rush hour), while keeping the emergency shoulder clear. This reserved lane is a permanent feature and, as such, no dynamic lane management system was installed: the signaling is static.

Feedback has been very positive. Travel times for overall traffic have not considerably changed (identical downstream flow), yet the coach traffic is now much more regular, with stable times (around 85 s) rarely hitting 140 seconds. In noting a spike in fraud, a semi-automatic penalty control system featuring license plate recognition will soon be introduced.



The A7 motorway in Marseille, a redistribution of the cross-section without any widening and in retaining the emergency shoulder

We observe also efficient solutions in other European countries, such as in Netherlands (The Zuidtengent lines in south of Amsterdam), in Spain (The emblematic A6 Corridor BUS-HOV System in Madrid, the new interurban services, C-31, C-58, in Barcelona).

3.6. BRT case studies collected

The following BRT case studies have been collected and described by the TC 2.2 members :

- Buses on freeway shoulder - Minneapolis - Saint Paul, Minnesota - USA;
- Buses on hard shoulder on the A48, Grenoble - France;
- BRT Trends on motorways in Île de France (Paris region) - France;
- Switzerland - Lucerne - the Rbus network program;
- The BRT program in City of Seoul - South Korea;
- A6 Corridor BUS-HOV System, Madrid - Spain;
- Interurban services, C-31, C-58, Barcelona - Spain;
- The bus network (DART) in Melbourne, city centre - Australia;
- The BRT key route n°1 and 2, Nagoya city - Japan;
- GuideWay Bus System Shidami Line, Nagoya city - Japan;
- Development of the BRT program called "Metrobus", Buenos Aires - Argentina;
- The BRT program, Santiago - Chile;

The first observations are as follows:

- There can be significant challenges in reallocating public space to accommodate segregated BRT lanes.

- Difficulties are often observed when reducing road space for cars, which can affect the mobility habits of drivers and impact traffic congestion. Public education can be required to increase acceptability of such projects.

- There is a wide range of BRT projects, with different approaches

- The bus like the metro (highest capacity) : Brisbanne, Bogota, Ottawa, Nagoya partly,…
- The bus like the tramway: Europe, Japan, USA, Korea, Australia, an increasing trend..
- Light BRT : for lower capacity, In Europe, Melbourne, … called “improved bus systems”
- A much lower BRT market in « rail » or dense cities (Germany, Vienna, Switzerland, Japan.

- A slow emerging “BRT” market on motorways, since the 90’s, with promising trends.

- Reliability and Intermodality are the first key factors for successful projects (speed for long distance projects).

- BRT strategies are opportunities to obtain substantial benefits from a low cost investment.

The full description of these case studies is available into the separate file called "**Summery of HOV, HOT, BRT case studies collected",** annex of this report.

Short feedbacks from the case studies collected:

Case studies collected	**Benefits / Success factors / strengths**	**Barriers / weaknesses /points to monitor**	**Lessons learnt**
Buses on freeway shoulder - Minneapolis - Saint Paul, Minnesota - USA	Shorter, more predictable travel times and fewer missed transfer connections have increased ridership. High gain of Average speed of buses in the 2.6 km segment of I-35W between I-494 and 46th St. : Southbound, 20% ; Northbound, 90%		Reliability benefits are more important (coupled with priority in downtown) for attractivity than speed gain.
Busses on hard shoulder on the A48, Grenoble - France	First, buses are faster and their travel time is more reliable than before. Second, bus clients are highly satisfied with the hard shoulder bus lane and most of them want this measure to be extended. Third, a very good safety level, and very few fraud.	Always under the experimental status, since 2007 . A flexible entrance into the hard shoulder: to let the bus driver the decision to enter where he feels the best (the congestion length is variable).	The regularity of the whole line is the key issue to get attractiveness. Such a system should not to be so rigid for buses. Enforcement measures should be developed during the project, and be ready before opening the system.
Trends in Île de France (Paris region) - France	Studies on progress	Difficulties to analyse impacts on general traffic. Need to refine the method to evaluate the benefit of regularity gain of buses involved. New signalisation is needed, that implies discussion, as in Grenoble.	Importance of a network approach for public transport (connexion with the existing network).
The BRT program in City of Seoul - South Korea	Solution to traffic problems such as the impossibility of building new roads, deterioration of quality services, traffic congestion, and air pollution. According to a transportation card data aggregation from March 2009, the number of daily commuters per km in metropolitan area was on average 3,755 person(s)/day/km (minimum 734 and maximum 10,699), showing potential for sufficient bus demands. In addition, constant increase in the number of vehicles is expected to worsen traffic congestion, and thus it is necessary to adopt the BRT system for preventive reasons. Construction cost of the BRT per km is 2.5~30% of the LRT, and is at least 50% or more lower than the urban railway while it can provide a more flexible public transportation service.	Rather than the recognition of the new public transport, it is easy to recognize in the existing bus system. difficulty in improving lane efficiencies due to civil complaints. therefore new routes are being added, but existing bus lanes are stayed unmodified. however, service complications followed the addition of buses, causing opposing arguments against adding bus routes from outside Seoul to inside Seoul. It was initially expected to complete the whole distance in 40 minutes, but it actually took about 1 hour when measured by the Incheon Transportation Authority.	Though the initial support and subsidy to revitalize public transportation successfully led the bus system, continuous addition of bus routes and subsidy expenditure with no efficiency is straining Seoul's finance. Thus the establishment of an integrated organization to adjust bus and railway routes, akin to France's RATP, is being argued for in the academia. Including the sections that are currently being expanded, more routes are anticipated to be built in the future. The development of the TOD type will also be possible with the increased usage of the new transportation system.
A6 Corridor BUS-HOV System, Madrid - Spain	The key success elements are four: 5. The Bus-HOV stretch = 12.3 km 6. The only-Bus stretch = 3.8 km 7. The underground interchange point in Moncloa 8. Good connections with metro lines and urban buses routes	Need of urban space (not always available) to implement such infrastructure Need of coordination of different administrations, also taking into account the needs/worries of citizens Need of important amount of economic resources for such big investment.	Intermodality is a key factor in public transport systems. Interchanges are a key element to favor the use of public transport and the ease of connections among modes (including private vehicles) are decisive for the modal shift.
Interurban services, C-31, C-58, Barcelona - Spain	C-31 : Remarkable travel time savings for bus users plus external cost reductions at an extremely low infrastructure marginal cost needed to introduce the bus dedicated lane	Penetration of the bus dedicated lane to BCN city centre. Northward extension of the bus reserved lane.	Opportunities to obtain substantial socioeconomic and environmental benefits from a low cost investment. Need to revise the bus VAO infrastructure concept. Little use of the bus VAO lane by highly occupied cars. Low modal share of bus in the C-58 corridor (Vallès Occidental).
The bus network (DART) in Melbourne, city centre - Australia	DART has upgraded infrequent and limited hours bus services to create an all-day service with frequency that is equivalent to Melbourne's tram and train network. This has dramatically improved off-peak levels of service, and boosted patronage by over 50% in the first two years of operation.	Delays caused by road traffic and lack of bus priority. Hoddle Street is heavily trafficked, leading to bus delays particularly in the PM peak when no bus	The introduction of the DART service has shown that Melbournians will use bus services that are frequent and provide a good range of operating hours. Public acceptance of bus priority measures is a fought

		priority is provided.	process. There has been considerable local opposition to new bus lanes on the basis of lost kerb carparking.
The BRT key route n°1 and 2, Nagoya city - Japan		Reduced rapidness as it became necessary to make additional stops at the bus stops that were passed du express operation. Due to the large number of passengers getting off, it takes time for discharging customers at bus stops connecting to subways, which sometimes leads to a line of buses waiting to discharge passengers in the bus lane.	While the Key Route Bus Investigating Committee of City of Nagoya announced the policy that it is ideal that a central running system will be introduced to future routes of the Key Route Bus, it will be necessary to examine alleviation measures including running systems for the routes which will have great impact on automobile traffic.
GuideWay Bus System Shidami Line, Nagoya city - Japan	As the line operates in the suburb area where a large-scale housing land development is underway, the ridership is on an increasing trend, and demand is expected to increase in the future. Until the demand increases to a certain level, it is possible to respond in stages within the possible scope of operator's management, such as increasing the number of buses by utilizing increased fare revenue as the resource.	As the applicable laws and regulations are different for the elevated track segment and the non-elevated segment, car remodelling, etc., is required to satisfy each safety standard; in addition, as the system is not diffused in Japan, renewal of cars, etc., requires high development costs, which makes it difficult for the operator alone to manage in terms of business.	When buses continuously operate in the elevated track segment and the non-elevated road segment, delays in the non-elevated road segment due to congestions, etc., will be passed on to the elevated track segment; if it is not possible to increase the number of buses for the elevated track segment due to the restriction of the number of cars owned or staff, it will impair the punctuality of the elevated track segment.
Development of the BRT program called "Metrobus", Buenos Aires - Argentina	BRT on "9 de Julio" avenue: Capacity: 200 busses/hour/2direction with 11 different lines, 200 000 passengers / day along this central corridor. Pedestrians: before, the avenue of 20 lanes used to be a barrier for pedestrians. Now, it can be crossed in more steps and there are pedestrian boulevards in-between. In addition, the project has created a new pedestrian path between stations. Improved safety in pedestrian roads, particularly in the Avenue crossing with 16 lanes Public transport: travel time was reduced from 55 minutes to less than 20. Taxis (cabs): their activity shows an improvement since the lanes next to sidewalks are now free of buses. Alternative connection between the two main Retiro and Constitución Railways Stations, which complements the connection of the existing metro line.	Difficulties to convince the stakeholders by the feasibility of removing of 4 car lanes Traffic flow significantly affected, particularly with the removal of left turns from central roads. Removal of central traffic islands which were important green spaces with different types of trees.	Efficient operation in organised bus transport, although traffic direction was changed to the left in exclusive lanes after building central platforms for bus units with right access only. By moving trees and planting new species the public space was offset and improved, thus complying with the demands of the current environmental impact laws. The total capacity of 9 de Julio Avenue, in terms of traffic direction, was not affected, even though part of the central roads has been used for the Metrobus infrastructure to improve traffic direction flow.
The BRT program, Santiago - Chile	- Electronic card BIP, model of payment - Improvement of the environment - Agreement with Metro - Technology innovation - Contract signed and regulation of the systems - Increase safety , dismiss crime - Streamlining buses - Better working conditions for drivers - Decreased financial deficit in 2009 there were $CH 395.251 million, in 2012 to $CH was 340.295.	- Infrastructure - Empowered Institutions - Transfers - Reliability and forecast travel times - Evasion, not to pay passengers - User information	- To build adequate infrastructure: corridors and exclusive lanes - To set a period of time for test these plans, it could be by sector or in small towns - To incentive the number of passengers carried in contracts - To incentive to the passengers to use the public transport - To detect user needs - To improved control - To develop and integrated system with Metro and trains - Decrease transfers - To improve the comfort of the users Projects must be approved by all the stakeholders Projects must be add value to the city

3.7. Key findings

Key findings :

- Alternative solutions to the single-passenger car are no longer limited to urban settings, as developments now extend further into suburban zones, thus offering the significant benefit of vastly improved intermodal connections with the urban network. Advances and innovative solutions are also readily available.
- BRT is not the only solution for an efficient public transport system. Light rail systems offer different characteristics and advantages that can greatly complement BRT systems.
- Generally speaking, and according to the context, the bus systems can play a high strategic role in public transport, while using the structuring motorway road network.
- The BRT concept is very attractive due to its flexibility, versatility and relatively simple implementation solutions in urban and sub-urban areas
- Reliability is of crucial importance for any public transport system as it directly affects ridership and customer satisfaction.
- Technical evolutions are possible; in the future, articulated and double articulated buses as well as electrical and self-guided buses will make BRT even more attractive.
- To stimulate innovation and expand BRT with better implementation, experiences should continue to be exchanged.

Efficient modal interchanges are always widely requested, in order to improve mode shifting, as, in any urban and country context, it appears that there is a definite need to combine a wide range of virtuous mobility modes.

4. THE ACTIVE MODES ISSUE, WALKING AND BICYCLE

4.1. Why promotion of walking and cycling

The challenges associated with achieving sustainable and efficient mobility around the world are vast. To succeed, it is necessary to develop strong cycling and pedestrian policies in both cities and metropolitan areas.

Nowadays, air pollution is widely recognised as a health threat that particularly affects children and the elderly in urban areas. Climate change is another threat. Despite being a global problem, most of the air pollutants and greenhouse gas emissions are emitted in metropolitan areas and cities due to the wide use of private cars and motorbikes in these settings. Congestion and safety are also common problems in our cities and metropolitan areas.

Walking and cycling are the best transport modes to tackle these threats. To foster them, we need to develop its own infrastructures and information channels and to create its own legal framework.

For these reasons, the PIARC Technical committee 2.2, "Improved mobility in urban areas" decided to launch a survey in cities and metropolitan areas to analyse the introduction of cycling and walking modes and the diversity of approaches to its policies.

Although the development of cycling and pedestrian plans and infrastructures differs from one city to another, the results of the survey indicate that, in a way, there are many measures and experiences of these type of mobility around the world, but, in another way, there is a lot of work to do to increase its modal share.

Furthermore, the last two years have bought about new trends that are bound to gain traction on a global scale. The introduction of walking and cycling mobile applications that guide people in unknown places, electric bikes to climb steep slopes and new bike-sharing systems; are all examples of such trends. We will need to further understand their impact in the coming years.

Finally, we must strengthen public awareness to promote cycling and walking policies since they are the best modes to fight climate change and pollution, reduce noise, combat obesity and sedentary life style, reduce energy dependency and above all, leave a better world to future generations.

4.2. Survey conducted on cyclists and pedestrians

A survey[20] was conducted to gather information on cycling and pedestrian policies in various cities around the world.

A feedback survey was developed for the analysis of good practices in different countries, regarding policies towards pedestrians and cyclists.

The survey comprised 17 questions, with the first one being a short review of the mobility model in the city, where respondents provided data on population, land area, density, income per capita (ppp[21]), and modal split. The remaining questions dealt with seven areas:

- Planning and budgeting for such policies.
- The development of specific infrastructure.
- Safety.
- Intermodal transport.
- Accessibility Measures for persons with reduced mobility.
- Public participation.
- Public awareness.

All the questions included a section dedicated to cyclists and pedestrians. Thirteen questions could be answered with a “Yes” or “No”, and the remaining questions could be completed with numerical information pertaining to these policy areas.

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[20] An article has been published about this study in "Routes-Roads 2015 - N°365" Cycling and pedestrian policies in cities and metropolitan areas worldwide - By Lluis Alegre (ATM Barcelona) and Francesc Carbonell (ALG consultant, Spain).

[21] ppp: purchasing power parity

The questions were chosen to require a simple yes/no answer in order to facilitate data analysis and enable comparisons to be drawn and statistics to be calculated.

The detail of the survey is included in an annex to this document. The survey was completed by the following 38 cities, listed by geographical location:

- Latin America: Buenos Aires (central), Lima, Mexico City (central), Montevideo, Rosario.
- North America: Montréal.
- Europe: Barcelona (metropolitan area), Bern, Brussels, Gävle, Gothenburg, Helsinki, London (Greater London), Lund, Lyon (Greater Lyon), Malmö, Oslo, Seville, Toulouse (metropolitan area).
- Africa: Agadir (Greater Agadir), Casablanca (Greater Casablanca), Lagos (Greater Lagos).
- Asia: Dhaka, Gifu, Kumamoto, Niigata, Sendai, Suwon, Toyama, Yokohama;
- Australia: Adelaide, Brisbane, Canberra, Darwin, Hobart, Melbourne, Perth, Sydney.

Obviously these 38 cities are not a perfect statistical representation of the world. Nevertheless, the sample is geographically and culturally diverse to provide valuable information on the current status of cycling and pedestrian policies and offer examples to inspire other cities that are taking action to support cyclists and pedestrians or are planning to do so.

Based on the results of the poll conducted, several analysis are presented in different sections below.

Firstly, key data on population, land area, density and income per capita (ppp)22 of the 38 cities and metropolitan areas which completed the survey are listed in Table 1. Figure 1 depicts their geographical location.

As well, supplementary information on modal split in terms of motorised transport (both public and private) and non-motorised transport (pedestrian and bicycle trips) is also provided as background information to support the analysis of the survey results.

Section 3 provides an analysis of the planning and budget policies, studying the level of application of the different cities surveyed.

Section 4 analyses the responses pertaining to the following topics:

- The development of specific infrastructure.
- Safety.
- Intermodal transport.
- Accessibility Measures for persons with reduced mobility.
- Public participation.
- Public awareness.

Section 3 and Section 4 include charts showing the percentage of cities that answered “yes” to each question. When applicable, we have indicated with the abbreviation N.A., the percentage of cities that did not answer or did not have the necessary data to answer a particular question.

Section 5 contains supplementary results, where the survey responses can be related to income per capita level, modal split and geographical analysis (by continent).

In Section 6 provides a summary of base case good practices realized at different cities. The details can be found in the annex. This section also includes European projects.

Section 7 contains a summary of some of the future trends at the international level. Finally, Section 8 makes recommendations for the next survey, based on the lessons learned.

Table 1: Cities and metropolitan areas

Continent	Country	City	Population	Area (km²)	Density (population per km²) 23	Per capita income (ppp) USD 2012	Modal Split (%)					
							Motorised Transport			Non-motorised Transport		
							Public	Private	Total	Bicycle	Pedestrian	Total
Latin America	Argentina	Buenos Aires City	2,890,000	200	14,450	26.129	51	28	79	0.5	20.5	21
	Argentina	Rosario	948,312	179	5,374	19.266	n/a	n/a	n/a	n/a	n/a	n/a
	Mexico	Mexico City	8,600,000	1,480	5,862	14.773	37,5	36,2	73,7	5,3	21	26,3
	Peru	Lima	7,605,742	2,672	2854	19.940	58	17	75	n/a	n/a	25
	Uruguay	Montevideo	1,300,000	199	6,523	17.340	60,5	13,5	74	1	25	26
North America	Canada	Montréal	1,717,767	365	4,518	36.227	36,3	52	88,3	3,2	8,5	11,7
Europa (1)	Belgium	Brussels	1,138,854	161	7,057	45.607	27,9	44,3	72,2	2,5	25,3	27,8
	France	Greater Lyon	1,282,000	516	2,485	41.038	16	52	68	2	33	35
	France	Toulouse (metrop. area)	700,000	460	1,521	37.907	8	66	74	3	23	26
	Spain	Barcelona (metrop.area)	5,030,000	3,222	1,561	36.280	16,9	37,6	54,5	n/a	n/a	45,5
	Spain	Sevilla	700,169	141	4,973	24.875	34,8	56,2	91	9	n/a	9
	Switzerland	Bern	132,000	52	2,555	42.900	52	41	93	3	4	7
Europe (2)	Finland	Helsinki	595,400	213	2,800	47.705	38	25	63	11	26	37
	Norway	Oslo	623,966	454	5,222	55.509	27	37	64	6	30	36
	Sweden	Gavle	96,170	1,782	54	33.208	10	65	75	14	11	25
	Sweden	Gothenburg	520,000	450	1,700	38.902	26	43	69	6	25	31
	Sweden	Lund	113,000	25	3,215	35.059	8	26	34	43	23	66
	Sweden	Malmo	307,758	158	1,962	35.059	14	43	57	23	20	43
	United Kingdom	Greater London	8400000	1579	5,320	51.978	44	33	77	2	21	23
Africa	Morocco	Casablanca	3,818,701	1,139	3354	9.210	28,5	14,5	43	n/a	53	57
	Morocco	Grand Agadir	1,132,000	755	1,500	5.400	27,2	20,8	48	4	48	52
	Nigeria	Lagos	20,204,503	3,577	5,928	3.649	46	14	60	n/a	40	40
Asia	Japan	City of Toyama	416,223	1,242	335	39.684	7,8	72,8	80,6	9	5,8	19,4
	Japan	Gifu City	417,955	203	2,060	33.106	7,7	60,1	67,8	n/a	16,6	32,2

[23] Source: World Cities Forum, OECD, Global Metro Monitor and own elaboration

Continent	Country	City	Population	Area (km²)	Density (population per km²) 23	Per capita income (ppp) USD 2012	Modal Split (%)					
							Motorised Transport			Non-motorised Transport		
							Public	Private	Total	Bicycle	Pedestrian	Total
	Japan	Kumamoto City	738,578	390	1,896	29.638	n/a	n/a	n/a	n/a	n/a	n/a
	Japan	Niigata City	807,029	726	1,112	33.727	18,3	58,4	76,7	15,4	7,9	23,3
	Japan	Sendai City	1,063,608	786	1,353	29.999	14,6	55,6	70,2	9,8	20	29,8
	Japan	Yokohama City	3,694,802	435	8,490	33.940	40	26	66	8	26	34
	Republic of Korea	Suwon	1,193,695	121	9,864	22.708	44,7	54,4	99,1	0,9	n/a	0,9
	Bangladesh	Dhaka	11,030,000	299	36,924	3.100	28,3	5,1	33,4		19,8	19,8
Oceania	Australia	Adelaide	1,260,000	1,827	659	36.969	n/a	n/a	n/a	n/a	n/a	n/a
	Australia	Brisbane	2,150,000	5,950	346	40.490	n/a	n/a	n/a	n/a	n/a	n/a
	Australia	Canberra	367,752	814	429	54.278	n/a	n/a	n/a	n/a	n/a	n/a
	Australia	Darwin	129,100	112	926	54.219	n/a	n/a	n/a	n/a	n/a	n/a
	Australia	Hobart	216,276	1,696	125	34.994	n/a	n/a	n/a	n/a	n/a	n/a
	Australia	Melbourne	4,170,000	8,806	1,567	41.374	n/a	n/a	n/a	n/a	n/a	n/a
	Australia	Perth	1,830,000	5,386	286	63.400	n/a	n/a	n/a	n/a	n/a	n/a
	Australia	Sydney	4,610,000	12,144	2,058	45.377	n/a	n/a	n/a	n/a	n/a	n/a

For each of the four key measures (population, area, density and income per capita), each city was grouped into one of three categories as per the following tables. There are a similar number of cities in each group.

Table 2: Characteristics

Population		Cities
P1	< 1,000,000	Hobart, Canberra, Darwin, Gavle, Oslo, Goteborg, Helsinki, Malmo, Lund, Toulouse Métropole, Sevilla, Berne, City of Toyama, Niigata City, Kumamoto City, Gifu City, Rosario,.
P2	1,000,000 – 4,000,000	Brisbane, Perth, Adelaide, Grand Lyon, Brussels, Suwon, Sendai City, Yokohama City, Buenos Aires City, Montréal, Montevideo, Casablanca, Grand Agadir.
P3	> 4,000,000	Sydney, Melbourne, Barcelona Metropolitan, Greater London, Dhaka, Lima, Mexico City, Lagos.
Surface (km²)		Cities
S1	< 500	Darwin, Helsinki, Malmo, Lund, Brussels, Sevilla, Berne, Suwon, Kumamoto City, Dhaka, Gifu City, Buenos Aires City, Rosario, Montréal, Montevideo
S2	500 – 2000	Canberra, Oslo, Goteborg, Grand Lyon, Toulouse Métropole, City of Toyama, Sendai City, Niigata City, Yokohama City, Casablanca, Grand Agadir.
S3	> 2,000+	Sydney, Melbourne, Brisbane, Perth, Adelaide, Hobart, Gavle, Barcelona Metropolitan, Greater London, Lima, Mexico City, Lagos.
Density (population per km²)		Cities
D1	< 1,500	Brisbane, Perth, Adelaide, Hobart, Canberra, Darwin, Gavle, City of Toyama, Niigata City.

D2	1,500-4,000	Sydney, Melbourne, Goteborg, Malmo, Barcelona Metropolitan, Toulouse Métropole, Sendai City, Kumamoto City, Gifu City, Grand Agadir.
D3	> 4,000	Oslo, Helsinki, Lund, Grand Lyon, Brussels, Sevilla, Berne, Greater London, Suwon, Yokohama City, Dhaka, Lima, Buenos Aires City, Rosario, Mexico City, Montréal, Montevideo, Lagos, Casablanca.
Income per capita - ppp (USD 2012)		Cities
I1	1< 25,000	Mexico City, Gifu City, Lagos, Grand Agadir, Casablanca, Dhaka, Lima, Rosario, Montevideo, Sevilla
I2	25,000-40,000	Barcelona Metropolitan, Gavle, Goteborg, Lund, Malmo, Kumamoto City, Niigata City, Sendai City, City of Toyama, Yokohama City, Adelaide, Hobart, Toulouse Métropole, Montréal, Suwon, Sevilla.
I3	> 40,000	Brussels, Helsinki, Oslo, Sydney, Melbourne, Brisbane, Perth, Canberra, Darwin, Berne Grand Lyon, Greater London.

4.3. Results of survey on cyclists and pedestrians

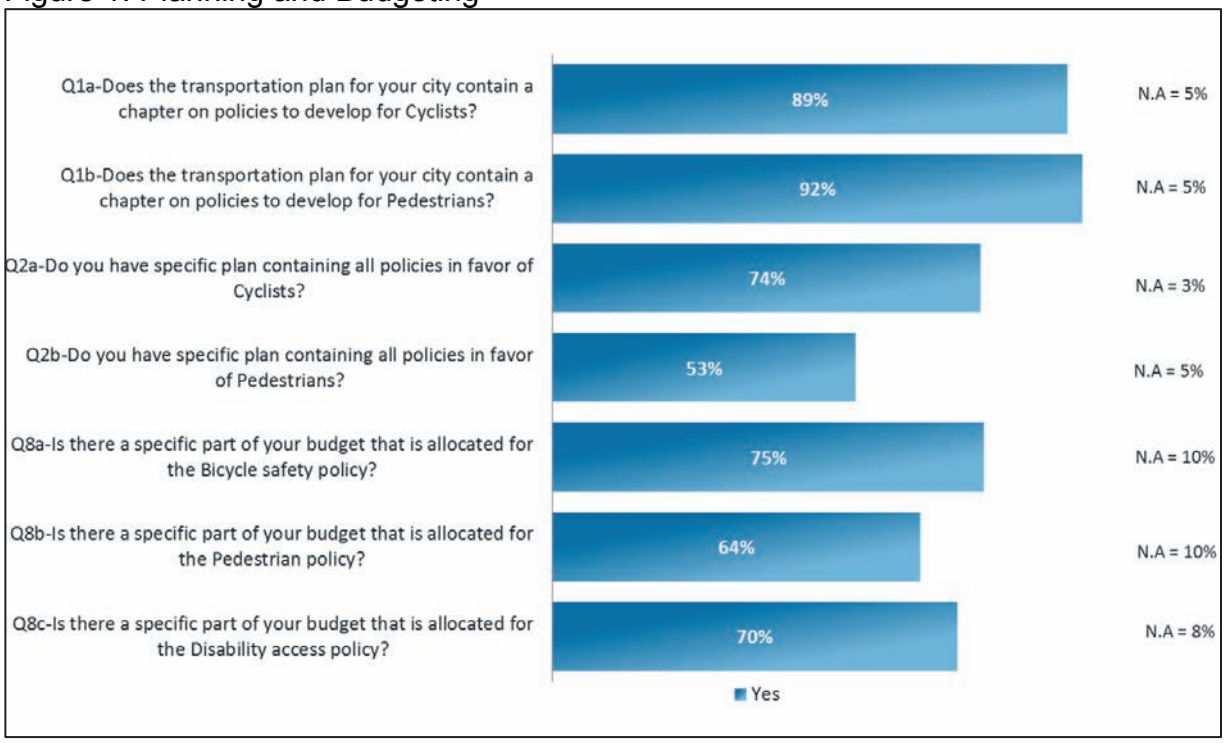
4.3.1 Planning and budgeting

In this section, we analyse the commitment that the different cities and metropolitan areas have made towards cyclists and pedestrians in their policies and mobility plans as well as the budget that they dedicate to these modes.

The results indicate that 75 percent of the cities and metropolitan areas surveyed allocate a specific amount to cycling policies. Specifically, all of the cities and metropolitan areas in Groups P1 and D1 (fewer than 1 million inhabitants and fewer than 1,500 inhabitants per km^2) have specific cycling budgets, which shows that specific budgeting for cycling is more common in smaller cities (Oslo is the only exception).

Specific budget allocations for pedestrian policies are less common. Only 64 percent of the cities and metropolitan areas surveyed provide such allocations, although once again the figure is higher (100 percent) for cities and metropolitan areas in Groups P1 and D1 (Oslo is the only exception). The number of measures applied for bicycles is also higher than the number of measures applied for pedestrians. The cities and metropolitan areas surveyed, overall, apply 65 percent of the bicycle measures included in the survey, whereas, with regard to measures for pedestrian, this percentage drops to 56 percent. Only 10 percent of the cities and metropolitan areas surveyed apply a higher percentage of measures to pedestrians in comparison to bicycles.

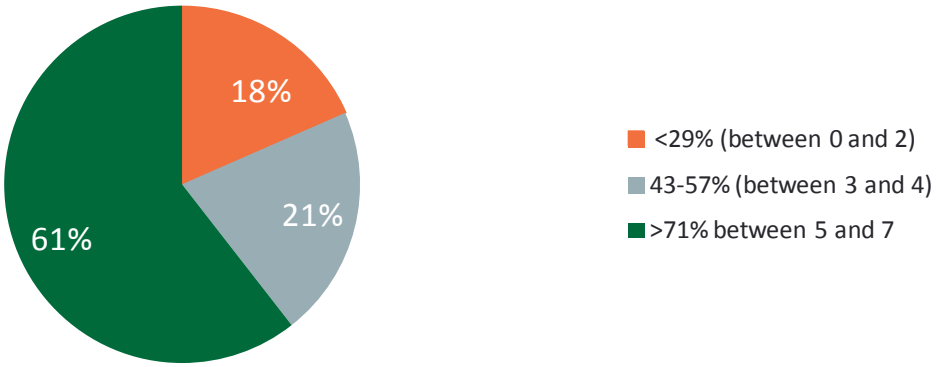
Figure 1. Planning and Budgeting



A total of 61 percent of the surveyed cities and metropolitan areas responded positively to at least five of the seven questions related to whether they have planning and budgeting policies. More than 82 percent of the cities and metropolitan areas in the survey have policies on planning and budgeting proposals for these transport modes. This means that more than half of the cities and metropolitan areas analysed have good planning and budgeting for the mobility of pedestrians and cyclists.

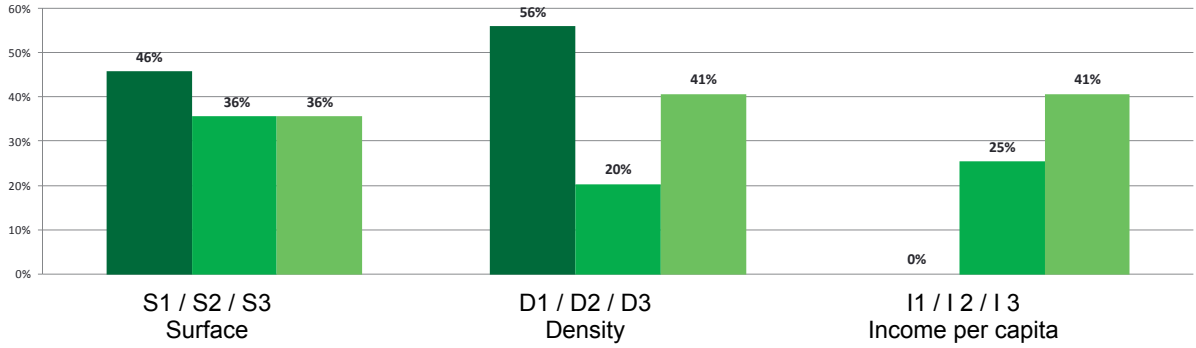
Only 18 percent of the cities and metropolitan areas respond positively to only 0 to 2 questions in relation to whether they have planning and budgeting policies. These cities and metropolitan areas apply less than 29 percent of the planning and budgeting policy proposals asked about in the survey.

Figure 2. Positive responses to the questions on Planning and Budgeting



Most of these cities and metropolitan areas that stated to apply policies of planning and budgeting relating to over 82 percent of the questions in this area, are in Groups S1, D1 and I3, which shows that specific planning and budgeting for cycling and walking is more common in cities with a small land area (less than 500 km^2), low population density (less than 1,500 inhabitants per km^2) and high income per capita (more than 40,000 USD).

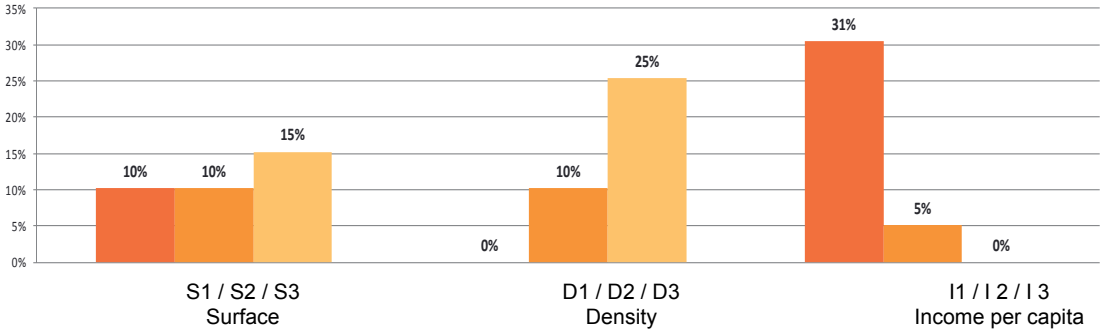
Figure 3. Planning and Budgeting (> 82%)



The cities and metropolitan areas that have developed between 0 and 2 (less than 29 percent) planning and budgeting policies for pedestrians and cycling are in Group D3, i.e. those with a high population density (more than 4,000 inhabitants per km^2).

Most of the cities and metropolitan areas' implementing cycling or pedestrian policies related to planning and budgeting are in Group I1, i.e. those with an income per capita below 25,000 USD (see Figure 4).

Figure 4. Planning and Budgeting (< 30%)



It is interesting to analyse the link between the existence of cycling and pedestrians planning and their degree of implementation. The following table shows this relationship:

Table 1. Planning and measures linkage

Planning degree		Percentage of measures applied					
	Number of cities and metropolitan areas	Infraestructure	Participation	Safety	Intermodal transport	Publi awareness	TOTAL MEASURES
Chapters and specific plans (all "yes" or "in progress)	17	84	60	67	61	49	**66**
Chapters but not specific plans	7	60	50	69	48	37	**53**
Not chapters not specific plans	1	50	0	0	0	0	**15**

It can be concluded that there is a clear relationship between the existence of specific plans for cyclists and pedestrians and the number of measures applied. Those cities and

metropolitan areas that have more planning, have a much higher number of implemented measures, especially pertaining to infrastructure. However, this relationship cannot be seen in the case of safety measures.

4.3.2 Infrastructure

This section analyses the responses related to infrastructure and more specifically: markings for cycling routes and pedestrians, special services and infrastructure such as cycle bridges and bike boxes at traffic lights.

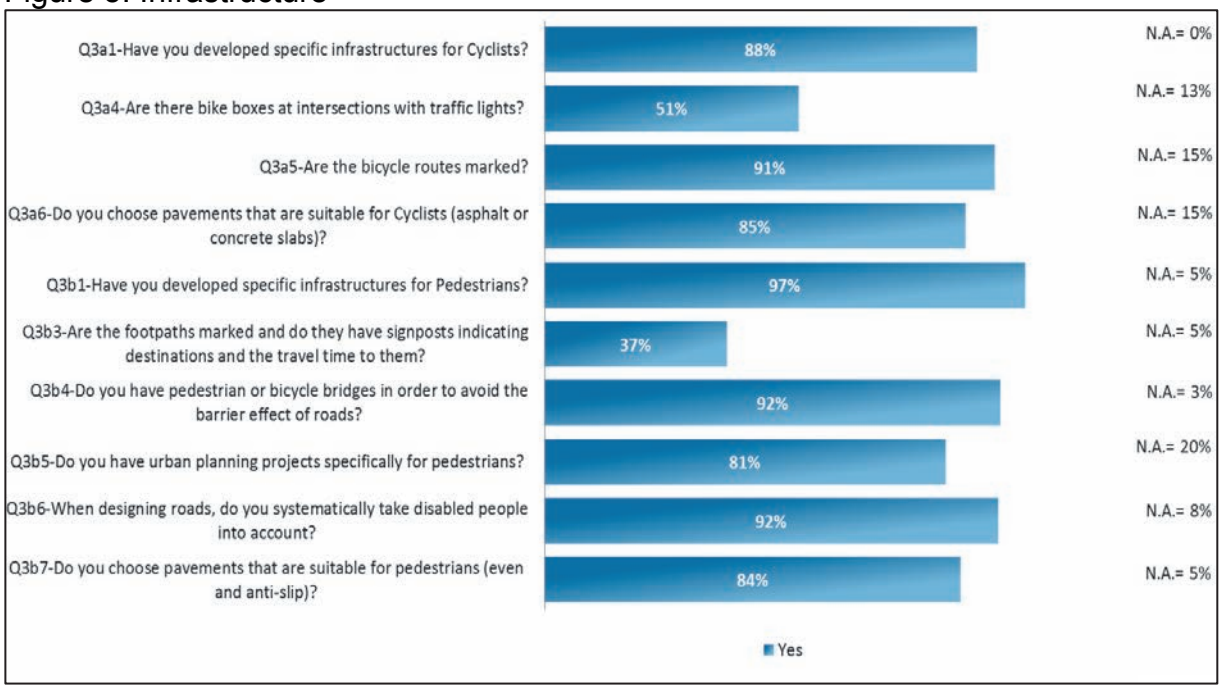
The great majority, 91 percent of the cities, reported to have marked cycle routes, but less than half (37 percent) have signposts on footpaths indicating destinations and travel time.

This latter finding is particularly true for large cities such as Buenos Aires and Mexico City, as well as African cities and those in Australia (0 percent).

There is a much smaller variation in the use of specific surfaces for cyclists (asphalt or monolithic concrete) and pedestrians (even anti-slip pavements), with 85 percent of the cities stating that they choose surfaces that are suitable for cyclists and 84 percent reporting to choose surfaces that are suitable for pedestrians.

Almost all the surveyed cities (92 percent) reported to have pedestrian or cycling bridges to avoid the barrier effect of roads, while around half (51 percent) reported to have bike boxes at junctions with traffic lights. Bike boxes do not exist in Japan, Africa and in most Latin-American cities, and are used in few cities in Groups P2, S2 and D2.

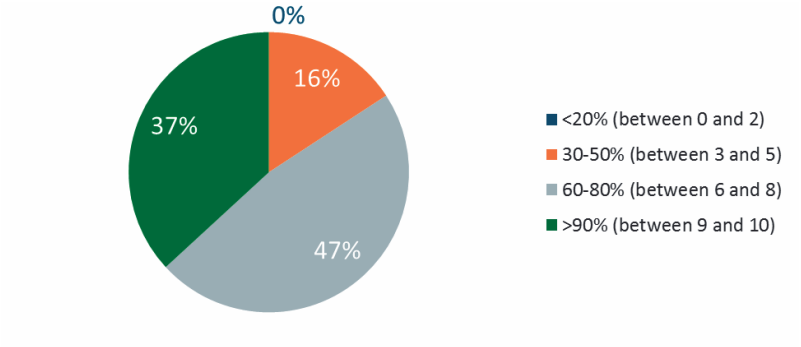
Figure 5. Infrastructure



In total, 37 percent of surveyed cities responded positively to at least nine of the ten questions related to whether they have infrastructure for pedestrians and/or cyclists, signifying that these cities perform over 90 percent of the policies relating to infrastructure proposals in the survey.

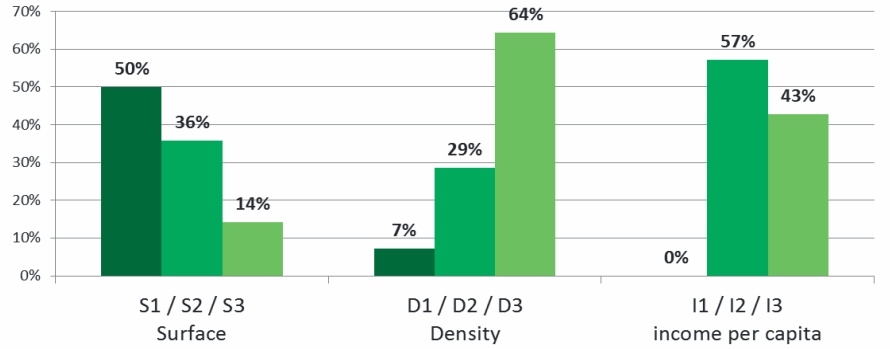
Only 16 percent of the cities responded positively to only three to five questions in relation to whether they have infrastructures. This means that these cities perform between 30 and 50 percent of the infrastructure proposals in the survey for pedestrians and/or cyclists. None of the cities responded positively to fewer than two questions proposed in the survey in relation to infrastructure. This means that all cities have a minimum infrastructure intended for pedestrians and/or cyclists.

Figure 6. Positive responses to the questions on Infrastructure



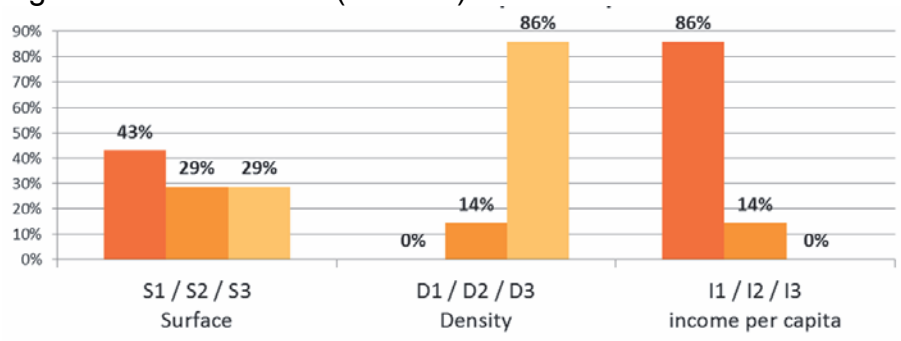
The cities surveyed stated that they have infrastructure policies for pedestrians and/or cyclists in more than 85 percent of the questions are mostly in Groups S1, D3 and I2, which shows that specific infrastructure for cycling and walking is more common in cities with a small area (less than 500 km2), high population density (more than 4,000 inhabitants per km2) and a medium to high income per capita (between 25,500 and 40,000 USD).

Figure 7. Infrastructure (> 90%)



The cities that have developed between three and five infrastructure types (30-50 percent of the policies asked about) for pedestrians and/or cyclists are in Groups D3 and I1, i.e. those with a high population density (more than 4,000 inhabitants per km2) and those with an income per capita below 25,000 USD.

Figure 8. Infrastructure (30-50%)



4.3.3 Safety

The survey included five questions on safety. The first three questions were related to statistics on accidents involving cyclists and to danger points where accidents involving cyclists and pedestrians are likely to occur or have occurred. This section analyses the responses related to the safety of cyclists and pedestrians.

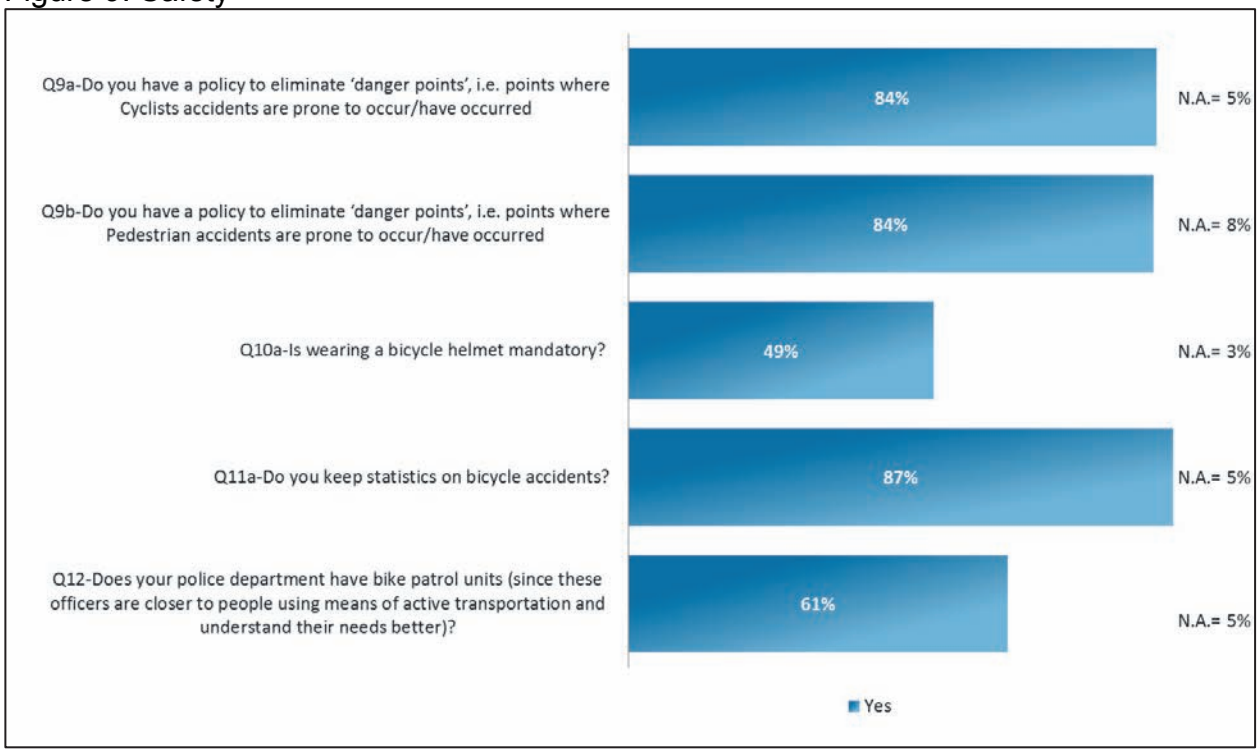
The majority, 87 percent of the cities, keep statistics on cycling accidents. We are aware that gathering statistics on cycling accidents is difficult because many of them are not reported to the authorities. Similarly, 84 percent of cities adopt a series of measures to eliminate danger points for cyclists and pedestrians.

Bicycle police patrols are used by 61 percent of the cities surveyed, often enabling the police to better understand cyclists' needs.

The cities have various policies regarding when cycling helmets are compulsory. Fewer than half of the cities (49 percent) reported that cycling helmets are compulsory in certain circumstances.

In Buenos Aires and all the Australian cities surveyed except Darwin, as well as Dhaka, Casablanca and Montevideo, helmets are compulsory for all cyclists. In Darwin they are compulsory except on cycle tracks. In the four Swedish cities (Gavle, Gothenburg, Lund and Malmö), helmets are compulsory for cyclists under the age of 15. Finally, in Gifu, Japan, they are compulsory for young children, while in Toyama, also in Japan, they are compulsory for adolescents.

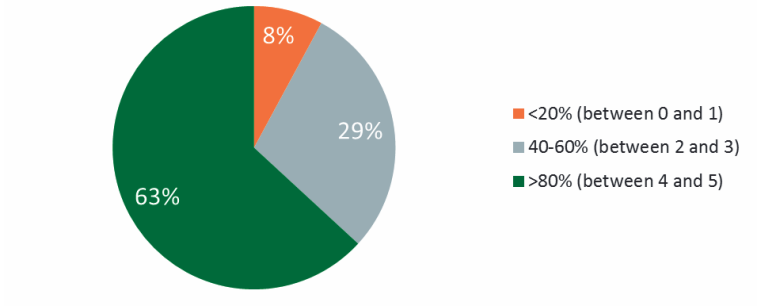
Figure 9. Safety



A total of 63 percent of surveyed cities responded positively to at least four of the five questions related to safety proposals, and this means that these perform more than 80 percent of the safety proposals in the survey.

This means that more than half of the cities analysed have good safety policies for the mobility of pedestrians and cyclists. Only 8 percent of the cities responded positively to less than one question related to safety. This means that these cities perform less than 20 percent of the safety proposals inquired in the survey.

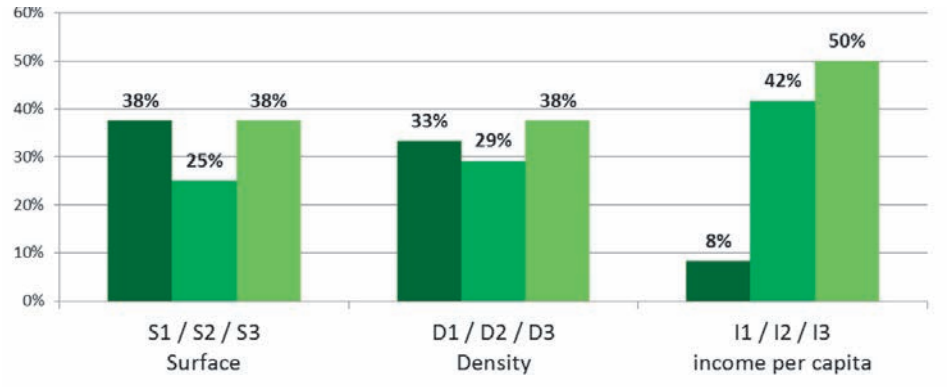
Figure 10. Positive responses to the questions on Safety



Most of these cities that stated that they apply safety policies in more than 80 percent of the questions are in Groups I3 and I2, i.e. those with an income per capita between 25,000 and 40,000 USD.

In this case the variables of land area and population density are similar.

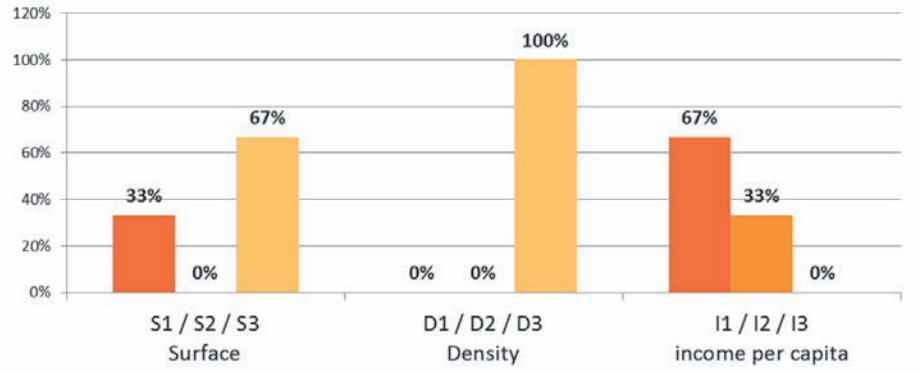
Figure 11. Safety (> 80%)



The cities that have developed less than one of the safety proposals inquired (less than 20 percent of the policies asked about) for pedestrians and/or cyclists are in Groups S3 and D3, i.e. those with a large land area (more than 4,000 km2) and a high population density (more than 4,000 inhabitants per km2).

Most of the cities that have developed cycling or pedestrian safety policies belong to Group I1, i.e. those with an income per capita below 25,000 USD (see Figure 12).

Figure 12. Safety (< 20%)

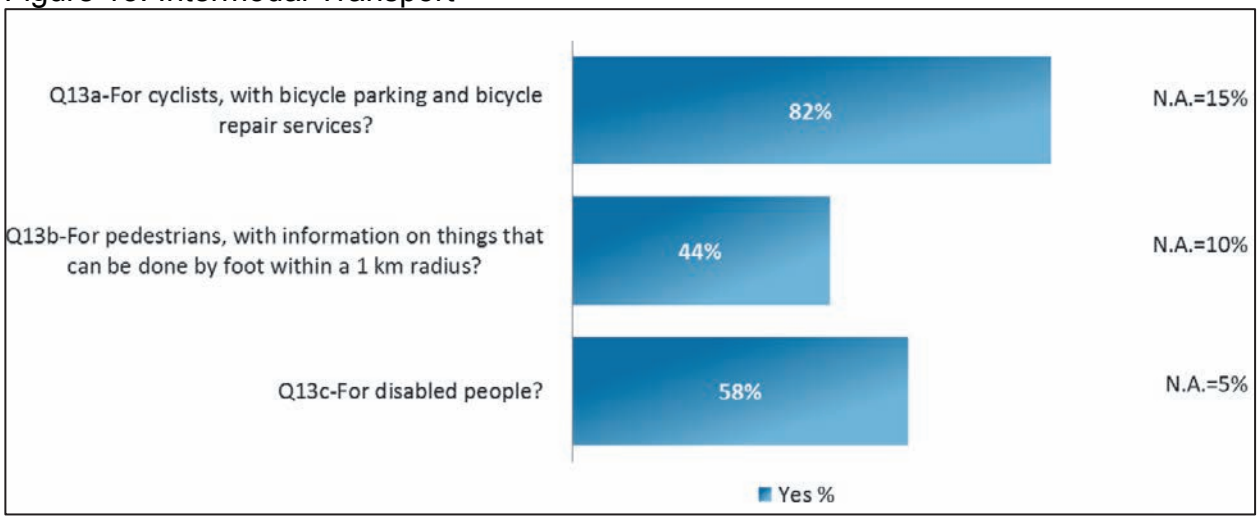


4.3.4 Intermodal transport

The survey included three questions on intermodal transport. The first questions were related to whether bicycle parking with bike repair services is available near public transport stops. The other two questions inquired whether information is provided near public transport stops on destinations located within 1 km on foot.

Only 15 percent of the cities did not answer the question on bicycle parking near public transport stops, but all those who did (82 percent) responded that they do provide such facilities (although not all the services mentioned as examples are offered everywhere). However, only 44 percent replied that they provide signs for pedestrians near public transport stops, providing further evidence that cycling policy is more developed than pedestrian policy (see Figure 14).

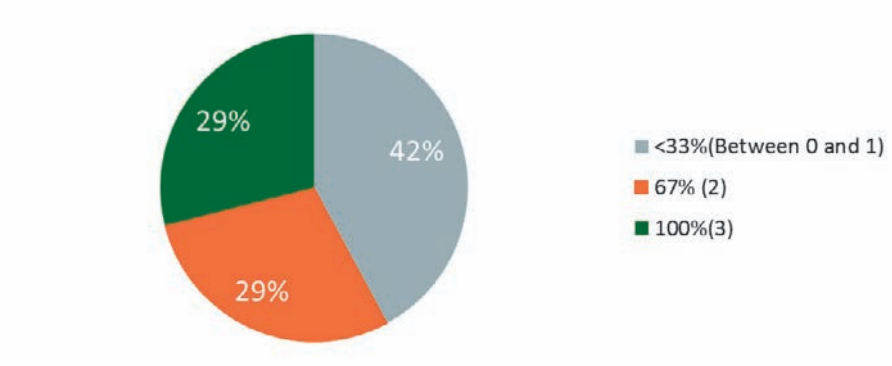
Figure 13. Intermodal Transport



A total of 29 percent of surveyed cities responded positively to all the questions asked in relation to whether they have intermodal transport, signifying that these cities apply 100 percent of the proposals included in the intermodal transport survey. Another 29 percent applies two of the three proposals inquired. This means that more than half of the cities analysed have a good plan for intermodal transport for the mobility of pedestrians and cyclists.

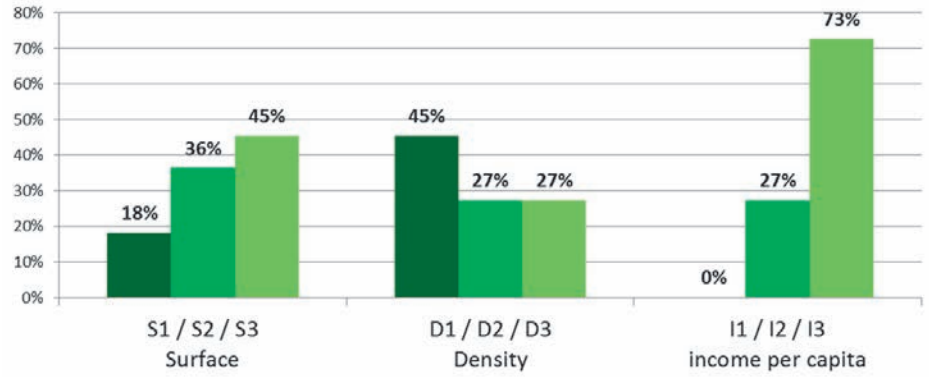
Overall, 42 percent of the cities responded positively to less than one of the questions in relation to whether they have plans or infrastructures for intermodal transport. This means that these cities apply less than 33 percent of the intermodal transport policies asked about in the survey.

Figure 14. Positive responses to the questions of Intermodal transport



Most of these cities that stated that they allocate policies of intermodal transport to the 100 percent of the total number of questions are in Groups I3, i.e. those with an income per capita higher than 40,000 USD. In this case the variables of land area and population density are similar.

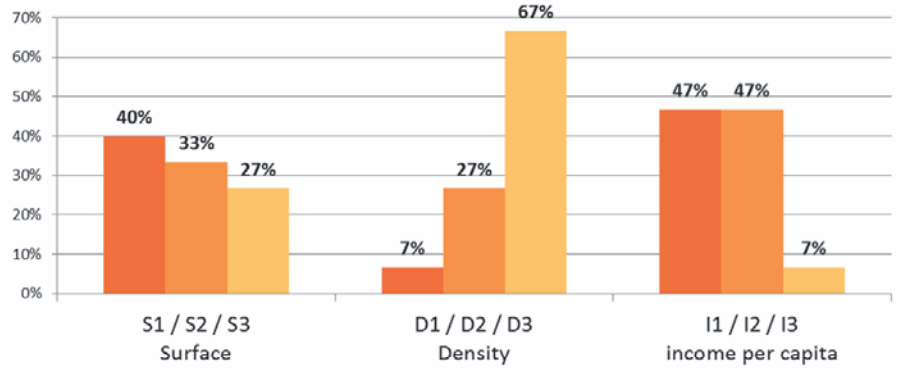
Figure 15. Intermodal (100%)



The cities that have developed less than one safety policy (less than 33 percent of the policies asked about) for pedestrians and/or cyclists are in Group D3, i.e. those with a high population density (more than 4,000 inhabitants per km2).

Most of the cities that have developed cycling or pedestrian safety belong to Group I1and I2, i.e. those with an income per capita below 40,000 USD (see Figure 17).

Figure 16. Intermodal (< 33%)

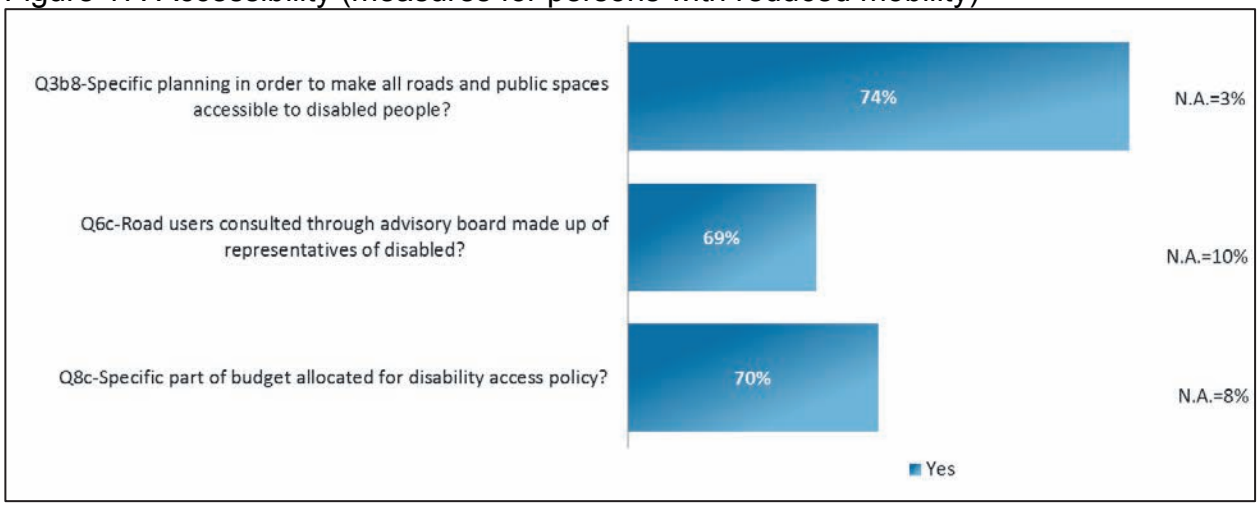


4.3.5 Accessibility (Measures for persons with reduced mobility)

This section of this document focuses specifically on policies for persons with reduced mobility.
Some questions were asked regarding measures to facilitate travel for persons with reduced mobility (PRM). These include wheelchair users, whose mobility depends on appropriately designed footpaths, curbs, etc. Such measures are similar to those taken to facilitate pedestrian travel.

The majority, 70 percent of the cities, allocate specific budgets for work to facilitate travel for PRM. Most cities (74 percent) also plan specifically for such work on roads and public spaces. A lower proportion of cities (69 percent) consult associations representing PRM (see Figure 17).

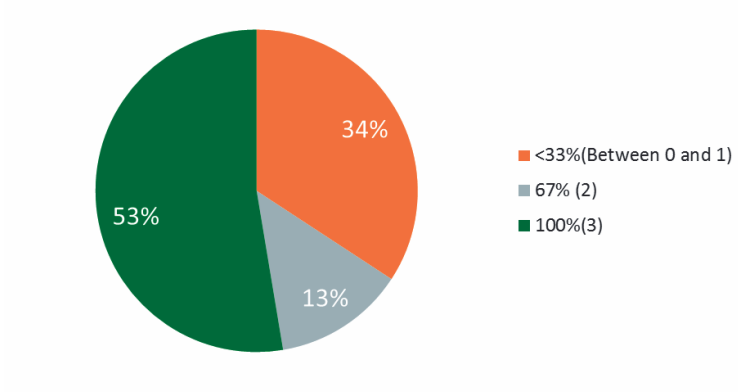
Figure 17. Accessibility (measures for persons with reduced mobility)



Close to half, 53 percent of surveyed cities responded positively to all the questions asked in relation to whether they have measures for persons with reduced mobility, signifying that these cities apply 100 percent of the proposals relating to this area in the intermodal transport survey. This means that more than half of the cities analysed have good measure for persons with reduced mobility.

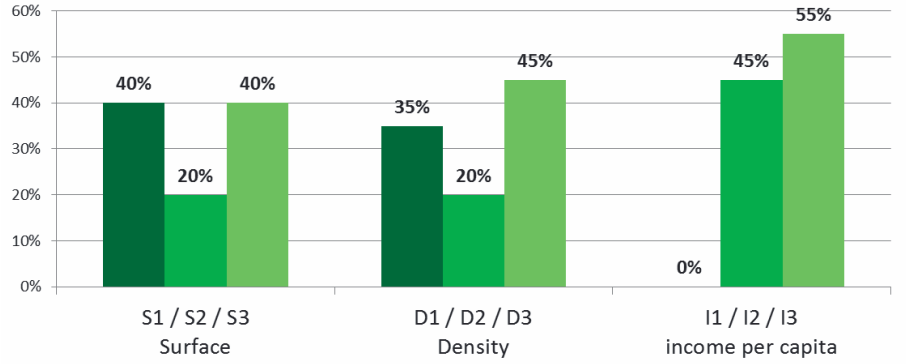
Only 34 percent of the cities responded positively to less than one question in relation to whether they have measures for persons with reduced mobility, signifying that these cities perform less than 33 percent of all accessibility policies in the survey.

Figure 18. Positive responses to the questions on Accessibility



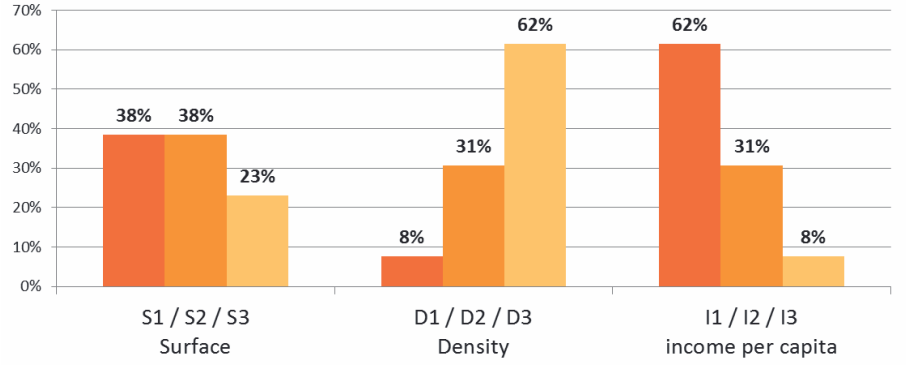
Most of these cities that apply the total number of measures inquired are in Groups I3 and I2, i.e. those with an income per capita higher than 25,000 USD.
In this case, the variables of land area and population density provide similar results. That is, only cities in Groups S2 and D2 apply a low percentages of the measures mentioned in the survey for persons with reduced mobility.

Figure 19. Accessibility (100%)



The cities that have developed one or less of the measures (less than 33 percent of the policies asked about) for persons with reduced mobility are those in Groups D3, i.e. those with a high population density (more than 4,000 inhabitants per km2). Most of the cities applying measures for persons with reduced mobility belong to Group I1, i.e. those with an income per capita below 25,000 USD.

Figure 20. Accessibility (< 33%)



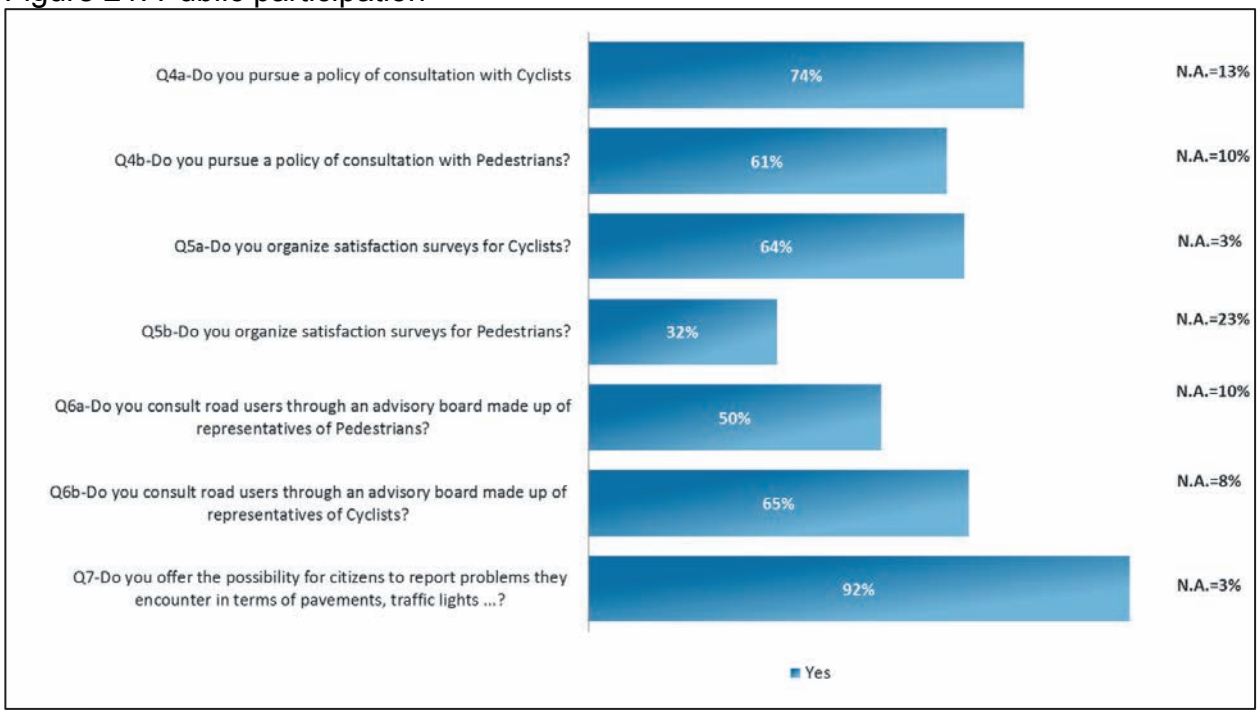
4.3.6. Public participation

Public participation was analysed from various perspectives. Can the public report problems with surfaces, traffic lights, lack of bicycle parking, dropped kerbs, etc.? Does the council consult cyclists and pedestrians regarding its cycling and pedestrian policies? Is there an advisory board formed by representatives of cyclists and pedestrians? Are satisfaction surveys conducted?

The vast majority, 92 percent of the cities responded that citizens can report problems such as the state of pavements. It would perhaps be useful to explore this factor in greater detail by obtaining more precise information on the reporting system used. Do they use a scheme similar to “FixMyStreet” in the United Kingdom, for example?

The majority, 74 percent of the cities consult cyclists, 64 percent conduct satisfaction surveys and 65 percent consult cycling organisations. Fewer cities consult pedestrians (61 percent) and pedestrian organisations (50 percent), and very few (32 percent) conduct satisfaction surveys with pedestrians, although almost one fifth of the cities (18 percent) said they were unaware whether they conducted such surveys.

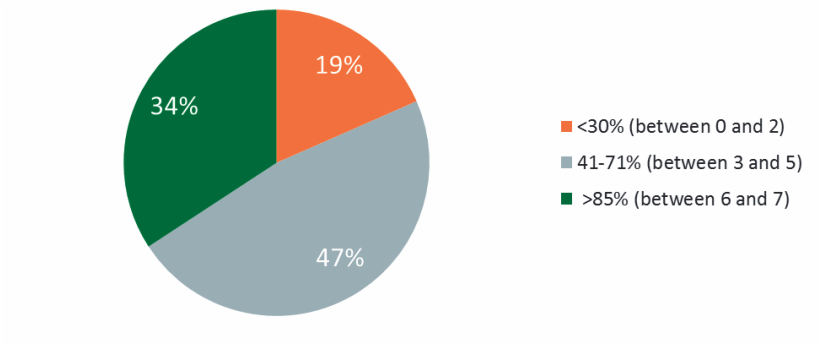
Figure 21. Public participation



A total of 34 percent of surveyed cities responded positively to at least six of the seven questions proposed in relation to public participation, signifying that these cities perform more than 85 percent of the public participation policies proposed in the survey.

Only 19 percent of the cities responded positively to two or less questions in relation with whether they apply public participation policies. This means that these cities perform less than 30 percent of policies on public participation proposed in the survey.

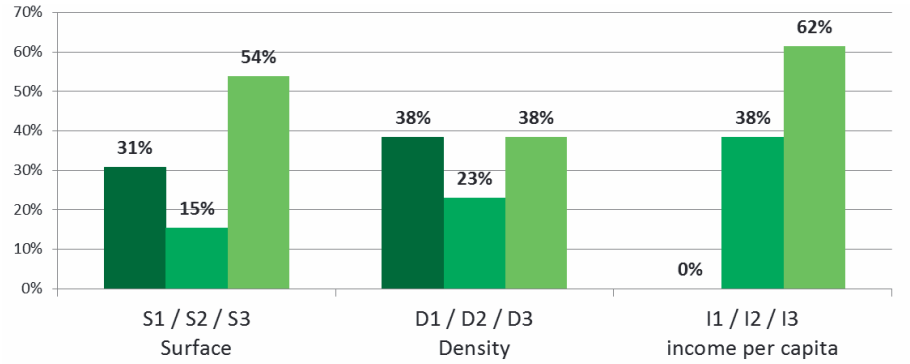
Figure 22. Positive responses to the questions on Public participation



Most of these cities that answered positively at least six of the seven questions on public participation are in Group I3, i.e. those with an income per capita higher than 40,000 USD.

In this case the variables of land area and population density are once again similar. Only Groups S2 and D2 apply low percentages of measures for public participation policies.

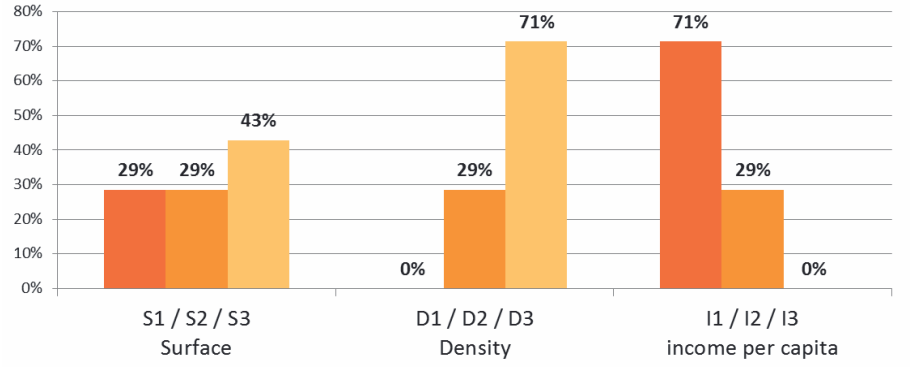
Figure 23. Participation of citizens (>85%)



The cities that have developed one or less public participation policy (less than 30 percent of the policies asked about) are in Group D3, i.e. those with a high population density (more than 4,000 inhabitants per km2).

Most of the cities applying public participation measures belong in Group I1, i.e. those with an income per capita below 25,000 USD.

Figure 24. Participation of citizens (< 30%)



4.3.7. Public awareness

Public awareness was analysed from various perspectives. Campaigns, educations and gender were the main topics.

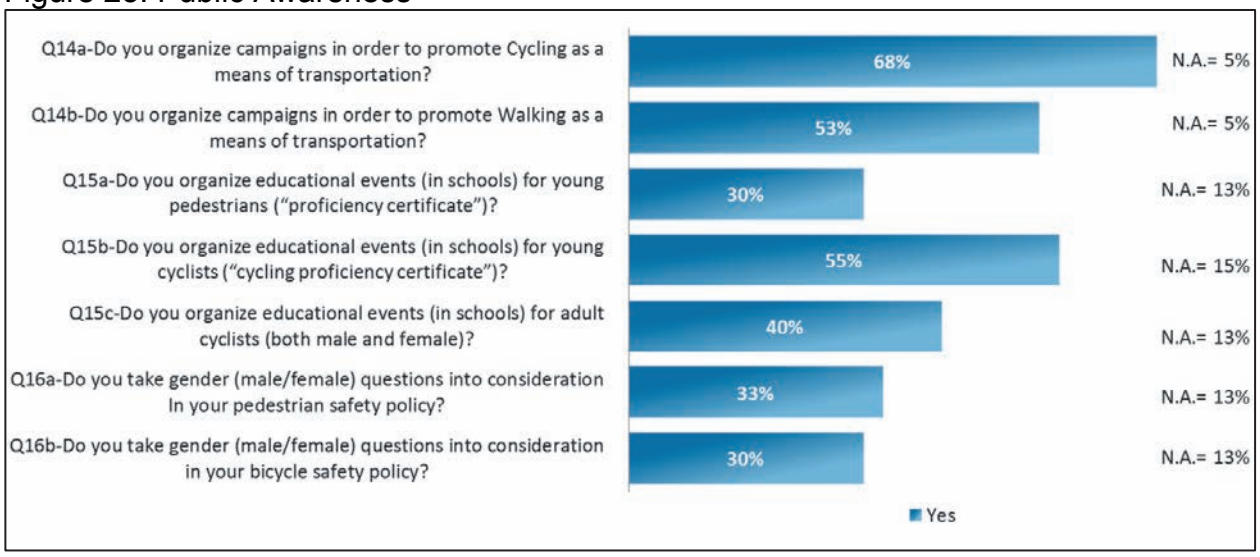
A total of 68 percent of the cities surveyed have campaigns to promote cycling; and just over half of the cities (55 percent) promote walking as a means of travel.

Questions were also asked on measures to increase public awareness of active travel including educational activities (such as in schools) for young cyclists (cycling proficiency certificates) and young pedestrians (pedestrian safety certificates), and the provision of information to adults. About 55 percent of the cities organise educational events for young cyclists, with those in Groups P1, S1 and D3 being the least active in this area.

For adult cyclists less than half (40 percent) of the cities organise educational activities, with cities in Groups P1, S1 and D3 again being the least active.

Only 30 percent of the cities reported to organise educational activities for young pedestrians. Meanwhile only between 30 and 33 percent of the cities reported to take gender into account in their cycling or pedestrian policies. Measures to encourage women to travel by bicycle, such as in Brussels, are not very widespread.

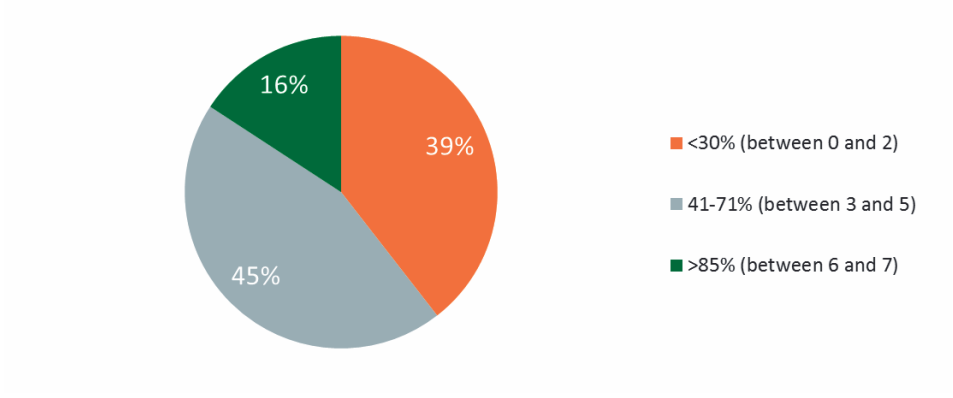
Figure 25. Public Awareness



Only 16 percent of cities surveyed responded positively to at least six of the seven questions asked in relation to whether they carry out public awareness policies, signifying that these cities apply more than 85 percent of the public awareness policies proposed in the survey.

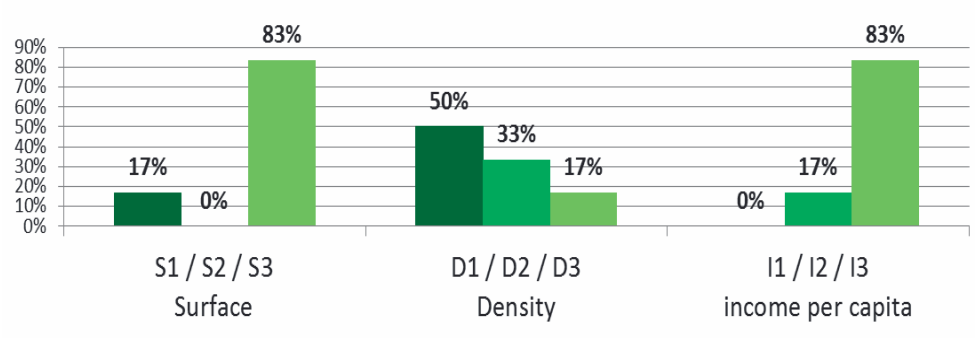
A total of 39 percent of the cities responded positively to two or less of the questions related to public awareness. This means that these apply less than 30 percent of the public awareness policies proposed in the survey.

Figure 26. Positive responses to the questions on Public awareness



Of the cities surveyed who state that they apply more than 85 percent of all the public awareness policies asked about in questions, most are in Groups S3, and I3, which shows that specific public awareness policies on cycling and walking are more common in cities with a large land area (more than 2,000 km2) and a high income per capita (higher than 40,000 USD).

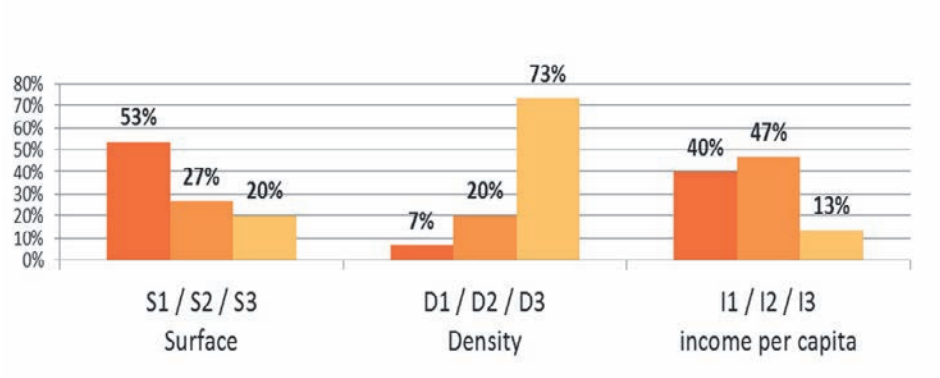
Figure 27. Public awareness (> 85%)



The cities that have developed between none and two of the public awareness proposals for pedestrians and/or cyclists (less than 30 percent of the policies asked about) are in Groups S1 and D3, i.e. those with a large land area (less than 500 km2) and a high population density (more than 4,000 inhabitants per km2).

Most of the cities applying public awareness policies belong to Group I1, i.e. those with an income per capita below 25,000 USD.

Figure 28. Public awareness (< 30%)



4.4. Supplementary results

4.4.1 Private motorised transport level and measures applied

From the analysis of the survey results it can be concluded that there is no relationship between the percentage of private motorised transport in cities and metropolitan areas and the number of measures on infrastructures or other measures implemented to promote non-motorised transport. The following figure shows the data.

Figure 29. Percentage of private motorized transport and percentage of infrastructure measures implemented

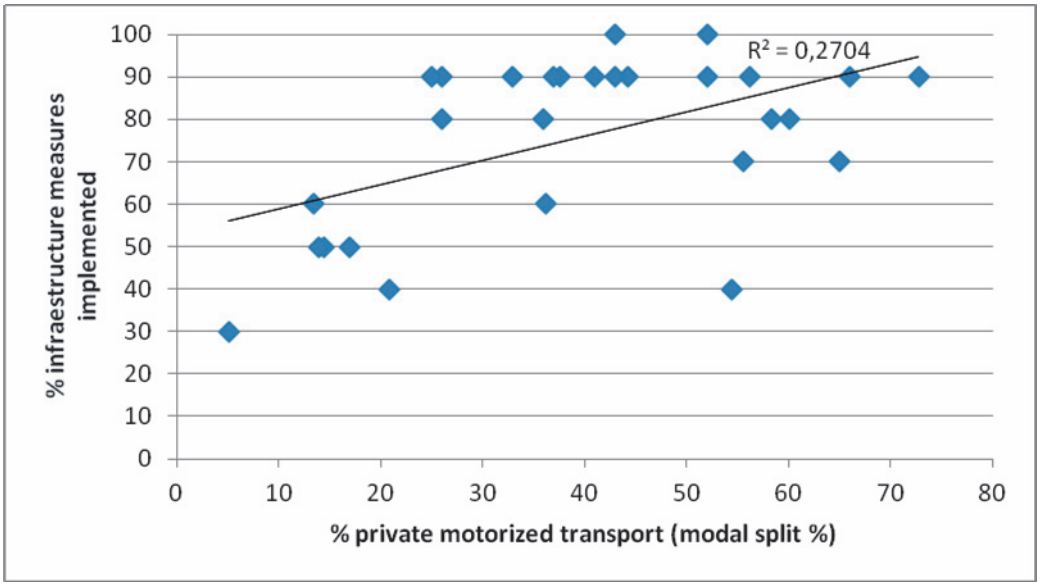
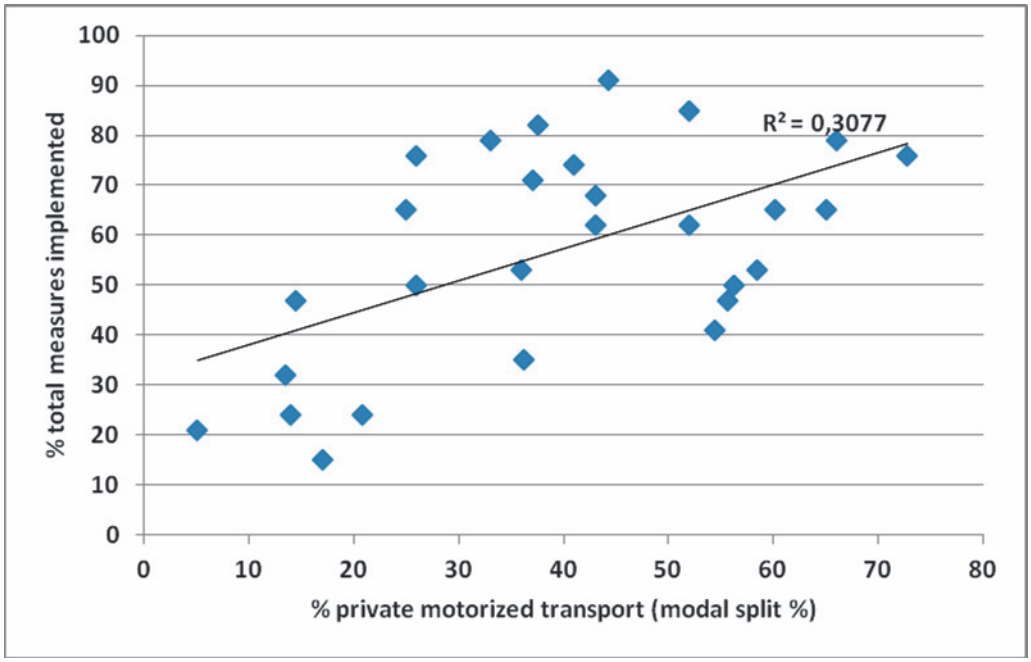


Figure 30. Percentage of private motorized transport and percentage of total measures implemented



From the figures above it can be concluded that there is no linear relationship between the percentage of motorized transport and the number of measures applied. The regression line explains only 27 percent of the variance considering only measures on infrastructure, and 30 percent if we consider all measures.

4.4.2 Income per capita level and modal split[24]

From the analysis of the 38 surveyed cities there seems to be no direct correlation between income per capita level and modal split characteristics. However, more descriptive case-by-case analyses can be carried out.
The I3 Group (income per capita above 40,000 USD) has shares of public transport ranging from 16 to 52 percent and shares of private transport between 33 and 52 percent. Meanwhile, shares of pedestrian trips range between 21 and 30 percent (average share of 23 percent), the highest scores corresponding to Grand Lyon, and shares of bicycle trips are between 2 and 11 percent (average share of 4 percent), the highest value being for Helsinki.

The I2 Group (income per capita between 25,000 and 40,000 USD) has shares of public transport ranging from 8 to 40 percent and shares of private transport between 26 and 66 percent.

Pedestrian shares in medium income cities range between 6 and 25 percent (average share of 15 percent) and bicycle shares range between 3 and 43 percent (average share of 12 percent), with the highest scores corresponding to Scandinavian cities.

Finally, the I1 Group (income per capita below 25,000 USD) has shares of public transport ranging from 27 to 60 percent and shares of private transport between 14 and 60 percent. Shares of pedestrian trips in lower income cities range between 9 and 53 percent (average share of 31 percent), particularly high in the case of the African cities surveyed, which have income per capita levels below 10,000 USD. For bicycle trips, cities in this group range between 1 and 5 percent (average share of 4 percent)

4.4.3 Geographical analysis (by continent)

By continents the main conclusions that can be formulated from the analysis of the survey are as follows:

- Much higher pedestrian shares (20 to 30 percent) in European cities as compared to South and North American cities (8 to 25 percent), as well as in the case of bike shares, which are over 10 to 15 percent in Scandinavian cities.
- European cities showed a high level of positive answers to all pedestrian and bicycle policies inquired. All of them also have strong policies for disabled people.
- Most South American cities have pedestrian and bicycle planning policies in place and some of them also have public participation and public awareness policies. However, most cities seem to have rather weak policies in terms of budgeting, development of specific infrastructure, safety and intermodal transport. Most of them have strong policies for disabled people, although not in terms of intermodality.
- Asian city rates fall between Europe and America in terms of cycling and pedestrian shares in the total modal split, with pedestrians shares around 10 to 25 percent and bicycle shares around 10 to 15 percent. Among the group of Asian cities, Japanese cities show a high level of positive answers in all pedestrian and bicycle policy domains and all of them have strong policies for disabled people, whereas for other Asian cities surveyed pedestrian and bicycle policies are scarce.

[24] It should be noted that modal split here only takes into account the main mode used. Walking and cycling are often part of an itinerary but are not represented in the modal split.

- African cities tend to behave quite differently from those in other continents, showing very high pedestrian shares (40 to 50 percent). Although having some planning policies in place, African cities have limited pedestrian and bicycle policies in terms of budgeting, development of specific infrastructure, as well as in regard to public participation, safety, intermodality and public awareness. However, most surveyed cities provided positive answers regarding the development of pedestrian infrastructures adapted for disabled people

4.5. Good practices

From the survey carried out, information has been gathered on best practices and other best practices implemented in cities around the world, for 13 locations in total. Below is a summary of these.

Planning

- Barcelona Metropolitan Region, Spain. Barcelona's currently in force "Mobility Master Plan 2013-2018" includes a section on pedestrians and cycling and try to encourage the use of non-motorized transport through: encouraging the Urban Mobility Plans, developing an interurban bike-network, promoting the use of bikes and promoting ecological vehicles in fleets and encouraging innovation.
- Bolzano, Italy. Bolzano created a Master Plan for Cycling Mobility that includes the following measures: bike network, e-bike bike-sharing, two photovoltaic charging stations, communication, marketing and events, bicycle Barometer, coverings and bicycle racks.
- Edinburgh, United Kingdom. Edinburgh's Travel Action Plan 2010, currently in force, encourages Walking and Cycling for travel. It includes measures such as the development of two parallel networks (a family network and another one for the more experienced cyclist); on-street bicycle parking at shopping centres; new development of parking standards; development of school travel plans and safe routes to schools, among other.
- Queretaro Metropolitan, Mexico. Currently active plan to decrease pollution through increasing the percentage of pedestrians and cyclists in the modal split. Rosario, Argentina created a Bikeway Plan. The municipality's next step will be to deploy a bike-sharing system in the city, which will consist of 18 stations and 480 bikes.
- Washington DC, United States of America. Washington, DC, is the leading walkable urban area in the USA.

Bike-sharing

- Barcelona, Spain. Barcelona's bike-sharing system consists of 477 stations and has an estimated 6,000 bikes. The service also offers electric bikes.
- Changwon, South Korea. Changwon has the largest system in South Korea, with 3,000 bicycles and 240 stations.
- Madrid, Spain. Madrid's bike-sharing system consists of 123 stations and 1,560 bikes. 100 percent are electrical bikes.
- Paris, France. Paris bike-sharing system consists of 1,625 stations and has an estimated 18,000 bikes.

- Great Lyon, France, has implemented the first "Decaud" bike sharing in 2005, now with 350 stations and around 4000 bikes. 23000 trips are made per day in average.
- Montreal, Canada: Bixi is Montreal`s bike sharing system with over 5,600 bikes, deployed at 460 stations across the city. Accessible to anyone, the bikes are available 24 hours a day, 7 days a week, from April to November.

Bridges and tunnels for pedestrian and cyclist

- Antwerp, Belgium. The Saint-Anna Tunnel, or “Pedestrian tunnel” as Antwerpers call it, is a tunnel for pedestrians and cyclists that runs under the River Scheldt, connecting the left and right banks of the river.
- Bath, United Kingdom. The Bath Two Tunnels Circuit is a 13 mile circular route taking in the iconic Bath Two Tunnels.
- Brisbane, Australia. The Brisbane river loop consists of a 36 km long cycle route that runs along the river bank.
- San Sebastian, Spain. Morlans tunnel, a 1 km-long old railway tunnel turned into a unique urban cycling lane.
- In Lyon, city centre, has been built a 1.5 km tunnel dedicated only to pedestrian, bicycle and busses (one direction only). This tunnel is implemented along an existing road tunnel, in order to secure it.

Lanes

- Bangkok, Thailand. A 23.5 km cycle track around the airport perimeter.
- Bologna, Italy: Bologna has shown good practice in public participation in bike lane design. For the design of pathways, a questionnaire has been distributed to a sample of 150 cyclists.
- Lima, Peru has created a Guidebook for the Promotion and Implementation of bikeways, to train technical staff for the implementation, promotion and operation of bike-lane, and the “Ciclodia” a temporary closure of Arequipa Avenue for the exclusive use of pedestrians and cyclists that takes place every Sunday from 7 to 1 pm.
- Ljubljana, Slovenia: Design actions - based on a previous survey- for lanes and coexistence between pedestrians and cyclists in the city, especially in its pedestrian zone.
- Orebro, Sweden: Örebro City Council designed and implemented a main bicycle route (Orange route) opened in May 2012 (5.4 km): pedestrian and cyclists are segregated, cars have to give way when crossing bicycle lanes, conventional pedestrian and bicycle crossings, crossings with specific traffic lights, among others.
- Perth, Australia: Latest addition to hundreds of km of bike paths in Perth, Australia.
- Vancouver, Canada: Bike-lanes and crossings in Vancouver.
- Montreal, Canada: Over 450 km of bikes lanes throughout the city including segregated bikes lines in the city centre.
- Buenos Aires, Argentina. *Bicisendas*: A bike lane network with a total length of 130 km, designed as a network segregated from other forms of transport (motorized vehicles), and connecting the main and major transport interchanges of the city.

- 43 countries in Europe and Asia: Eurovelo. The ECF (European Cyclists Federation) is the owner of the brand Euro Velo and coordinates its development in Europe. It is a network of 14 routes connecting all Europe and it allows cyclists circulation in a safety way.

Parking

- Amsterdam, Netherlands: 3-level off-street parking for bicycles in Amsterdam
- Barcelona, Spain. Safety bicycle parking lots deployed in different municipalities
- Groningen, Netherlands: Bicycle parking in Groningen. Introduction of several measures for on-street bicycle parking and also measures to facilitate bicycle parking (new bicycle parking garages, especially on prime hotspots and at the ends of major bicycle routes)
- Rosario, Argentina, Bike-network and on-street parking.
- Buenos Aires, Argentina: On-street parking: the municipality has created 4,200 slots, located mainly at transport stations, public buildings, hospitals, schools, malls, city centre, etc

Technology

- Krommenie, Netherlands: Solar panels embedded in the cycle path near Amsterdam could generate enough electricity to power three houses, with potential to extend the scheme to roads.

The annex to this document includes the detail of good practices.

4.6. European projects:

In this section, we have introduced some of the biggest European projects which are also organized by type.

Planning and management of urban mobility
TRACY, Systematic study on the mobility needs of the elderly.
GOAL, Development of an action plan with measures to meet the new needs of the elderly.
ARCHIMEDES Planning of attractive and effective measures to achieve more sustainable modes, in contrast to the modes used in the short trips at the beginning and end of the modal chain.

Safety
SAFEWAY2SCHOOL. Redesign and incorporation of technological elements for improving safety related to school mobility: redefine routes towards safer roads, passive safety features for kids, smart stops, signage and special information for drivers, children and parents at stops, etc.
ASPECSS. Development of standardized methodologies for the evaluation of security systems in vehicles aimed at protecting pedestrians and cyclists.
Transport of bicycles on public transport
BIKE INTERMODAL Development of a prototype of a compact and collapsible bike that facilitates transport on public transport vehicles, easy to use and comfortable for a majority of users.

Accessibly
PICAV. Personal Intelligent City Accessible Vehicle. Aims to develop a scheme based on the car sharing concept but using electric vehicles for moving about in pedestrian areas, specially designed for people with reduced mobility

4.7. Future trends

This section includes some of the new trends that are developing at different levels, and presents a brief summary of each one of them. These are some examples:

Bicycle motorways
The Danish capital began to develop this project in 2009, with participation from public administrations as well as major cooperation from the public. The project encompasses Copenhagen and 20 municipalities in its metropolitan area. 13 routes were initially plotted, but currently intend to create 26 lines that will be 300 km in length when the project is finished. The first segment open is 17.5 km long and passes through the municipalities of Copenhagen and Frederiksberg, Albertslund, RØDOVRE. They are called bike highways but routes take advantage of the infrastructure of existing lanes, while adding a number of features.

Goods movement
Two types of goods movement: supplies for bars, shops and other businesses and messaging. Both of these can be carried out by bicycle. Compared to a bicycle, with a load of 180 kilos, a van can carry between 1,000 and 1,500 kilos. Some studies state that when delivering, vans transport an average of 100 kilograms over a distance of 15 km.
Several traditional distribution companies, such as SEUR, have begun to include bicycles in their planning. In place where the bike has fully become part of everyday life, cyclists themselves are exploring the limits of bicycle goods delivery. In Barcelona, the Vanapedal Company has been distributing for over three years.

Interchange services
It is frequent that as they begin to focus bikes in the around of the stations appear services and businesses that help the rider.
Danish railways (DSB) offer cycling services at 10 stations where travellers leaves their bikes in the morning and pick them up at the end of the day.
A similar case exists already in Barcelona, in the lobby of the station of Sarrià (FGC), which in addition to repairs, allows cyclists to park bike, even in closed lockers.
The BHLS (or BRT) standard in Sweden, UK, Netherlands, is to offer bicycle parking at each stops or stations, as most as possible.

Bike-Sharing, electric vehicle
Copenhagen, the city that popularized bike sharing in the 1990s, is replacing its coin-operated clunkers with electric motor–assisted bicycles with their own touch-screen instrument panels. The bikes, which the city beta-tested this past September and October, house motors that can provide up to 450 watts of power from a battery pack that is rechargeable at dozens of docking stations around the city.
Currently there are many cities that are following these trends, such as for example Barcelona.

Generate energy bike lane

The Netherlands recently announced that it is readying a 70-metre bike lane with built-in solar panels. SolaRoad, the consortium who came up with the project along with the Netherlands Organization for Applied Scientific Research (TNO), hopes to expand the lane to 100 meters by 2016 and perhaps extend the project to other areas.

The bike lane will open on November 12 in Krommenie, 25 km from Amsterdam. It is made of rectangular concrete blocks that have layers of solar panels built into them. The fragile panels are encased in 1-inch thick glass that can withstand the weight and pressure of a truck without cracking. According to SolaRoad, even this small chunk of road can generate enough electricity to power three homes, although the solar panels can't be moved or angled toward the sun for maximum ray absorption.

A simulator determines the most effective urban planning measures to increase the use of the bike.

Researchers at Barcelona's Universitat Autonoma have developed a computer model simulation that helps local politicians to decide what improvements can be made in infrastructure to increase the number of cycle users. The model compares and determines what the most suitable package is, according to its estimated impact.

Initially developed for the city of Skopje, Macedonia, the model allows the municipality to anticipate results and predicts the effect of a series of actions on numbers of bicycle users. Thanks to the application of the model, the City of Skopje expects to increase the current rate of 2.5 to 5 percent, a value typical of Nordic cities where bicycle travel is consolidated.

The improvements contemplated by the programme are improved paving of roads, building new roads to cover new routes, building stations and bicycle parking and changing the capacity of these stations

To calculate the impact of each possible change, the model takes into account the characteristics of public users, such as their motivation for starting to use a bike, the degree of motivation that occurs over time when ideal user conditions are not met, or the increase in motivation when other residents also travel by bicycle.

4.8. Future inquiries

This survey has identified the current state of certain aspects of cycling and pedestrian policies in 38 cities around the world.

Despite this, this survey omitted several questions which would have enabled a more detailed analysis of the current situation around the world.

Firstly, a more detailed analysis could be made of how the relationship of policies and actions carried out by every city depends on its topography and climate, and we believe that these are two factors to take into account when analysing bicycle use, as they can be dissuasive to bicycle use.

These variables could be included for future analyses because it would be useful to see if these factors really affect the use of bicycle and pedestrian modes.

Cycling and pedestrian policies are becoming more and more important in the world, hand in hand with the development of new kinds of non-motorised vehicles and the on-going deployment of new information and communication technologies (apps, real-time information for users, etc.).

These innovations demand further analyses as well as joint collaboration and experience exchange between cities. A thorough follow-up of the current and coming technological developments will also be required.

The survey did not deal with these topics. However, it is commonly known that some cities have already undertaken actions and assignments in that direction, such as for example the Velib' public bicycle rental system in the Paris region or the EU co-funded project "SUPERHUB" (Sustainable and Persuasive Human Users mobility in future cities), committed to the realisation of an open source platform and mobile applications able to plan customised urban routes, combining all mobility offers in real time – the three pilot cities being Milan, Barcelona and Helsinki.

Further to the use of intelligent transport systems to optimise journeys by bicycle or foot, future surveys could look at other aspects, such as bicycle-renting schemes, electric bikes, new infrastructures for pedestrian and cyclist and the reasons behind the cities' policies.

4.9. Key findings

Cities of all shapes, sizes and income levels took part in the survey, with populations ranging from 100,000 to 20.2 million, population densities ranging from 50 to 36,900 inhabitants per km² and income per capita levels ranging from 3,000 to 60,000 USD. Overall, 38 cities participated in the survey, providing a good indication of the current status of cycling and pedestrian policies around the world.

Various conclusions can be drawn from the results:

- The vast majority of the cities and metropolitan areas' mobility policies specifically take into account cycling (89 percent) and walking (92 percent).
- There is a clear relationship between having specific plans for cyclists and pedestrians and the number of measures applied. Those cities and metropolitan areas that have more planning have a much higher number of implemented measures, especially regarding infrastructure. However, this relationship cannot be seen in the case of safety measures.
- The proportion of cities and metropolitan areas allocating a budget for cyclists (75 percent of cities and metropolitan areas) is greater than for pedestrians (64 percent of the total surveyed), even though public transport users, motorcyclists and motorists are all pedestrians too, and even though mobility statistics show that in many cities and metropolitan areas, between 25 and 40 percent of journeys are made by foot.
- The number of measures applied for bicycles is also higher than the number of measures applied for pedestrians. The cities and metropolitan areas surveyed, overall, apply 65 percent of the bicycle measures included in the survey, whereas, with regard to measures for pedestrian, this percentage drops to 56 percent. Only 10 percent of the cities and metropolitan areas surveyed apply a higher percentage of measures to pedestrians in comparison to bicycles.
- A good number of the cities and metropolitan areas surveyed (between 84 and 91 percent) have cycling and pedestrian routes with specific signposts and markings and choose appropriate surfaces for cyclists and pedestrians. All cities and metropolitan areas have a minimum infrastructure intended for pedestrians and/or cyclists.

- Many cities and metropolitan areas (65percent) consult cyclists or cyclist associations when drawing up cycling policies, but satisfaction surveys for pedestrians are rare (only 32 percent).
- Nearly all the cities and metropolitan areas (84 percent) adopt measures to deal with danger points where cyclists and pedestrians are more likely to be involved in an accident.
- More than half of the cities and metropolitan areas have a good plan for intermodal transport for the mobility of pedestrians and cyclists.
- 44 percent of the cities and metropolitan areas have signs for pedestrians near public transport stops.
- Although campaigns to promote active travel and activities to educate young cyclists are widespread (55 percent of the cities and metropolitan areas have them), only a few of the cities and metropolitan areas (30 percent) have activities to educate young pedestrians.
- The majority of the cities and metropolitan areas (74 percent) say that they have introduced specific measures to facilitate travel for persons with reduced mobility.
- There is no relationship between the percentage of private motorised transport in cities and metropolitan areas and the number of measures on infrastructures or other measures implemented to promote non-motorised transport.
- Some high density cities and metropolitan areas face the big challenge of increasing non-motorised transport rates and implementing measures for cyclists and pedestrians.
- It seems to be no direct correlation between income per capita level and modal split characteristics.
- There are much higher pedestrian shares in European cities and metropolitan areas as compared to South and North American cities, as well as bicycle shares, which are significant in Scandinavian cities.
- Asian city rates are somewhere in between Europe and America in terms of cycling and pedestrian shares in the total modal split.
- African cities and metropolitan areas tend to behave quite differently from those in other continents, showing very high pedestrian shares.
- High density cities and metropolitan areas with low income per capita are those which have more challenges on planning and budgeting, safety, intermodal transport, public participation and public awareness.

Recommendations for future studies:

- It has not been possible to analyse relationships on variables of climate, terrain, etc. because the survey did not give us this information. It is recommended to include these variables in future surveys.
- It has not been possible to specifically analyse the use of intelligent transport systems, because the survey did not capture this information. It is recommended to formulate questions on future technologies.
- No data related to differences between the situation in the city centres and their outskirts is available. It would be convenient, in future studies, to take this factor into account.
- There is no detailed information related to accessibility policies. This is another important issue to be included in future surveys.
- Some questions could be made clearer to avoid misinterpretation and collection of more accurate data.

- The order of the survey should also be reviewed, starting with more general questions, followed by more detailed questions..
- The countries with low monthly per capita income are in all cases those which implement the least policies when it comes to pedestrians and cyclists.
- It is recommended to carry out a more detailed study focusing exclusively on such countries.

GLOSSARY

PPP:	purchasing power parity
N.A.	not answer
P1	Population < 1,000,000
P2	Population=1,000,000 – 4,000,000
P3	Population > 4,000,000
S1	Surface < 500
S2	Surface=500 – 2000
S3	Surface> 2,000
D1	Density < 1,500
D2	Density=1,500-4,000
D3	Density > 4,000
I1	Income per capita < 25,000
I2	Income per capita=25,000-40,000
I3	Income per capita > 40,000

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ANNEX

EXAMPLE OF QUESTIONNAIRE REGARDING BICYCLE AND PEDESTRIAN SAFETY POLICIES

Q0) General information:
Q0a- City and country
Q0b- Number of inhabitants
Q0b- Surface area
Q0b- Population density
Q0c- The percentage that the following means of transportation represent in relation to all traffic

public transportation
cars
bicycles
pedestrian
motorcycles
taxi

Q0d- Number of commuters coming in and going out

Q1) Does the transportation plan for your city contain a chapter on policies to develop for:
Q1a- Cyclists?
Q1b- Pedestrians?

Q2) Do you have specific plan containing all policies in favor of:
Q2a- Cyclists?
Q2b- Pedestrians?

Q3) Have you developed specific infrastructures for:
Q3a1- Cyclists?
If yes:
Q3a2- How many kilometers of bikeways or bike lanes are there and how many kilometers of roads?
Q3a3- How many bicycle parking places are there and for how many bikes?
Q3a4- How many one-way streets do you have that are two-way for cyclists?
Q3a5- Are the bicycle routes marked?
-How many kilometers of footway are there? (and how many kilometers of roads?)
Q3a6- Do you choose pavements that are suitable for cyclists (asphalt or concrete slabs)? Yes or no?
Q3b1- Are the bicycle routes marked? Pedestrians? Yes or no?
Q3b2- Are there bike boxes at intersections with traffic lights?
Q3b3- Are the footpaths marked and do they have signposts indicating destinations and the travel time to them? Yes or no?
Q3b4- Do you have pedestrian or bicycle bridges in order to avoid the barrier effect of roads? Yes or no?
Q3b5- Do you have urban planning projects specifically for pedestrians? Yes.
Q3b6- When designing roads, do you systematically take disabled people into account?
Q3b7- Do you choose pavements that are suitable for pedestrians (even and anti-slip)?

Q3b8- Is there specific planning in order to make all roads and public spaces accessible to disabled people?

Q4) Do you pursue a policy of consultation with the following road users:
Q4a- Cyclists?
Q4b- Pedestrians?

Q5) Do you organize satisfaction surveys for:
Q5a- Cyclists?
Q5b- Pedestrians?

Q6) Do you consult road users through an advisory board made up of:
Q6a- Representatives of pedestrians?
Q6b- Representatives of cyclists?
Q6c- Representatives of the disabled?

Q7) Do you offer the possibility for citizens to report problems they encounter in terms of pavements, traffic lights being out, curbs being too high, a lack of bicycle parking, benches etc.?

Q8) Is there a specific part of your budget that is allocated for the:
Q8a- Bicycle safety policy?
Q8b- Pedestrian policy?
Q8c- Disability access policy?

Q9) Do you have a policy to eliminate 'danger points', i.e. points where accidents are prone to occur/have occurred?
Q9a- For cyclists?
Q9b- For pedestrians?

Q10) Is wearing a bicycle helmet mandatory?
If yes:
Q10a- Is this the case for all cyclists?
Q10b- Is this only the case for certain cyclists (children etc.)?

Q11) Do you keep statistics on bicycle accidents?
If yes:
How has the number of bicycle accidents evolved as compared to the number of cyclists?

Q12) Does your police department have bike patrol units (since these officers are closer to people using means of active transportation and understand their needs better)?

Q13) Are you developing an intermodal passenger transport policy, starting from public transport stations/stops?
Q13a- For cyclists, with bicycle parking and bicycle repair services?
Q13b- For pedestrians, with information on things that can be done by foot within a 1 km radius?
Q13c- For disabled people?

Q14) Do you organize campaigns in order to promote:
Q14a- Cycling as a means of transportation?

Q14b- Walking as a means of transportation?

Q15) Do you organize educational events in schools:
Q15a- For young cyclists (“cycling proficiency certificate”)?
Q15b- For adult cyclists (both male and female)?
Q15c- For young pedestrians (“proficiency certificate”)?

Q16) Do you take gender (male/female) questions into consideration:
Q16a- In your pedestrian safety policy? Yes or no?
Q16b- In your bicycle safety policy? Yes or no?

Q17) Do you have other noteworthy information?

We would like to thank you for participating in our survey, which we use to gather information for our work, of which we will keep you informed.

5. CONCLUSION

This report shows how large is the scope of actions that are implemented in various cities over the world to improve urban mobility. All these actions refer to specific situations and to general principles.

In addition to this report, the reader will find the report called **"Summery of HOV, HOT, BRT case studies collected"**[25].

Such lessons learnt can be set up for discussion at the Seoul conference:

- The existing road network, and mostly the motorways, can play a strategic role in promoting virtuous, sustainable transportation modes. Alternative solutions to the single-passenger car are no longer limited to urban settings, as developments now extend further into suburban zones, thus offering the significant benefit of vastly improved intermodal connections with the urban network. Advances and innovative solutions are also readily available. Technical guidelines and design practices need to evolve towards greater flexibility in order to expand such tools and stimulate innovation. With this goal in mind, experiences should continue to be exchanged.
- Examine existing long-standing transportation practices and effect changes in established policies to allow for the planning and implementation of innovative transportation alternatives to reverse trends of increasing single occupant vehicle travel that are resulting from increasingly suburban population. Examples include HOV/HOT lanes, TOD, bicycle/pedestrian networks, and BRT. These include: obtaining enabling legislation (supporting laws), developing support among States and local elected officials, and public acceptance for these innovative alternatives.
- A great interest in benchmarking the TOD strategies, now widely developed for financing efficient modal interchanges and improving intermodality connecting all virtuous modes that are numerous and complementary, from rail to active modes.
- With growing congestion and increasing competition for limited road space, prioritising the use of this road space by mode, by time and by location provides a strategic logic for road managers and land use planners. Road space reallocation is a short term action. In congested cities it is also hard to implement. It will require a change in culture of thinking by transport and land use planners if it is to be implemented on a wider city-scale. Importantly, it is one element that can help move us towards a more sustainable transport system.
- BRT, as a road mode, is only one attractive way of contributing to sustainable urban mobility. The rail modes, well developed in big or mega cities in Europe and Asia, are also great virtuous and efficient modes that are able to offer reliable high capacity, sometimes with high speed on long distance services.
- Efficient modal interchanges are always widely requested, in order to improve mode shifting, as, in any urban and country context, it appears that there is a definite need to combine a wide range of virtuous mobility modes.

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[25] By the sub-group 2.2.2 : Design of transport infrastructure for multimodality in urban areas

- Cycling and pedestrian policies are becoming more and more important in the world, hand in hand with the development of new kinds of non-motorised vehicles and the on-going deployment of new information and communication technologies. Nevertheless there are many differences among countries regarding cycling and pedestrian plans and infrastructures that suggest it's necessary to go into detail about the main factors to improve its networks and to increase the benchmarking.
- Motorcycles and scooters are a major form of transport in a number of countries and are particularly prevalent in many Asian cities. They provide a low cost transport option and improve mobility for people. Our efforts to collect information on the planning, operation and development of road infrastructure for this mode was not successful. There appears to be limited specific attention given to the planning and operation of this vehicle mode. It is recommended that further attention is given to this mode in future PIARC work.

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