DEVELOPING PUBLIC TRANSPORT STRATEGIES IN SPAIN: KEYS FOR SUCCESS

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1.- ABSTRACT

There is a growing concern in the urban transport field about the development of a data set of indicators that would allow to undertake ongoing monitoring and evaluation of current transportation policies, compare data from territories facing the same kind of challenges, identify good practices and strategies to be followed, and strengthen the information, participation and decision-making process. These data set of indicators, known as *observatories*, are aimed to fulfil stakeholders needs, so that they achieve the precise knowledge to adopt pertinent policies.

This paper is based on the results of a recent research conducted in the 11 major metropolitan areas in Spain, in the context of the development of a Metropolitan Mobility Observatory, aiming to serve as a permanent monitoring mechanism of sustainable urban mobility in major Spanish cities, as well as to serve as basis for Metropolitan Transport Authorities to improve operation of their public transport system, and thus increasing their contribution to sustainable mobility.

Results from the study suggest that coordination of all public transport modes within one integrated system is a key element for the progress or maintenance of public transport share. But, even though significant improvements have been achieved, existing strategies seem insufficient to cope with major urban challenges. New policies should be adopted to promote public transport and non-motorised modes; in which the key elements for action move from infrastructure investment to soft measures and travel demand management schemes; integrating environmental and sustainability objectives, and developing pricing policies coherent with those goals.

2.- INTRODUCTION

Most cities across Europe, and many more world wide, share a common concern and interest regarding the transportation system in their metropolitan areas: achieving a sustainable mobility. The importance given to this concept has grown in a way that nowadays we could say that it characterises a typically European way to approach urban transport policies in metropolitan areas. But this approach does not only consist in adopting several particular measures. Moreover, this approach should comprise the consolidation of certain trends and sensibilities among stakeholders, seeking consensus and expert participation. It is also important to adopt long term strategies, while improving the information and decision-making process.

In order to do so, there is a growing concern about the development of a data set of indicators that would allow to:

- Undertake ongoing monitoring and evaluation of current transportation policies
- Compare data from territories facing the same kind of challenges
- Identify good practices and strategies to be followed
- Strengthen the information, participation and decision-making process

These data set of indicators, known as *observatories*, are aimed to fulfil stakeholders needs, so that they achieve the precise knowledge to adopt pertinent policies.

This paper is based on the results of a recent research conducted in the 11 major metropolitan areas in Spain, in the context of the development of a Metropolitan Mobility Observatory, aiming to serve as a permanent monitoring mechanism of sustainable urban mobility in major Spanish cities.

3.- METROPOLITAN MOBILITY OBSERVATORY

The Spanish Metropolitan Mobility Observatory, sponsored by the Spanish Ministry of Environment, was launched in 2003 by the Metropolitan Transport Authorities of the major metropolitan areas in Spain, and TRANSyT. Its scope is to identify those elements within urban transport policy packages which have had a more significant impact on mobility (i.e. global transport demand, travel time, modal split,…), and on land use patterns.

For that purpose, a set of data from the different Metropolitan Transport Authorities over a 10 year period (1993 to 2002) has been collected. The research summarises, compares and analyses this information, and identifies those key transport policy choices taken by decision-makers within this period.

The objectives of the research are:

- To highlight public transport contribution to improve urban areas and sustainable development, as well as the main challenges of mobility regarding urban environment (energy consumption, pollutant emissions, accidentality,…)
- To describe the role of Metropolitan Transport Authorities in achieving an attractive and quality public transport system
- To monitor transport supply and demand characteristics, focusing on public transport
- To analyse the resources dedicated to the public transport system
- To describe the financial models used for the public transport system
- To highlight the main initiatives and innovations developed by the metropolitan areas

Furthermore, the main purpose of the Metropolitan Mobility Observatory is to serve as basis for Metropolitan Transport Authorities to improve operation of

their public transport system, and thus increasing their contribution to sustainable mobility.

4.- MAIN RESULTS

4.1.- Basic Data of Metropolitan Areas

The following table shows some basic characteristics of the metropolitan areas considered:

Table 1: Metropolitan areas characteristics

Metropolitan Area	Population (2001)	Surface (km^2)	Density (Inhab/km^2)	Nº Municipalities	Comparison with the whole region	
					Population	Surface
Alicante	393.736	354	1.113	5	26,9%	6,1%
Asturias	932.891	4	190	42	87,8%	46,3%
Barcelona	4.482.623	3	1.385	164	93,3%	41,9%
Bilbao	865.799	365	2.372	26	77,1%	16,5%
Cádiz	615.600	2	295	7	55,1%	28,1%
Granada	445.361	859	518	32	54,2%	6,8%
Madrid	5.423.384	8	675	179	100,0%	100,0%
Málaga	817.899	1	650	12	63,5%	17,2%
Sevilla	1.121.208	1	808	22	64,9%	9,9%
Valencia	1.603.655	1	1.133	60	72,4%	13,1%
Valladolid	327.086	192	1.704	1	65,7%	2,4%
TOTALES	17.635.637	24				

Nearly half of the Spanish population lives in the metropolitan areas considered (44%), while the territory considered represents less than a 5% of the total surface of Spain.

The metropolitan areas concerned are a very heterogeneous group in terms of population and surface. This will lead to drawbacks in terms of clarity from some of the analysis undertaken below.

In regards of the public transport system performing in each metropolitan area, table 2 shows the operators for the different means of transport present in each metropolitan area.

Table 2: Public transport operators						
	Rail (National competence)	**Rail (Regional competence)**	**Underground**	**Tramway**	**Suburban Bus**	**Urban Bus**
Alicante		FGV		FGV	Private Companies	Private Companies
Asturias	RENFE, FEVE				Private Companies	TUA (Oviedo)
Barcelona	RENFE	FGC	FMB; FGC		Private Companies	TB
Bilbao	RENFE, FEVE	EuskoTren	MetroBilbao	EuskoTran	Private Companies	TCSA
Cádiz	RENFE				Private Companies	Private Companies
Granada					Private Companies	ROBAR
Madrid	RENFE		Metro de Madrid, TFM		Private Companies	EMT
Málaga	RENFE				Private Companies	EMT
Sevilla	RENFE				Private Companies	TUSSAM
Valencia	RENFE	FGV	FGV	FGV	Private Companies	EMT
Valladolid						AUVASA

Railroad services are mainly provided by the national railroad company (RENFE - FEVE), but there are several metropolitan areas where this service is also provided by regional operators.

Larger metropolitan areas incorporate underground network to their public transport system, while tramway network is only present in 3 metropolitan areas.

Regarding bus transport, to highlight that urban services are mainly supplied by a single municipal company, while suburban services are operated by a large number of private companies.

4.2.- Modal Split: the Role of Public Transport

4.2.1.- Work trips

Data collected reveal that the private car is the most usual mode for work trips in the metropolitan areas considered:

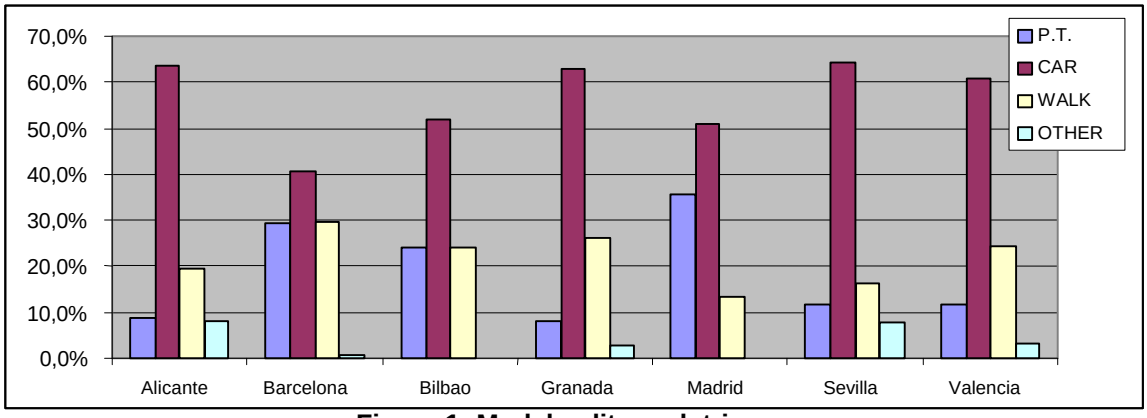

Figure 1: Modal split: work trips

Results from the study revealed that the traditional dense and compact morphology of Spanish cities haven't yet disappear, and walking trips maintain a significant share on the modal split for work trips. Nevertheless, evolution trend points to a decrease in the use of this mode over time. To highlight that the use of the bicycle is still very low in Spanish metropolitan areas, compared to European cities.

From this analysis we can infer that Spanish metropolitan areas provide a favourable framework to make promotion of the non-motorised modes of transport. For that purpose, decision-makers should develop supporting policies focusing on these modes. But Metropolitan Transport Authorities should get involved in the development of this kind of policies too, since non-motorised trips are usually one step in the public transport chain (specially if we consider walking, which is always one step in the public transport chain), and many times it determines the public transport mode chosen.

4.4.2.- Non-work trips

Considering non-work trips, modal split data collected revealed a significant decrease in the share of private car, and an important increase in the proportion of journeys made by walking. Results from this analysis suggest that leisure trips, shopping trips, etc. are usually made within a more reduced area from home. Nevertheless, as in the work trips, evolution trend points to an increase in the use of the motorised modes over time.

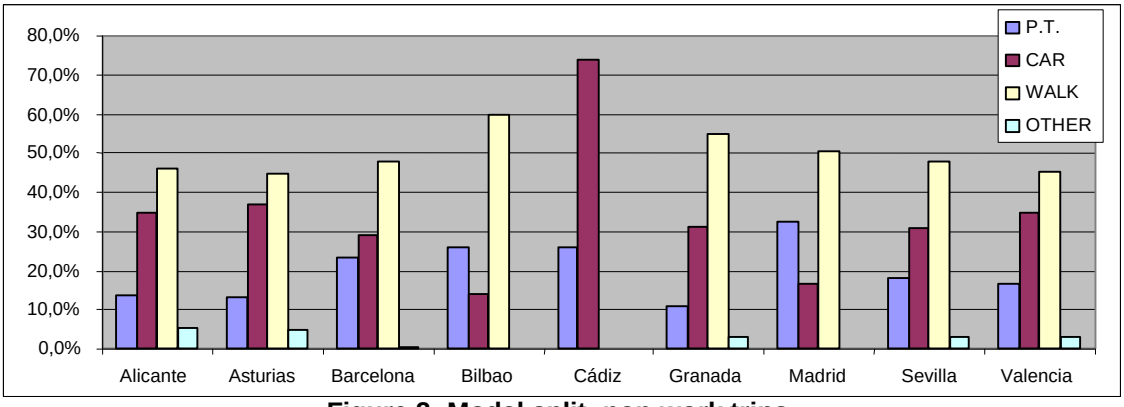

Figure 2: Modal split: non-work trips

4.2.3.- The role of public transport

Regarding the overall role of the public transport system, and of each mode in particular, it is mainly influenced by the size of the metropolitan area considered. The annual number of trips per habitant made by public transport modes show a big variation, ranging from 279 in Madrid to 64 in Málaga. Commute railroad services have a significant weight in big cities such as Madrid and Barcelona (13% and 18% respectively). The underground has a very important share in those metropolitan areas where it is present (with 45% of the total public transport trips in Barcelona made by this mode). But it is the high use of the bus system (either urban or suburban) what characterises most Spanish metropolitan areas – even in those ones featuring commuting railroad services too.

4.3- Mobility and urban environment

4.3.1.- Pollutant emissions

Motorised mobility is the main source of pollutant emissions which causes a severe damage to the air quality in our cities. The European Directive 1999/30/CE establish the threshold limit values for the number of times that the hourly or daily concentration of the main pollutants related to traffic (NO_2 and PM_{10}) can be exceeded:

- NO_2 - 1 hour concentration: no more than 18 times exceeded (by January 1st, 2010)
- PM_{10} - 24 hours concentration: no more than 35 times exceeded (by January 1st, 2005)

Data collected revealed that there is a big challenge to be faced regarding pollutant emissions in most Spanish metropolitan areas, in order to comply with the mentioned Directive:

Table 3: NO_2 hourly concentration excess

	Worst station		Number of stations exceeding more than 18 times
	Location	Number of times excess	
Alicante	-	0	0
Asturias	Palacio de Deportes	1	0
Barcelona	IH-Barcelona (Eixample) E1- Terrassa	10 10	0
Bilbao	Txurdinaga	1	0
Granada	Avda. de Cádiz	11	0
Madrid	Marqués de Vadillo	47	4
Málaga	-	0	0
Sevilla	Torneo	101	3
Valencia	Linares	161	1
Valladolid	Arco de Ladrillo II	12	0

Table 4: Pm_{10} daily concentration excess			
	Worst station		Number of stations exceeding more than 35 times
	Location	Number of times excess	
Alicante	El Plá	6	0
Asturias	Sama I	285	10
Barcelona	IC Escola Josep Pla	185	27
Bilbao	Dirección de Salud	59	1
Granada	Avda. de Cádiz	82	3
Madrid	Torrejón	180	24
Málaga	Hilera	122	1
Sevilla	Siderúrgica	207	7
Valencia	Vivers	9	0
Valladolid	Motores FASA	68	5

Almost every metropolitan area considered presents at least one pollutant emission measurement station which recorded higher excess values than the threshold limit value defined by the Directive for PM_{10} emissions (with the only exception of Alicante and Valencia). In addition, Madrid, Sevilla and Valencia are having the same problem with NO_2 emissions.

4.3.2.- Energy consumption and green-house gasses

Attempting to approximate energy consumption values, as well as green-house gasses (CO_2) emission levels, trends in fuel sales evolution were evaluated. The following table shows fuel sales variation between years 2000 and 2001 for the whole region in which each metropolitan area considered is located:

Table 5: Annual fuel sales variation (2000-20001)			
Region	**Gasoline**	**Diesel**	**Total**
Alicante	1,2%	6,9%	4,6%
Asturias	-6,0%	6,7%	3,0%
Barcelona	-3,7%	8,3%	3,5%
Bizkaia	-3,9%	1,5%	-0,2%
Granada	-0,1%	9,5%	6,3%
Madrid	2,4%	15,0%	9,7%
Málaga	-0,4%	15,5%	8,6%
Sevilla	-3,7%	5,6%	2,3%
Valencia	-4,7%	4,1%	1,4%
Valladolid	-5,0%	5,7%	2,3%
National average	-0,5%	7,8%	5,0%

Trends revealed by the analysis (5% average growth) point to a significant increase in motorised mobility by private vehicle, mostly due to increasing urban sprawl and motorization rates, as well as population growth.

Results regarding emissions and energy consumption evidence the need to develop more determined policies aimed to achieve a sustainable mobility, and more particularly to promote public transport and non-motorised modes.

4.2.3.- Accidentality

Another important aspect related to mobility and the urban environments is accidentality. Accidents in the whole region area for the metropolitan areas considered have been evaluated, differentiating those who take place in the urban context. Data collected revealed that 71% of the accidents in urban areas takes place within the 11 metropolitan areas considered. 51% of the deaths caused by this accidents takes place within these metropolitan areas too. To highlight that, while the private vehicle is involved in the vast majority of these accidents, accidentality in the public transportation system is comparatively insignificant.

4.4.- Financial aspects

4.4.1.- Coverage of operational costs

Looking at the rate of coverage of operational costs by fare revenues, the average coverage rate ranges from 50% to 75% of the total operational expenses of the public transport system. The rest of the costs are mainly covered by public subsidies, and to a less extend by publicity revenues in major metropolitan areas (reaching up to 87M€ and 19M€ for Madrid and Barcelona's urban transport system respectively).

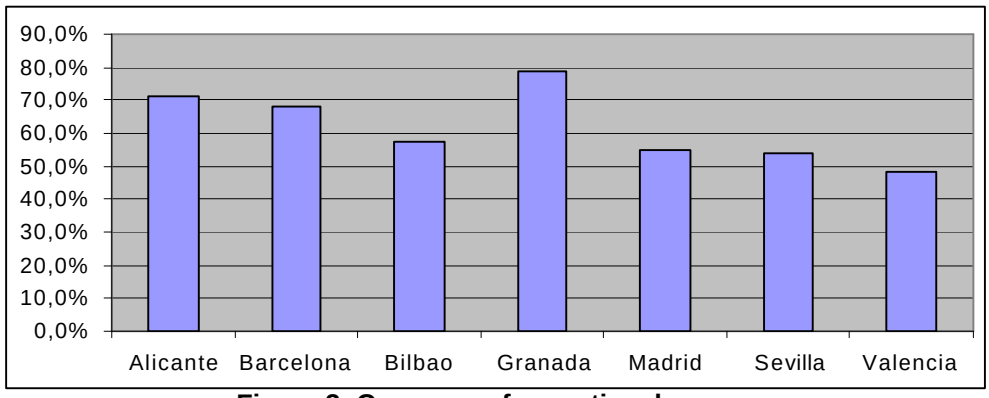

Figure 3: Coverage of operational expenses

4.4.2.- Fares

Most metropolitan areas surveyed have a wide range of tickets available, including discount tickets for youngsters or students (the age limit ranges from 21 to 26 years old, depending on the metropolitan area considered), and elderly people. These discount tickets represent a very important amount of resources that are being subsidized to favour these collectives (it is estimated that discounts sum up to 133M€ in Madrid).

Table 6: Public transport price compared to petrol price and parking fares					
Public transport fares and evolution (1995-2002)				1 hour parking fare	1 l petrol price
	Urban		Metropolitan		
	Single ticket	Monthly ticket	Monthly ticket		
Alicante	0,75 (-)	- (-)	- (-)	1,00 (-)	0,79 (23,0%)
Barcelona	1,00 (33,3%)	36,30 (34,9%)	52,30 (-)	1,60 (18,5%)	0,78 (21,5%)
Bilbao	0,81 (42,0%)	23,00 (27,6%)	27,50 (27,2%)	1,95 (68,1%)	0,82 (27,3%)
Granada	0,49 (26,9%)	- (-)	- (-)	1,00 (3,6%)	- (-)
Madrid	0,95 (26,7%)	32,30 (37,8%)	42,80 (39,0%)	1,70 (28,8%)	0,82 (27,3%)
Málaga	0,80 (-)	27,05 (-)	- (-)	1,20 (-)	0,80 (24,6%)
Sevilla	0,90 (29,0%)	26,00 (29,0%)	30,00 (-)	1,00 (-)	
Valencia	0,85 (77,1%)	29,50 (33,5%)	43,25 (2,8%)	1,50 (-)	0,79 (23,0%)

Public transport fares evolution revealed that they are growing faster than petrol prices and parking rates do, which means that current pricing policies are more attractive for private vehicle users than for public transport users.

In some of the metropolitan areas considered, public transport fares evolution also revealed that monthly ticket fares are growing faster that single ticket fares do, which means that current pricing policies in those metropolitan areas are not favouring the use of the public transport system with a regular basis.

4.5.- Investments and projects

The annual average investment in the public transport system (mostly infrastructure investment, and to a less extend fleet renovation and maintenance) along the last few years (1998-2002) show significant values for all metropolitan areas considered: 158€ per inhabitant in Madrid, 67€ in Barcelona, 56€ in Valencia or 46€ in Alicante.

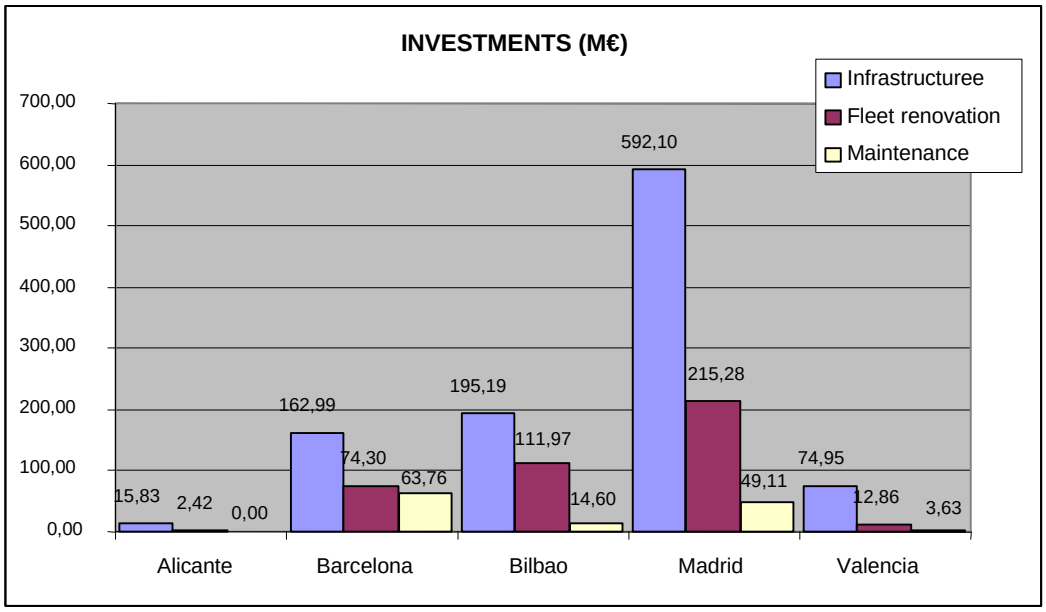

Figure 4: Annual average investment (1998-2002)

But major investments in new public transport facilities do not seem to be translated into significant changes in modal split, in terms of transferring private car users to public transport. In fact, these investments merely transfer public transport users from one mode to another. This general conclusion is, however, contested in some particular cases, where a number of conditions converge: corridors or links with previous poor quality services, lines where new public transport services have exclusive rights-of-way, key interchanges making transfers much easier… The many particularities in the cases identified suggest that transport investments should be much more planned and designed on a case-by-case basis.

4.6.- Public transport supply

4.6.1.- Public transport system density

The following table shows the public transport system density:

Table 7: Public transport density - I

	Railroad		Bus		Density
	Network length / 1000 inhab	Network length / km^2	Network length / 1000 inhab	Network length / km^2	Inhab/km^2
Alicante	0,331	0,368	1,936	2,154	1.113
Barcelona	0,147	0,203	1,481	2,051	1.385
Bilbao	0,173	0,088	5,863	2,969	2.372
Granada	-	-	1,856	0,962	518
Madrid	0,095	0,064	4,091	2,763	675
Málaga	0,083	0,054	2,585	1,681	650
Sevilla	0,081	0,101	1,096	1,366	808
Valencia	0,297	0,336	1,799	2,040	1.133

Data collected revealed that the more populated metropolitan areas present a denser railroad network, while the bus network density show more homogeneous figures (with the only exception of Madrid and Bizkaia, where the total region area was considered for this analysis).

Service provision indicators revealed that, in terms of vehicles-km, and moreover in terms of passengers-km, railroad supply is significantly higher than bus supply, due to the higher capacity of this mode:

Table 8: Public transport density - II

	Veh-km/inhab		Veh-km/km^2		Pax-km/inhab		Pax-km/km^2	
	Rail	**Bus**	**Rail**	**Bus**	**Rail**	**Bus**	**Rail**	**Bus**
Alicante	0,4	19,3	414	21.441	37	1.831	41.420	2.036.882
Barcelona	43,0	18,6	59.576	25.833	5.174	1.548	7.166.924	2.144.120
Bilbao	12,3	29,2	6.210	14.781	2.612	2.732	1.322.774	1.383.415
Granada	-	24,3	-	12.584	-	-	-	-
Madrid	42,0	44,1	28.341	29.811	5.745	3.259	3.880.807	2.201.146
Málaga	1,3	18,9	845	12.285				
Sevilla	0,7	21,6	577	17.422		2.048		1.655.137
Valencia	9,0	19,1	10.205	21.676	1.719	1.481	1.948.360	1.678.601

4.6.2.- Other public transport supply characteristics

Achieving an attractive and efficient public transport system requires the development of public transport priority schemes , allowing to bypass congestion and decreasing delays due to traffic flow inefficiencies. Most of the Spanish metropolitan areas surveyed have large BUS-ONLY lanes networks, but just a very small proportion of them are separate BUS-ONLY lanes:

Table 9: BUS-Only lanes network

	BUS-ONLY lanes (km)	
	Separate	**Non-separate**
Alicante	0	5,0
Barcelona	3,0	92,0
Bilbao	0	5,3
Madrid	17,8	93,8
Sevilla	3,1	11,2
Valencia	9,0	63,0

There is also a very small proportion of metropolitan areas that incorporate priority intersections for public transport in their public transport system. Where present, it is usually linked to the tramway service.

Public transport interchange stations are a very effective measure in promoting the use of public transport that is widely introduced in the public transport system in major Spanish metropolitan areas.

Park-&-Ride schemes are present in larger metropolitan areas.

Table 10: Park-&-Ride supply					
	Barcelona	**Bilbao**	**Madrid**	**Sevilla**	**Valencia**
Parking spots provided	8.000	250	17.129	3.000	1.672

4.6.3.- Quality of the public transport system

The accessibility to People with Reduced Mobility (PMR), as well as the emission rates of public transport fleet, are directly linked to the quality and sustainability of the system. The following table shows data collected regarding these two concepts for bus fleet:

Table 11: Bus fleet quality				
	Accessible for PRM buses (%)		**Low emission buses (%)**	
	Urban	**Suburban**	**Urban**	**Suburban**
Barcelona	53,5		7	0
Bilbao	41,0	29,0	2	0
Granada	-	-	-	0
Madrid	75,5	33,0	7,0	0
Sevilla	52,1	20,3		0
Valencia	59,6	9,6	0,6	0
Valladolid	16,1	-	-	0

Figures in table 11 reveal that urban fleet (mostly operated by municipal companies) reach higher quality levels than suburban services do. But there is still a big challenge for Spanish metropolitan areas to be faced.

5.- CONCLUSIONS

The research conducted under de Spanish Metropolitan Mobility Observatory framework revealed the great effort that Metropolitan Transport Authorities are making in order to improve the infrastructure and operation of their public transport systems. Results suggest that coordination of all public transport modes within one integrated system is a key element for the progress or maintenance of public transport share. Furthermore, reshaping existing transport services, avoiding competition among modes and encouraging convenient transfers, have proved to give clear results in terms of public transport patronage.

Foundations have been settled, but there is still a lot of work to be done. From the point of view of sustainability, existing strategies seem clearly insufficient to cope with major urban challenges, particularly in the field of the environment (air quality and pollutant emission trends in most metropolitan areas seem to challenge existing objectives), and car traffic (although curved in many city centres, continues exploding in the suburbs). New policies should be adopted to promote public transport and non-motorised modes; in which the key elements for action move from infrastructure investment to soft measures and travel demand management schemes; integrating environmental and sustainability objectives, and developing pricing policies coherent with those goals.

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